# NEUROPHYSIOLOGICAL MECHANISM OF ATTACHMENT STYLE: EVENT-RELATED POTENTIAL STUDY DURING FACIAL EXPRESSION PROCESSING

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NEUROPHYSIOLOGICAL MECHANISM OF ATTACHMENT STYLE: AN EVENT-RELATED POTENTIAL STUDY DURING FACIAL EXPRESSION PROCESSING

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**ABSTRACT**

NEUROPHYSIOLOGICAL MECHANISM OF ATTACHMENT STYLE:

AN EVENT-RELATED POTENTIAL STUDY DURING FACIAL

EXPRESSION PROCESSING

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Previous studies indicated attachment-related differences in emotional information processing. However, few studies investigated the neural correlates of emotional information processing in adult attachment. This study aims to investigate both behavioural and neural correlates of emotional information processing in adult attachment during interpretation and recognition of emotional faces (happy, angry and surprised). 39 participants completed self-reports (ECR-R, STAI, DERS and DASS) and also facial expression task including interpretation (Phase 1) and recognition (Phase 2) phases. Behavioural measures (response and RTs) and ERPs were recorded during the task. The amplitude and latency values of N100, P200, N200 and P300 at midline electrodes (Fz, Cz and Pz) were investigated for all responses in Phase 1 and for correct/incorrect responses in Phase 2. Additionally, during Phase 2, ERP analyses also focused on the FN400 peak at the same electrode sites.At neural level, the findings did not reveal statistically significant information processing differences among attachment groups during both phases of task but visual analysis of ERPs did. In Phase 1, attachment anxiety groups displayed larger N100 amplitudes to happy and angry faces over fronto-central sites and larger N200 amplitudes to angry and surprised faces over central locations, compared with attachment avoidance group. Surprised faces modulated larger N100 amplitudes at different electrode locations for each attachment groups. In Phase 2, attachment avoidance group displayed larger N100 and N200 amplitudes over midline locations in response to old angry and surprised faces, compared with attachment anxiety group. Old happy faces modulated larger N100 and N200 amplitudes at different electrode locations for each attachment group. At later stages, attachment anxiety group displayed larger FN400 amplitudes in response to all types of emotional faces. Also, the differences in FN400 latency were significant when attachment style interacted with emotion type, as reflected in a delayed FN400 latency to surprised faces for attachment avoidance and to angry faces for attachment anxiety. At behavioural level, attachment groups differed in the interpretation of emotional faces, regardless of valance of the stimuli. The findings indicated a positive-interpretation tendency in attachment avoidance and a negative-interpretation tendency in attachment anxiety to all types of emotional stimuli. In Phase 2, behavioural findings revelaed old/new emotional face differences in each group. Retrieval difficulties were found in attachment anxiety for happy and angry faces and attachment avoidance for all types of faces. The findings were discussed in in the context of secondary attachment strategies.

**Key words:** Adult attachment style, Event-related potentials, Emotional information processing, Interpretation bias, Memory bias

# ÖZ

YETİŞKİN BAĞLANMA STİLLERİNİN NÖROFİZYOLOJİK TEMELLERİ: YÜZ İFADELERİNİN İŞLENMESİ SIRASINDA OLAY-İLİŞKİLİ BEYİN POTANSİYELLERİNİN (OİP) DEĞERLENDİRİLMESİ

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Önceki çalışmalar, emosyonel bilgi işleme süreçlerinde bağlanma ile ilişkili farklılıklara işaret etmektedir. Fakat, az sayıda çalışma yetişkin bağlanmasında emosyonel bilgi işleme süreçlerinin nöral birleşenlerini incelemiştir. Bu çalışmanın amacı, yetişkin bağlanmasında emosyonel yüzlerin (mutlu, kızgın ve şaşırmış) yorumlanması ve hatırlanması sırasındaki bilgi işleme süreçlerinin davranışsal ve nöral bağlantılarını incelemektir. 39 katılımcı, kendini değerlendirme ölçeklerini (ECR-R, STAI, DERS ve DASS) ve yorumlama (Aşama 1) – tanıma (Aşama 2) aşamalarını içeren yüz ifadeleri testini tamamlamıştır.Test sırasında, davranış (tepki ve tepki süresi) ve olay-ilişkili potansiyellerin (OİP) ölçümleri alınmıştır. N100, P200, N200 ve P300 zirvelerinin genlik ve latans değerleri orta hat elektrot alanı (Fz ve Cz and Pz) için birinci aşamadaki tüm tepkiler ve ikinci aşamadaki doğru ve yanlış tepkiler altında incelenmiştir.Ek olarak,ikinci aşama sırasında,aynı elektrot alanındaki

FN400 zirvesi de incelenmiştir. Bulgular, her iki aşama sırasında, bağlanma grupları arasında nöral düzeyde istatiksel olarak anlamlı bilgi işleme farklılığına işaret etmemiştir. Ancak, görsel ÖİP analizleri bu farklığı göstermiştir. İlk aşamada, kaygılı bağlanma, kaçıngan bağlanma grubuyla karşılaştırıldığında, mutlu ve kızgın yüzlere karşı fronto-central alanlarda daha büyük N100 genliği ve ilerleyen süreçlerde kızgın ve şaşırmış yüzlere karşı central bölgelerde daha büyük N200 genliği göstermiştir. Şaşırmış yüzler ise her bir bağlanma grubu için farklı elektrot lokasyonlarında olmak üzere büyük N100 genliği yaratmıştır. İkinci aşamada, kaçıngan bağlanma, kaygılı bağlanma grubuna göre, orta hat elektrot alanında önceden gösterilen kızgın ve şaşırmış yüzlere daha büyük N100 ve N200 genlikleri göstermiştir. Daha önce gösterilen mutlu yüzler ise her iki bağlanma grubu için farklı elektrot alanlarında büyük N100 ve N200 genlikler ortaya çıkarmıştır. İlerleyen süreçlerde ise, kaygılı bağlanma grubu tüm emosyonel yüzlere daha büyük FN400 genliği göstermiştir. FN400 latans farklılıkları, bağlanma grubu emosyon türü etkileşimdeyken anlamlıdır. Kaçıngan bağlanma grubunda şaşırmış yüzlere ve kaygılı bağlanma grubunda ise kızgın yüzlere karşı geçiklemeli FN400 latansı bulunmuştur. Davranışsal düzeyde, bağlanma grupları emosyonel yüzlerin yorumlanmasında emosyonel değerlik farkı olmaksızın ayrışmış; kaçıngan bağlanma grubunda positif yorumlama ve kaygılı bağlanma grubunda ise negatif yorumlama eğilimi bulunmuştur İkinci aşamada ise, her bir bağlanma grubunda eski/yeni emosyonel yüz farklılıkları ortaya çıkmıştır. Kaygılı bağlanma grubunda mutlu ve kızgın yüzler ve kaçıngan bağlanma grubunda ise tüm yüz uyaranlarına karşı geri çağırma zorlukları bulunmuştur. Bulgular ikincil bağlanma stratejileri çerçevesinde tartışılmıştır.

***Anahtar kelimeler:*** Yetişkin bağlanma stilleri, Olay-ilişkili potansiyeller, Emosyonel bilgi işleme, Yorumlama yanlılığı, Bellek yanlılığı

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AAI: Adult Attachment Interview

ECR: Experiences in Close Relationship Scale

ECR-R: Experiences in Close Relationship Scale

ERPs: Event-related Potentials

IWMs: Internal Working Models

LPC: Late Positive Component

LTM: Long-term Memory

RQ: Relationship Questionnaire

RSQ: Relationship Styles Questionnaire

RTs: Reaction Times

# CHAPTER 1

# INTRODUCTION

## 1.1 Theoretical Perspectives on Attachment: Key Concepts of Attachment

Adult attachment theory derives from John Bowlby's seminal work (1969/1982) on infant attachment to their primary caregiver. In Bowlby's theoretical framework (1969/1982; 1973), infants are born with biological predisposition (attachment behaviour system), motivating themselves to seek and maintain proximity towards their *attachment figure* in times of need and threat. To illustrate, any real or perceived situations that threaten emotional bonds activate attachment behaviour system by manifesting attachment behaviours (e.g crying or clinging) in order to re-establish proximity and maintain emotional bond (Mikulincer & Goodman, 2006). In such cases, the proximity-seeking has been considered as a *primary attachment strategy* of attachment system that serves to protect a human from physical and psychological threats and to alleviate distress (Mikulincer & Shaver, 2007). Moreover, as attachment theorists emphasized, a successful accomplishment of this affect-regulation mechanism (e.g feeling relived and secure when infant regained safety and obtained proximity to his/her attachment figure) facilitate development of a sense of attachment security: that one is worthy of love and receiving care; that caregiver will physically and emotionally available, rresponsive and supportive in times of need. On the other hand, negative attachment experiences, such as lack of caregiving support in times need, lead to a sense of attachment insecurity.

Early attachment interactions with primary caregiver are stored as mental representations of self and others, which Bowlby (1973) called *Internal working models (IWMs)*. These working models of attachment are dynamic mental representations that continue to evolve throughout life-span (Bowlby, 1973) and that provide a basis for other mental representations of particular relationships such as romantic relationships (Mikulincer & Shaver, 2007). Attachment theorists (Bowlby, 1973; Mikulincer & Shaver, 2007) and also researchers (Pietromonaco, Beck & Lindsey, 2015) emphasize that IWMs are guided by individuals' beliefs and expectations concerning whether attachment figure will be available, emotional and responsive and whether the self is worthy of receiving such care. For instances, experiences with attachment figures, who are available and sensitive responsive in times of need, develop a stable sense of attachment security involving positive representations of both self (e.g a sense of worthy of love; a sense of self-efficiency to deal with threats) and others (e.g world is safe and trustworthy). On the other hand, experiences with attachment figures, who are unavailable or exhibit unpredictable responses in times of need, are internalised as negative mental representation of self and others and that leads to a sense of attachment insecurity. Thus, in order to regulate their emotions (such as alleviating distress), infants tend to use *secondary attachment strategies* (Cassidy & Kobak, 1988): *hyperactivation vs.*

*deactivation*. *Hyperactivating strategies* derive from experiences with attachment figures who exhibit inconsistent or unpredictable responses to child's needs. These strategies are associated with excitatory pathways that elicit to an enhanced monitoring of any threats to self and others (i.e attachment-figure-unavaliability) (Shaver & Mikulincer, 2002). Thus, individuals, who adopt to hyperactivating strategies, remain constantly vigilant against possible threats or any concerns on attachment figure's availability and support (Mikulincer & Shaver, 2006). Also, these strategies reflect themselves as an exaggeratation of threat or threat-related cues, mental ruminations and self-blame (Mikulincer & Shaver,2007). Other secondary attachment strategy is *deactivating strategies* that stem from interactions with caregiver, who are internalised as unavailable and/or unresponsive to one's need. This secondary attachment strategy involves inhibitory patways (Shaver & Mikulincer, 2002) and aims to keep the attachment system deactivated in order to protect individuals from intense negative emotions inducing attachment-figure-unavalibility (Mikulincer, Shaver & Pereg, 2003). Therefore, *deactivating strategies* involve denial of attachment needs, minimization of proximity, suppression of attachment-related thoughts and striving for emotionally and physically distance manner (Fraley, Garner, & Shaver, 2000; Mikulincer & Shaver, 2006, 2012).

Based on these individual differences in the functioning of attachment system, attachment theorists (Bowlby, 1969/1982; Fraley & Shaver, 2000) have focused to define *attachment styles,* which refers to "the systematic pattern of relational expectations, emotions, and behaviour that results from a particular history of attachment experiences" (cited in Shaver & Mikulincer, 2002). In attachment literature, the studies on classifications of adult attachment style derive from Ainsworth's (1978) work on observations of infants' reactions to separations and reunions with mothers. In a study using Strange Situation paradigm, Ainsworth (1978) identified three attachment styles: *secure, anxious/ambivalent* and *avoidance. Secure* infants displayed active exploration of the environment and proximity-seeking, as indication of distress at separation episode, and then easily soothed on reunion. On the other hand, *anxious/ ambivalent* infant displayed a heightened separation distress at separation and ambivalent behaviours when proximity is gained after separation episode. *Avoidant* infants exhibited little separation distress and limited attempts to seek proximity and interact with caregiver during separation and ignorance the caregiver return. Ainsworth's (1978) conceptualization of attachment differences has inspired researchers to propose attachment assessment models for adults. These assessments could be defined into two basic categories: narrative-based assessment and self-reports.

Narrative-based assessment such as *Adult Attachment Q-sort* (AAI Q-sort, Kobak et al.,1993) and *Adult Attachment Interview* (AAI; George et al.,1996) are designed to examine attachment styles on implicit paradigm, assuming that mental representations may not be always consciously accessible as a consequence of maladaptive strategies. For instances, Main and colleagues (George, Kaplan, & Main, 1985; Main & Goldwyn, 1994) defined four attachment styles, which are *secure, insecure-dismissing, insecure-preoccupied* and *unresolved/disorganised*, by developing *AAI*, a semi-structured clinical interview, that examines interviewee's state of mind concerning attachment relationship. Interviewees are asked to provide descriptions of their childhood relationship with their parents and to provide specific memories in support of these descriptions. From Main and colleagues' perspectives, secure state of mind is characterised by a well-organised, direct and fluid manner in which general descriptions of early attachments are openly expressed with coherent specific examples. On the other hand, *insecure-dismissive* state of mind is represented with minimising the importance of attachment relationships and/or idealizing painful experiences with limited coherent examples. Difficulties in accessing childhood memories is also commonly seen in *insecure-dismissing* state of mind. Insecure-preoccupied state of mind is characterised by incoherent descriptions and confusion about memories by using long sentences with none-sense words, psychological jargon and/or childlike speech. *Unresolved/disorganised* state of mind has been considered to be shaped through adverse life experiences such as a significant childhood separation, loss and trauma Therefore, lapses in reasoning, extremely long slience and dissociative episodes are characterised as unresolved/ disorganised.

On the other hand, some researchers (Brennan, Clark & Shaver, 1998; Bartholomew & Horowitz, 1991; Fraley, Waller & Brennan, 2000; Hazan & Shaver, 1987) have proposed several models to define individual differences in attachment style, using the self-report measures. In general, self-report measures grounded on explicit assessment by examining individuals' cognitive, behavioural and emotional responses within romantic or other close relationships. Based on Ainstworth's (1979) description of attachment style, Hazan and Shaver (1987) proposed a threefold typology of adult attachment on Adult Attachment Scale (ASS): *Secure, Avoidant and Anxious/Ambivalant.* In contrast to Hazan and Shaver's (1987) categorical model, Bartholomew and Horowitz (1991) proposed a fourfold typology of adult attachment derived from positive and negative poles/axes of two dimensions that involve view of self and view of others. On Relationship Questionnaire (RQ; Bartholomew & Horowitz, 1991), four attachment style are described: *Secure*, *Dismissing-avoidant*, *Preoccupied* and *Fearful-avoidant*. Secure attachment style is represented with positive models of both self and others. Dismissing avoidant attachment refers to positive view of self and negative view of others that is portrayed as a having sense of worth of love combined with a rejection from others. In contrast to pattern of dismissing attachment style, negative view of self and positive view of others refers to *preoccupied* attachment style that is described as a having a sense of unworthiness and having a positive evaluation of others. Individuals with preoccupied attachment style seek to closeness with other but they consider themselves as unworthy of love. In addition to these attachment styles, negative views of both self and others refers to *fearful-avoidant* attachment style that is described as having a sense of unworthy of love and untrustworthy of others.

However, in recent years, individual differences in *adult attachment* are conceptualised into two-dimensional construct (Brennan, Clark & Shaver, 1998; Fraley, Waller & Brennan, 2000): *attachment anxiety and attachment avoidance*. Based on the studies employing Experiences in Close Relationship Scale (ECR; Brennan, Clark & Shaver, 1998) and Experiences in Close Relationship Revised Scale (ECR-R; Fraley, Waller & Brennan, 2000), low levels on both dimensions has been represented with secure attachment style. On the other hand, *Attachment anxiety* refers to low levels of avoidance and high level of anxiety. Individuals with attachment anxiety tend to lean toward hyperactivating strategies by displaying a persistently seeking proximity, a strong need for approval from others and a vigilance to abonnement and/or rejection (Mikulincer & Shaver, 2007). On the other hand, low level of anxiety and high level of avoidance has been defined as *attachment avoidance.* Individuals with attachment avoidance tend to use deactivating strategies by denying their attachment needs, displaying low level of intimacy and emotional involvement and striving for their independence in their relationships (Mikulincer & Shaver, 2007).

## 1.2 An Attachment-Theoretical Perspective on Information Processing

Attachment theorists (Bowlby, 1969/1982,1973; Main et al., 1985; Baldwin, 1992) and researchers (Dykas & Cassidy, 2011) enlighten the influential mechanism of attachment experiences on information processing, based on IWMs of attachment. The main assumption is that IWMs guide how individuals attend to, encode, interpret and recall attachment-related information (Dykas & Cassidy, 2011; Dykas, Ehrlich & Cassidy, 2010; Dykas et al., 2014; Pietromonaco & Barret, 2000). Thus, *IWMs, a*s a core concept of attachment theory, provide a broad perspective to understand how early experiences form individual differences in the functioning of attachment system across life-span and also to evaluate how these experiences influence emotional or attachment-related social information processing.

As mentioned earlier, IWMs are mentally internalised representations of self and significantly others, deriving from early experiences with attachment figures. These mental representations guide individuals' expectations and also beliefs concerning whether attachment figures will be available, emotional responsive and whether the self is worthy of receiving such care (Bowlby, 1973; Mikulincer & Shaver, 2007). However, extending Bowlby's concept of IWM, a number of attachment theorist (Main et al., 1985; Baldwin, 1992) reconstructed IWMs on cognitive domain. From this perspectives, IWM is regarded as "a set of conscious and/or unconscious rules for the organization of information relevant to attachment and for obtaining or limiting access to that information, that is, to information regarding attachment-related experiences, feedings and ideations" (cited in Main et al., 1985, p. 67). Thus, individuals are assumed to carry out rules based on their attachment orientated internal working models (either secure or insecure) while processing social or attachment-related information. And, such variations on rules manifest themselves in different cognitive aspects of information processing such as attention, encoding and interpretation (Dykas & Cassidy, 2011).

Several approaches on information processing have been proposed in recent years to enlighten a question: what sort of rules or strategies are individuals prone to use when social or attachment related information is encountered? One of the dominant approach is that individuals may display defence mechanisms to prevent re-experiencing emotional distress by filtering out social information from their conscious awareness (Bowlby, 1980; Mikulincer et al., 2009). This notion derives from Bowlby's (1980) concept of *defensive exclusion* which refers to an information processing capacity to block or supress potentially emotionally painful information from conscious awareness when attachment system is activated. In Bowlby's view (1980), social or attachment-related information, especially negative ones, may activate attachment system of individuals with insecure attachment orientation. In this case, in order to soothe activation of attachment system, insecure IWMs of attachment are functioning in three forms of defensive exclusion (Bowlby, 1980): (1) *deactivation* (2) *disconnection (3) segregated system.* Deactivation occurs at initial perceptual level (George & West, 2012) and serves to prevent individuals from distressing information that would enter their conscious awareness (George & West, 2011). Individuals deactivate potentially distressing information by shifting attention away from or limiting access to information (Dykas & Cassidy, 2011). As another form of defensive exclusion process, cognitive disconnection is related to conscious awareness of attachment activation that functions to disconnect emotional distress from true source by redirecting attention away from it (Bowlby, 1980). In addition to this, as a severe way of defensive exclusion process, *segregated system* works to segregate or block traumatic related attachment material from conscious awareness in order to extremely painful thought and feelings (Bowlby, 1980; George & West, 2001, 2011).

In addition to the Bowlby's (1980) concept of *defensive exclusion,* Fraley, Garner and Shaver (2000) describe two forms of deactivating strategies on cognitive level: *preemptive* and *postemptive* defensive strategies. Preemptive defensive strategies involve motivated inattention and serve to limit the amount of information that potentially induce distress at the encoding level. Through *preemptive strategies*, individuals avoid and withdraw from stimuli or experiences that evoke pain and threat. *Postemptive defensive strategies*, on the other hand, are used to minimize activation of information that has been already encoded through suppression and repression. Thus, individuals who adopt to *postemptive defensive strategies* remove information from their awareness to defend against its effects. The approach of Fraley, Garner and Shaver (2000) has been received considerable empirical support (Andriopoulos & Kafetsios, 2015; Fraley & Brumbaugh, 2007 (*see part 1.3.1)*; Zhai et al., 2016 *(see part 1.5)*) for cognitive processes of attachment avoidance.

On the other hand, other attachment theorists asserted that attachment system may not be always activated when social or attachment related stimuli is encountered (Dykas & Cassidy, 2011). In such case, individuals process social or attachment related information in *schematic-driven processing* manner based on their previously obtained attachment-related experiences (Dykas & Cassidy, 2011). For instance, individuals with secure attachment tend to process social or attachment-related information in positively biased manner based on previously positive experiences (e.g caregiver sensivity and emotionally responsiveness). However, individuals with insecure attachment tend to process social or attachment-related information in negatively biased manner due to previously negative attachment-related experiences.

## 1.3 Behavioural Evidence for Emotional Information Processing in Adult Attachment

### 1.3.1. Behavioural mechanism underlying Attachment-related Differences in Memory

A considerable body of research on memory and attachment (Edelstein, 2006; Edelstein et al., 2005; Fraley et al., 2000; Fraley & Brumbaugh, 2007; Mikulincer & Orbach, 1995) demonstrated attachment-related differences in memory, indicating the role of secondary attachment strategies on cognitive processes. There is also an increasing evidence (Edelstein, 2006; Fraley et al., 2000; Fraley & Brumbaugh, 2007) suggesting that memory deficits in attachment avoidance may derive from encoding or attentional process. For instance, Fraley et al. (2000) examined memory mechanism of individuals with different attachment styles using forgetting paradigm. Memory performance was assessed either immediately following presentation or after a delay ranging up to 3 weeks. Participants were asked to listen a recorded interview involving attachment-related themes such as intimacy and loss of a loved one. And then, a surprise recall test was given by asking them to answer questions concerning details of the interview. Significant findings were found for attachment avoidance, not for attachment anxiety. Participants with high avoidance displayed difficulties in recalling details, compared to participants with low avoidance, regardless of the length of retention interval. As the findings revealed, individuals with attachment avoidance appear to keep attachment-related stimuli out of their awareness or memory when such stimuli were encountered. Therefore, these findings come to conclusion that individuals with attachment avoidance tend to be less attentive to attachment-related stimuli and encode them less, in line with preemptive defensive strategies.

Fraley and Brumbaugh (2007) also suggested that individuals with attachment avoidance may pursue pre-emptive defensive strategies by minimizing their attentional resources for attachment-related information and excluding information at encoding phase. In their study (Fraley & Brumbaugh, 2007), participants, who were assessed with Relationship Styles Questionnaire (RSQ; Griffin & Bartholomew, 1994), listened a recorded interview involving attachment-related themes such as intimacy and separation. And then, implicit (fragment-completion task) and explicit memory (cued recall test) tests were given to complete. It was found that individuals, who had high level of attachment avoidance, showed poor recall performance on both implicit and explicit memory test. This finding indicated pre-emptive defensive strategies underlying limited attention and encoding process in attachment avoidance.

Several researchers that examined LTM performance in adult attachment emphasized significant memory difficulties in recalling emotional and/ or attachment-related experiences among individuals with attachment avoidance (Edelstein et al., 2005; Mikulincer & Orbach, 1995) and heightened accessibility in recalling emotional and/ or attachment-related experiences among individuals with attachment anxiety (Mikulincer & Orbach, 1995). In a study by Mikulincer and Orbach (1995) investigating attachment related differences in autobiographical memory for emotional personal experiences, participants, who were assessed with Hazan and Shaver (1987)'s threefold typology of adult attachment, were asked to recall early personal experiences involving happy, sad, angry and anxious themes and to rate emotional intense of these experiences. As an evidence of cognitive suppression, researchers found that participants with attachment avoidance displayed poor memory performance in recalling negative emotional experiences (i.e sadness and anxiety themes) with longest recall latencies. Also, they displayed least intense emotionality to such memories. On the other hand, as an evidence of hypervigilance, participants with attachment anxiety, in other words insecure anxiety/ambivalence, displayed better accessibility to such memories with short recall latencies and reported high emotional intensity to such memories. Consistent with Mikulincer and Orbach' s (1995) findings, a recent study (Edelstein et al., 2005), investigating attachment related differences in long-term memory for negative emotional experiences among childhood abuse survivors, also indicates memory difficulties in attachment avoidance. Researchers, who used RQ for assessment of attachment style, found that participants with attachment avoidance displayed less accuracy in recalling of negative life-experience details. However, attachment anxiety was found to be unrelated to memory accuracy.

Additionally, in a study investigating working memory capacity for attachment-related and non-attachment-related stimuli, Edelstein (2006) similarly found that attachment avoidance is related to poor working memory capacity for both positive and negative attachment-related words. In terms of their findings, they suggested that memory difficulties in attachment avoidance may due to defensive strategies that lead to devoting limited attentional resources for attachment-related stimuli. On the other hand, their findings revealed that attachment anxiety was not related working memory performance.

In sum up, the research reviewed above, indicate individuals with attachment avoidance have difficulties in retrieving attachment-related information due to defensive strategies, especially pre-emptive based defensive strategies. Fraley and colleagues (2000, 2007) argue that retrieval difficulties in attachment avoidance may derive from attention and/or encoding processes. However, their methodologies may not be convenient to examine directly attentional and encoding processing of attachment-related information. In this regard, studies on attention may provide further evidence to enlighten the mechanism underlying information-processing patterns in attachment avoidance for attachment-related information. On the other hand, a theoretical notion that individuals with attachment anxiety may display an enhanced memory performance for emotional and attachment related information in line with hyperactivation strategies has received little support (e.g Mikulincer & Orbach, 1995). In addition to this, some studies (Edelstein, 2006; Fraley et al., 2000; Fraley & Brumbaugh, 2007) suggest that there is no effect of attachment anxiety on memory.

### 1.3.2 Behavioural mechanism underlying Attachment-related Differences in Interpretation of Emotional or Attachment-related Information

Several studies (Collins, 1996; Collins & Feeney, 2004; Zhang & Hazan, 2002) on attachment has highlighted that attachment style affects the way individuals interpret emotional or attachment-related events and others' behaviours. In particular, a notion that individuals with insecure attachment, either anxiety or avoidance, tend to have negative inferences and interpretations concerning others' attitudes or reactions has received empirical support (Collins, 1996; Collins & Feeney, 2004; Collins et al., 2006; Gallo & Smith, 2001; Pearce & Halford, 2008). For instance, in the study by Collins and Feeney (2004, Study 1), participants were given to notes involving either more or less support content. Insecure individuals, both anxious and avoidant, are prone to evaluate the ambiguously support messages in negative fashion, compared to secure individuals. However, on highly supportive content, insecure and secure attachment groups did not differ from each other. In addition to the evidence of attachment anxiety, negative interpretation or attributions that individuals with attachment anxiety, are also influenced by contextual factors (e.g mood or feeling of support in the relationship) as some researchers (Gillath et al., 2016) stated. Pereg and Mikulincer (2004) conducted mood induction study (Study 2), assigning participants randomly to either negative mood condition and neutral mood condition in which participants were given a story about either a fatal accident or a developmental of kite respectively. And then, attributions of a scenario involving negative attachment-related theme concerning hypothetical partner were assessed. Participants with high level attachment anxiety in negative mood condition displayed negative attributions concerning hypothetical partner's behaviour, compared to participants in neutral mood condition. Based on the finding, researchers indicated that negative affects elicited more stable and global attributions for individuals with high level of anxiety while interpretating a negative event.

More evidence for interpretation differences in adult attachment arises from the studies using explicit rating scales of valance, pleasantness and arousal for emotional stimuli. In recent study by Vrticka, Sander and Vuilleumier (2012), participants were asked to rate emotional images (social and non-social content) by employing the scales of pleasantness (from very negative to very positive), arousal (from low to high) and control (from absence of control to presence of control). Participants with attachment avoidance reported reduced pleasantness rating for positive social images in consistent with deactivating strategies in attachment avoidance. On the other hand, participants with attachment anxiety reported higher arousal for emotional images in general, negative social images in particular, and low controllability for negative social images. Researchers suggested that individuals with attachment anxiety appears to employ hyperactivating strategies during appraisal of threatening information but also these individuals experience ambivalence while making judgments concerning positive and negative information. Also, Meyer (2010) examined the perception of facial expressions in adult attachment by employing emotion perception task in which participants were asked to identify each emotional face in terms of four mental state descriptors such as contemplative, suspicious, amused, annoyed. At judging negative emotional faces, dismissive participants displayed a lower accuracy whereas preoccupied participants displayed an enhanced accuracy. According to researchers, the differences in perception accuracy for negative emotional faces reflect a bias, in our words interpretation bias, for dismissive and preoccupied individuals.

In addition to these studies, the evidence coming from studies that examine perceptual processing of emotional information may bring additional insight to understand interpretation differences in adult attachment. Some studies (Maier et al., 2005; Niendenthal et al., 2002) suggest that individuals with attachment avoidance exhibit increased perceptual vigilance to emotional stimuli, indicating their findings that reveal lower perceptual thresholds for emotional stimuli. In Maier et al.'s (2005) study, participants who were assessed with AAI, were asked to identify the content of morphed emotional images. Dismissive participants displayed lower identification threshold for emotional images inducing facial expressions and social interactions as an indication of heightened perceptual vigilance for such stimuli. On the other hand, there is some evidence that perceptual vigilance for emotional stimuli could be observed for individuals with attachment anxiety. A study in which participants, assessed with ECR-R, were asked to detect emotional faces (happy, sad, angry and neutral) on movie at the point where facial expressions gradually changed another one (e.g emotional to neutral or neutral to emotional), Fraley et al. (2006) found that individuals with high attachment anxiety detect both onset and offset of positive and negative emotion quickly compared to individuals with less attachment anxiety. However, no significant differences were found for attachment avoidance.

Taken together, attachment studies on emotion perception indicate different cognitive processes guided by secondary attachment strategies in interpretation of emotional information such as facial expression, emotional image and etc. However, further research is needed by employing direct measures for interpretation of emotional or attachment-related stimuli among individuals with different attachment style.

## 1.4 Neurophysiological Evidence for Emotional Information Processing in Normative Populations

### 1.4.1 ERP Correlates of Emotional Information Processing in Normative Populations

In this study, ERPs were measured under interpretation and recognition of emotional faces (happy, angry and surprised faces). Therefore, in the following section, ERP studies on emotional information processing are discussed.

Event-related potentials (ERPs) provide excellent temporal precision and resolution in measuring the neural activity underlying information processing, as a useful non-invasive methodology (Hillyard & Anllo-Vento, 1998; Nelson & Luciana, 2001). ERP waveforms consist of a series of positive (P) and negative (N) voltage deflections which are time-locked to stimulus onset (Luck, 2014). These fluctuations in ERP waveform polarity are considered as a manifestation of specific cognitive processes such as attention, perception and memory. Previous electroencephalographic studies have demonstrated that emotional information has been processed by starting with early ERP modulations of brain activity (e.g 80/100 ms approx.) after stimulus onset (Pizzagalli et al., 1999; Eimer & Holmes, 2002). P100 and N100 are initial neural indexes of emotional information processing in the visual cortex (Brown et al., 2012; Olofson et al. ,2008).) These indexes are induced by physical properties of stimulus (Olofson et al., 2008) and are considered to reflect automatic mechanism of selective attention (Dennis et al., 2009). Specifically, P100 is a positive deflection peaking around 80-130 ms after stimulus onset. Previous studies (Dennis et al., 2009; Hillyard et al., 1999; Magnun & Hillyard, 1995; Vogel

& Luck, 2000) showed that attended stimuli elicited enhanced P100 compared to stimuli that were unattended. According to Luck et al. (2006, 1995) reduced P100 to unattended stimuli is indication of attention suppression. In addition to this, there are some research indicating differences in P100 amplitude in terms of content of stimuli such as pleasant vs. unpleasant and emotional vs. neutral. However, studies on P100 present inconsistent findings. For example, some researchers suggested that unpleasant pictures (Smith et al., 2003; Delplanque et al., 2004) or faces (Chammat et al., 2010; Luo et al., 2010; Pourtois et al., 2014; Williams et al., 2006) elicited a larger P100 than pleasant and/or neutral ones. However, others suggested enhanced P100 to emotional, both pleasant and unpleasant, pictures (Carretie ́et al., 2004) and faces (Batty & Taylor, 2003; Esslen et al., 2004) compared to neutral ones.

N100 is a negative deflection that peaks approximately 100 ms after stimulus onset (Fornayova Key et al., 2005). N100 reflects attentional process, as mentioned above, and several studies emphasized that N100 is sensitive to content of emotional stimuli. Williams et al. (2006) found fearful and happy facial expressions elicited more N100 amplitudes, compared to neutral ones. More recently, a study of Luo et al. (2010) revealed enhanced N100 in response to fearful facial expressions compared to neutral and happy facial expressions. On the other hand, Eimer and Holmes (2002) suggested no sensivity of N170 toward fearful facial expressions, demonstrating evidence of a more negativity to neutral compared to fearful facial expressions.

In addition to these, positive deflection peaking around 150-275 ms after stimulus onset refers to P200 (Carretie ́et al., 2004) that is assumed to be index of attention related processing which reflects detection of visual properties at the perceptual stage of information processing and responsible for structural coding of facial information that would allow the configural face representations (Luck and Hillyard, 1994; Thomas et al., 2007; Zhu et al., 2015). Also, P200 is assumed to be sensitive to content of emotional stimuli as some researchers (Carretié et al., 2004; Carretié et al., 2001; Delphanque et al., 2004; Eimer & Holmes, 2007; Herbet et al., 2006; Huang & Luo, et al., 2006; Zhu et al., 2015) demonstrated. For example, a study by Zhu et al. (2015) in which participants were asked to interpret emotional images in terms of valance (positive, negative and neutral) and judge the gender of person on emotion image indicated a greater P2 amplitude to emotional pictures compared to neutral ones. More specifically, Huang and Luo (2006) found negative emotional pictures modulated a larger P200 amplitude than positive emotional pictures, suggesting attentional negativity bias which occurs at early stages of information processing during emotion perception. On the other hand, Yuan et al. (2007) presented contradict findings by finding no differences in P2 amplitudes between emotional and neutral pictures.

N200 is a negative-going wave that peaks 200-350 ms post-stimulus and is found primarily over anterior scalp sites. N200 is believed to sensitive to arousal level of stimulus (Olofson et al., 2008; Eimer et al., 2007) and reflect stimulus identification (e.g. face versus non-face stimuli, and upright versus inverted faces) and differentiation (e.g. categorization) (Olofson et al., 2008; Patel & Azzam, 2005). Also, N200 is related to response inhibition, response conflict and error monitoring and sensitive to detection of perception novelty or attentional deviation (Patel & Azzam, 2005). The N200 has been previously suggested to indicate participants' cognitive control or response monitoring processes during effortful tasks (for a review, see Folstein& van Petten, 2008). In a study by Lithari (2009) asked participants to rate emotional images in terms of valance and arousal, the findings revealed that unpleasant images elicited greater N200 negativity relative to pleasant ones. In addition to this, several studies (Balconi & Pozzoli, 2003; Sato et al., 2001) suggest emotional-face specificity of N200. Sato et al. (2001) reported an enhanced negative peaking around 270 ms over posterior temporal sites for fear and happy compared to neutral facial expressions. More recently, Balconi and Pozzoli (2003) compared to different facial expressions (happiness, sadness, anger, fear and surprise) and they found increased N250 amplitudes in response to high arousal negative facial expressions (anger, fear and surprised) relative to positive (happy) and low arousal (sadness) expressions. Yet, Hermann et al. (2002) found no emotion specific ERP effects for sad, happy and neutral facial expressions.

P300 is a negative deflection peaking between 300 and 500 ms after stimulus onset (Hajcak, 2011) that involves two subcomponents: P3a and P3b (Polich, 2007). P3a is thought to reflect to frontal attentional mechanism modulated by stimulus context such as non-target or deviant stimulus (Polich, 2007). On the other hand, P3b is assumed to reflect allocation of attentional resources (Johnson, 1988; Polich, 2007) and activation of memory processes (Polich, 2007; Kaestner & Polich,2011). For example, Kaestner and Polich (2011) examined emotional information processing in healthy subjects during emotion recognition task. Participants were asked to recognised previously seen (target stimuli) and novel emotional images as accurately and rapidly as possible, pressing a button. Their findings revealed that high-arousal unpleasant target images elicited greater P300 positivity, suggesting that attentional resources engaged by motivational factors, such as arousal levels of stimuli, boost memory-related processing of information. In line with Kaestner and Polich’ s (2011) study, Polich (2007) emphasized that enhancement of P300 amplitude is reflection of retrieval and recognition processes which derive from successful encoding and memory storage.

### 1.4.2 ERP Correlates of Retrieval of Emotional Information in Normative Populations

Increasing evidence (Righi et al.2012; Schaefer & Philippot, 2005; Schaefer, Pottage & Rickart 2011) suggest emotional enhancement of memory by indicating better memory performances of healthy individuals for emotional information, compared to neutral information. More specifically, some researchers (Schaefer & Philippot, 2005; Schaefer, Pottage & Rickart 2011) emphasize that individuals tend to remember emotional events or stimuli with rich perceptual and sensory details by having great sense of vividness and confidence in the accuracy of details.

In order to examine the effect of emotional stimuli on ERP correlates of retrieval processing, Old/New paradigm has been commonly used by comparing the waveforms elicited by correctly classified old and new items (Rugg & Curran, 2007) during recognition memory task in which participants were asked to discriminate between previously seen item (old items presented in study phase of task) and novel items (unseen in study phase of task). Recognition memory tasks involve study-test protocol. The first phase, called study/encoding phase, aims to learning of a several stimuli (images, faces or words) presented on the screen. And then, second phase, called test phase, is given by asking participants to recognise whether presented item has been previously studied item (old) or novel item (new).

*Old/new effect* has been interpreted in terms of two distinct retrieval processes underlying recognition memory: *recollection* and *familiarity* (for review see Yonelinas, 2002). In light of dual-process theories, recollection refers to retrieval of contextual details from the encoding event or stimulus. Familiarity, on the other hand, refers to feeling of familiarity that a stimulus has been previously seen without retrieval of specific details. An increasing evidence (Curran, 2002; Curran & Hancock, 2006; Curran et al., 2015; Rugg et al., 1998; Schaefer, Pottage & Rickart, 2011) indicates that two different ERP signals were identified:  a negative going ERP signal peaking between 300 and 500 ms stimulus onset over mid-frontal regions, called FN400, and a positive going ERP signal peaking between 500 and 800 ms over parietal regions, called *parietal old/new effect*. *FN400,* as an early neural correlate of retrieval, is assumed to be sensitive *familiarity* process (Rugg et al.,1998; Curran, 2000; Curan & Clearly, 2003; Curran & Hancock, 2006). Curran (2000) suggested that new item elicited enhanced FN400 amplitudes, compared to old items. On the other hand, parietal old/new effect, as a late neural correlate of retrieval, is assumed to be related to *recollection* process (Curran, 2000; Curran et al., 2002). This effect manifests itself as enhanced positive amplitudes for correctly identified stimuli.

In addition to consensus on mid-frontal and *parietal old/new effects*, a few studies (Curran & Dien, 2003; Schaefer, Pottage & Rickart, 2011) suggest that old/new effect could be also observed at very early processing stages as reflected by P200 which consists of a sustained positivity at about 180 ms stimulus onset over frontal regions. In the study by Schaefer, Pottage and Rickart (2011) examined old/new effect for IAPS emotional scenes, participants performed encoding and recognition phases of recognition memory task with an interval of a one-week.

During encoding phase, emotional images (negative and neutral) were presented, asking participants to rate valance (positive/negative) and perceived arousal (calm/aroused) levels of stimuli. One week later, a surprised recognition memory task, in which intermixed old and new emotional faces were presented on the screen, was given to participants by asking them to make old/new image discrimination and rate confidence scale for their responses. They found the enhancements of frontal P200, FN400 (mid-frontal old/new effect) and late positive complex (*parietal old/new effects)* for negative images.

Also, recognition memory studies using old/new paradigms have also presented inconsistent results regarding encoding process during recognition memory tasks. Righi et al. (2012) examined old/new effect for faces by testing participants in encoding and retrieval phases of face recognition task. In contrast to the study of Schaefer, Pottage and Rickart (2011), during encoding phase, participants studied a series of emotional faces (happy, fearful, neutral), and then, retrieval phase were given in which old and new emotional faces were intermixed. Participants were asked to judge whether each face had previously seen or not. A significantly distinctive effect was found for fearful faces. They found that encoded (old) fearful faces elicited an enhanced P100 positivity; a decreased N170 negativity; enhanced FN400 negativity and enhanced parietal old/new effect, suggesting that modulation of retrieval processing derives from very early stages of emotional information (e.g structural encoding indexed by N170) and that encoded threat-related stimuli have long-lasting affects on memory.

### 1.5. Neurophysiological Evidence for Emotional Information Processing in Adult Attachment

In recent years, behavioural studies on adult attachment served as the basis for ERP studies. However, the neural mechanisms underlying emotion information processing in adult attachment are still poorly known and it still largely unknown whether individuals with different attachment orientations perform biased emotion information processing with some aspects of cognitive functions such as perception, interpretation and memory. Recent ERP studies on attachment emphasize attachment-related differences in emotional information processing, such as facial expressions/emotional faces (Dan & Raz, 2012; Escobar et al., 2013; Fraedrich et al., 2010; Leyh et al., 2016; Mark et al., 2012; Zhang et al., 2008) and emotional pictures (Zilber et al., 2007; Chavis & Kisley, 2012) by indicating findings on both early and late components of ERPs.

Dan and Raz (2012) provide an evidence that attachment style may influence the perception of angry and neutral facial expressions, suggesting attachment-related differences at very early stages of emotional information processing. They found differences in the mean amplitudes of C1 (a negative deflection occurring 50-80 ms post stimulus) and P100 at occipital and posterior-parietal regions in responses to angry facial expressions compared to neutral ones among individuals with attachment avoidance. Their findings interpreted as perceptual biases allowing that individuals with attachment avoidance have capacity to quickly identify potential sources of threat at early stages of information processing. Mark et al. (2012) focused on neural correlates of emotional information processing in different attachment styles in terms of attention aspect, using oddball paradigm. Emotional faces inducing angry, fear and neutral were presented within this paradigm and participants who were assessed on Attachment Style Questionnaire (ASQ), were asked to press the button as quickly as possible when deviant stimuli (oddball) appeared on the screen. Individuals with attachment security display highly attuned to threat related stimuli but they do not focus on it, as reflected in larger N100 and smaller P300 amplitudes. On the other hand, smaller N100 and larger P300 amplitudes were found in attachment anxiety, suggesting that individuals with attachment anxiety exhibit less attention to such stimuli but they focus on it later.

Zhang et al. (2008) examined the neural activity of individuals with different attachment styles in response to emotional facial expressions (happy, fearful and neutral) within backward-masking paradigm, by focusing both early and late components of ERPs. It was found that, when participants were engaged in the task, attachment avoidance group displayed less negativity (N100, N200 and N400) and more positivity (P200) to emotional faces compared to other groups (secure and attachment anxiety). Researchers interpreted that attachment avoidance is characterised by devoting less attentional resources at the initial stage of facial expressions processing, being less elaborative in encoding of the structural information of facial expressions, being sensitive to the arousal of emotional content, having difficulties in retrieving semantic of facial expressions. On the other hand, some researchers indicate that late component ERPs are modulated by individuals with different attachment styles while processing of emotional information. For instances, Zilber et al. (2007) investigated neural activity of information processing in individuals with different attachment style during interpretation of IAPS images. Participants, assessed by ECR, were asked to categorize different contents (pleasant, unpleasant and neutral) of IAPS images as pleasant, unpleasant and neutral. They found attachment-related differences in late ERP components such as LPP rather than early components (P100, N100 and P200). Participants with high level attachment anxiety displayed enhanced LPP response to negative images in relative to participants with low level attachment anxiety, suggesting that a heightened LPP is associated with an increase in motivational engagement and commitment of attentional resources which are characterised by hyperactivation strategies in attachment anxiety. Based on these findings on late ERPs component, researchers emphasize that hyperactivation leave its mark on late stages of information processing and controlled allocation of attention. On the other hand, Chavis and Kisley (2012**)** found contradict findings, using similar methodology but more complex emotional pictures. Researchers investigated neural correlates of information processing in individuals with different attachment style within affective oddball paradigm. In terms of this paradigm, infrequent target IAPS images (negative, positive and neutral) were embedded in a context of frequently neutral context images. Emotional images (negative, positive and neutral) were presented on screen and then participants, who were assessed by ECR, were asked to interpret them as positive, negative or neutral. Researchers, who only focused on late-positive potential (LPP) waveform, found stronger neural responses to negative images in attachment avoidance group, compared to positive images. According to researchers, individuals with attachment avoidance have a greater motivational relevance of negative emotional stimuli which elicit more motivated attention.

Regarding to memory-related processing in adult attachment, to our knowledge, a study by Zhai et al. (2016) provided preliminary neural findings on attachment-related differences in recognition of emotional image. Using a study-test paradigm under threat priming, Zhai et al. (2016) demonstrated a significant early old/new effect for emotional images in individuals with attachment avoidance. Participants were asked to describe three personal events involving their negative feelings such as sadness and anger on paper. Both prior to and following threat priming, emotion scale measuring emotional state (e.g anxiety, shame, depression and happiness) were assessed. After threat priming, IAPS images were presented in study session by giving instruction to memorize each emotional image for recognition in test session. Then, participants were asked to recognize whether presented image had been previously studied item (old) or novel item (new) by pressing the buttons. A broader distribution of early old/ new effect (latency window: 380 to 500 ms) was observed for positive and negative emotional images among participants with attachment avoidance. However, no late old/new effect (latency window: 500-800 ms) were observed for these participants. Researchers suggest a vigilance-avoidance dual-process model in recognition of emotional information that individuals with attachment avoidance display enhanced vigilance to previously encoded emotional images and then inhibit the retrieval of such images by using postemptive strategies.

### 1.6 Overview

Previous studies suggest that IWMs influence the way individuals attend to, encode, interpret and retrieve emotional or attachment-related information. (Dykas & Cassidy, 2011). More specifically, insecure individuals who possess negative IWMs, are assumed to implement different strategies in line with their secondary attachment strategies while processing emotional or attachment-related information.

Facial expressions, as non-verbal cues, provide considerable source in order to examine the effects of attachment style on emotional information processing, given the fact (Mikulincer and Goodman, 2006; Mikulincer, Shaver and Pereg, 2003; Fraley and Shaver, 2000) that attachment behaviour system serves to promote individuals' adaptations to social environment demands. As emotion theorists assumed, facial expressions convey specific emotions that are biological innate, evolutionarily adaptive (Darwin, 1872) and universally recognised (Ekman,1972). Therefore, the rapid and accurate processing of facial expressions become even more important for human to develop appreciate responding in social situations. However, in attachment literature, a notion that individuals with different attachment orientations perform biased information processing with some aspects of cognitive functions such as attention, perception and memory has received empirical support in recent years.

In this regard, behavioural studies on attachment presented inconsistent findings concerning whether individuals with different attachment styles display bias during information processing, specifically interpretation and retrieval of emotional stimuli. Therefore, more robust evidence is needed to clarify how cognitive and emotional processes contribute attachment-related differences in emotional information processing. Investigating the neural mechanism of emotional information processing in adult attachment may help to advance better understanding of cognitive and emotional processes underlying adult attachment style.

From neuroscience perspective, attachment behavioural system is a higher-order neural construct (Coan, 2008). The various neural mechanism underlying incentive motivation, emotional response, emotion regulation, and social behaviour are assumed to mediate attachment-related processes such as proximity-seeking, separation distress, social bonding and so on (Coan, 2008; Schore, 2000). fMRI studies that identified distinct neural correlates underlying attachment-related differences indicated the critical involvement of emotional brain systems (e.g ventral striatum and amygdala circuits) associated with social reward and threat during appraisal of facial expressions (Vrtička et al., 2008) and some neural systems (e.g anterior temporal pole, hippocampus, and dorsal anterior cingulate cortex and orbitofrontal cortex) associated with negative emotional states during processing of attachment-related information (Gilliath et al., 2005). On the other hand, only a small body of research with ERPs has examined neural correlates of emotional information processing in adult attachment. The vast majority of these ERP studies that reported attachment related differences in early stages of information processing emphasize the role of attentional functioning in adult attachment. In general, ERPs are sensitive measures that capture changes in brain activity within milliseconds. However, little is know about neural mechanism of emotional information processing while interpreting emotional stimuli. Moreover, to our knowledge, no studies to date have examined information processing among individuals with different attachment styles during face recognition using ERP methodology. Investigating ERP correlates of information processing in adult attachment during interpretation and recognition of emotional faces may help to identify which cognitive functions trigger individuals to display avoidant or anxious-type behavioural reactions to emotional situations. Also, neuroscientific perspective to attachment-related differences in information processing may enhance our understanding of neurobiological basis of adult attachment.

In light of these, the present research aims to investigate behavioural and neural correlates of emotional information processing in adult attachment by employing interpretation and recognition phases of facial expression task. In line with this purpose, it was hypothesised that as follows:

1) Attachment anxiety and attachment avoidance groups would be differentiated on amplitudes and latencies of specific ERP components in response to emotional stimuli during both interpretation and recognition phases of facial expression task.
2) These specific ERP components would also be varried according to different electrode locations and stimuli types (happy, angry and surprised faces).
3) During interpretation phase, anxiety and avoidant attachment groups would be differentiated on the interpretations of happy, angry and surprised facial expressions. Individuals with attachment avoidance would be more likely to interpret surprised facial expressions as a negative valance with highest RTs, compared to individuals with attachment anxiety. On the other hand, attachment anxiety individuals would be more likely to interpret angry facial expressions as a negative valance with lowest RTs, compared to individuals with attachment avoidance. For happy facial expressions, both groups would be differentiated on only RTs. Individuals with both attachment groups interpret these expressions as positive but reaction time would be lower for individuals with attachment anxiety.
4) During recognition phase of facial expression task, individuals with attachment anxiety would be more accurate to recognise happy, angry and surprised facial expressions, displaying lowest RTs, compared to individuals with attachment avoidance.

# CHAPTER 2

# METHOD

## 2.1. Participants

39 students (28 female, Mean age= 21.59 years, *SD* = .50) at Bahcesehir University participated in this study. They recruited from subject pool (300 students) at Bahcesehir University Brain and Cognition Lab, being selected on the basis of their attachment scores from ECR-R Questionnaire and their answers of pre-screening questions (i.e., medical history and basic demographic information). Participants in the highest 75% portion on avoidance subscale and at the same time in the lowest 25% portion on anxiety subscale were invited to take part in this study as avoidant individuals. On the other hand, participants in the highest 75% portion on anxiety subscale and at the same time in the lowest 25% portion on avoidance scale were invited to take part in this study as anxious individuals. All participants were screened for standard inclusion-exclusionary criteria that might affect data. The exclusion criteria were severe vision problem, history of neurological and/or psychiatric disorders, regularly used drugs of any sort that affect the central nervous system and being left-handed.

## 2.2. Materials

### 2.2.1. Facial Expression Task

In order to examine interpretation and memory biases, a computerised Facial Expression Task was designed, using NimStim standardized stimulus set of facial expressions (Tottenham et al., 2009). This task consists of two phases (see Figure 1): Interpretation Phase and Recognition Phase. In both phases, the emotion stimuli were randomly presented on 21-inch screen for 2000 milliseconds with 1000 milliseconds inter-stimulus interval.

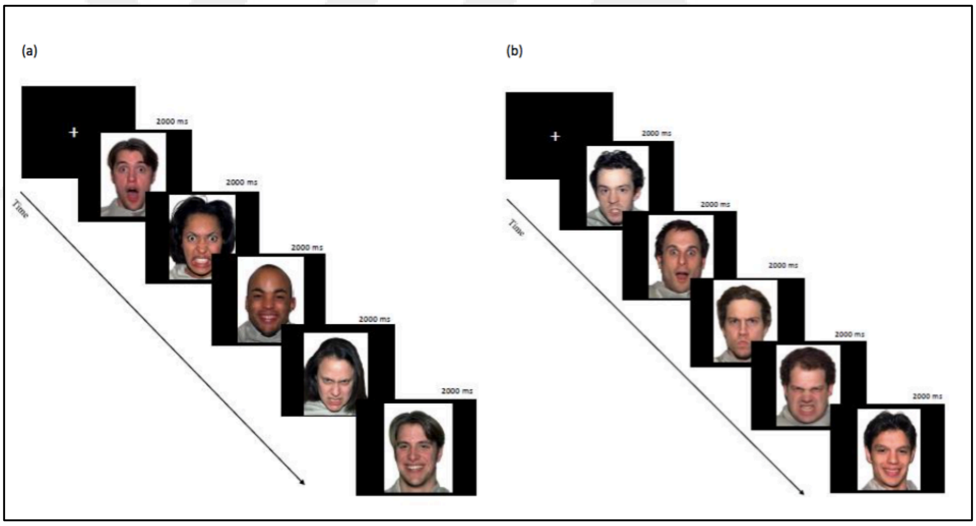



**Figure 2.1. Experimental Paradigm used in the Study (a) Interpretation Phase and (b) Recognition Phase**

First phase, called Interpretation Phase, aims to evaluate interpretation processing of emotional stimuli. In this phase, forty-eight colour photographs of faces expressing 3 different emotions (angry, happy, and surprise) were selected from NimStim Set of Facial Expressions as 4 female and 4 male having European American identities in each type of facial expression. All facial expressions were randomly presented on the screen. During the presentation of facial expressions, participants were asked to report subjective judgements regarding the valance of facial expressions, as quickly as possible, using right button (negative valance) or left button (positive valance) of mouse. Their reactions (positive or negative valence) and also reaction times (RTs) for each face expression were recorded. This phase also allows incidental encoding of faces for Recognition Phase. Participants completed incidental encoding of Recognition Phase by implicitly learning the faces during Interpretation Processing phase. Neither explicit instruction nor clue concerning Recognition Phase were given until finishing Interpretation Phase.

The second phase, called Recognition Phase, assesses face recognition ability. The set of 96 faces comprised 48 old/target faces and 48 novel/non-target faces which were selected from same database. Participants viewed 48 faces from Interpretation Phase (Phase 1) randomly intermingled with 48 novel faces. The height and width of facial images was 650 x 506 pixels. During presentation of faces, they were asked to identify whether or not they have seen face in the previous phase, pressing the either left or right button of mouse. Left button represented the faces presented during the previous phase whereas right button represented the novel faces in this phase. The number of correct and incorrect responses and their reaction times (RTs) are recorded for each trial.

### 2.2.2. Self-reporting measurements

#### 2.2.2.1. Experiences in Close Relationships-Revised (ECR-R) Questionnaire

In order to measure individual differences in adult attachment orientations as a continuous model, a Turkish version of Experiences in Close Relationship Revised Questionnaire (Selcuk, Gunaydin, Sumer & Uysal, 2005) was used. The ECR-R questionnaire was originally developed by Fraley, Waller and Brennan (2000). It is a 36-item self-report measure that involves two-dimensional continuum: avoidance (18 items) and anxiety (18 items). Each item is rated on seven-point Likert Scale (1= strongly disagree and 7= strongly agree). Of the 36 items, 14 are reverse keyed (12 items from the Avoidance subscale and 2 item from the Anxiety subscale). Higher scores on anxiety and avoidance subscales indicate higher attachment- related anxiety and avoidance, respectively. In addition to this, Fraley, Waller and Brennan (2000) indicated test-retest reliability of .93 and .94 for the Anxiety subscale and .95 and .95 for the Avoidance subscale.

ECR-R questionnaire was adopted to Turkish by Selcuk, Gunaydin, Sumer and Uysal (2005). The adaptation study of ECR-R questionnaire in Turkish population also confirmed two factor structure of original study. Test-retest correlation was .81 for Anxiety subscale and .82 for Avoidance subscale on two hundred fifty-six undergraduate students (45%female and 55%male). Cronbach alpha for Anxiety and Avoidance subscales were .86 and. 90 respectively.

#### 2.2.2.2. State-Trait Anxiety Inventory (STAI)

ATurkish version of State-Trait Anxiety Inventory (Oner & Le Compte 1985, STAI) was used to assess participants' anxiety symptoms associated with state and trait anxiety. This scale was originally developed by Spielberger, Gorsuch, Lushene, Vagg, and Jacobs (1983). It involves 41 item in total and consists of two subscales: STAI Form Y-1 for assessing state related anxiety symptoms and STAI Form Y-2 for assessing trait related anxiety symptoms. Considering how do you feel right now participants will be asked to rate items in each form according to 4-point Likert scale (1=almost never to 4=almost always). Higher scores on anxiety and avoidance subscales indicate higher attachment- related anxiety and avoidance, respectively.

This scale was adopted to Turkish by Oner and Le Compte (1985). The adaptation of STAI has been found valid and reliable for Turkish population. The internal consistency was found to range from .83 to .87 for the Trait Anxiety Scale and from .94 to 96 for the State Trait Anxiety Scale. The item reliability correlation was found to ranged from .42 to .85. In addition to these, Test-retest reliability was found to range from .71 to .86 for the Trait Anxiety Scale and from .26 to .68 for the State Anxiety Scale.

### 2.2.2.3. Difficulties in Emotion Regulation Scale (DERS)

In order to assess participants' difficulties in emotion regulation, Turkish adaptation of Difficulties in Emotion Regulation Scale (Ruganci & Gencoz, 2010) was used. It was originally developed by Gratz and Roemer (2004). It involves 36 items and consist of 6 dimensions: Strategies (8items), Impulse (6 items), Non-acceptance (6 items), Awareness(6items), Clarity (5items) and Goals (5 items). Each item is rated on a 5-point Likert scale ranging from 1 = "almost never" to 5 = "almost always". Higher scores represent more difficulties in emotion regulation.

An adaptation of DERS to Turkish population was performed by Ruganci and Gencoz (2010). In adaptation study of this scale, internal consistency was found between .82 and .90 for subscales and .94 for total scale. Also, test-retest reliabilities of subscales were reported between .60 to .85 by researchers.

### 2.2.2.4. Depression Anxiety Stress Scale (DASS)

A Turkish version of Depression Anxiety Stress Scale (Akin & Cetin,2007) was used to assessnegative emotional states of Depression, Anxiety and Stress. It was developed by Lovibond and Lovibond (1995). This scale involves 42 items and three sub-dimensions: depression (14 items), anxiety (14 items), and stress (14 items). Each item is rated on four-point Likert Scale (0= did not apply to me at all and 3= applied to me very much, or most of the time). Higher scores on each subscales indicates increasing severity of depression, anxiety and stress respectively. Internal consistencies were found .96 for depression, .89 for anxiety and .93 for stress. In addition to these, test-retest reliability score was .48 for total scale.

DASS was adopted to Turkish by Akin and Cetin (2007). An adaptation study of DASS was found to be reliable and valid scale for Turkish population, as researchers (Akin & Cetin, 2007) indicated. Test-retest reliabilities were found to be .99 for total scale and .98 for each subscale. Also, Cronbach alpha was reported as .90 for depression, .92 for anxiety and .92 for stress subscales and .89 for total scale.

## 2.3. Apparatus

### 2.3.1. ERP recording and analysis

Using a 32- channel EEG/EP NeuroScan system (Neuroscan, Compumedics, Inc., Charlotte) (28 EEG channels, 4 channels for eye-movement), stimulus presentation, recording, storage and analysis were carried out. EEG recordings were made in an electrically shielded, sound-proof chamber.EEG activity was recorded through 30 electrodes placed over the scalp according to International 10-20 System: FP1, FP2, AFz, F7, F3, Fz, F4, F8, FT7, FC5, FC3, FCz, FC4, FC6, FT8, A1, T7, C5, C3, Cz, C4, C6, T8, A2, TP7, CP5, CP3, CPz, CP4, CP6, TP8, P7, P3, Pz, P4, P8, O1, Oz, and O2. For the recordings, the US FDA-approved QuickCap with Ag-Ag/Cl was used (ref.: linked mastoid; ground: forehead). The ground electrode was placed on the forehead and the left mastoid served as reference. As well as this, electrodes were placed on both eyes (VEOG, HEOH) in order to identify eye-movement artefacts. EEG signals were filtered between 0.16 and 100 Hz, and sampling rate was 512 Hz. Impedance was $\leq$ 5 K ohms in all recording sites. EEG recording was observed for 1024 ms before stimulus and for 1022 ms after stimulus; 2046 ms in total. ERPs of the brain consist of peaks created by amplitude variations on the time axis. In the present study as well, the electrophysiological records were analysed in the time-domain. The ERP epochs were obtained offline and included

-200 to 1.000 ms around stimulus onset or -300 to -1.000 ms around response onset The stimulus-locked epoch included a -200 to 0 ms baseline, and the response-locked epoch included a -300 to 0 ms baseline. Epochs with eye blinks and slow eye movements excluded from analysis. The ERP averages included data where the response for the current trial was correct (average number of trials for stimulus-locked epoch).

### 2.4. Procedure

The study was conducted with the approval of Bahcesehir University Research Ethic Committee. Also, participants were provided with informed consent form (Appendix A). Prior to the start of the experiment, participants were asked to complete battery of self-report (DASS, DERS and STAI). An EEG cap (Quik-Caps) fitted with sintered Ag/AgCl electrodes were placed on participants' head. During the Facial Expression Task, participants' EEG were continuously recorded. The emotional stimuli in the facial expression task were presented on 21-inch screen for 2000 ms on a black background. The inter-stimulus interval was 1000 ms. In the Interpretation Phase, participants were asked to report subjective judgements regarding the valance of facial expressions, as quickly as possible, using right button (negative valance) or left button (positive valance) of mouse. While participants were performing instructions related to interpretation of facial expressions, faces were incidentally encoded to proceed to Recognition Phase. In the Recognition phase, participants were asked to identify, through the left and right buttons of mouse, whether the face expression were shown during previous phase (left button) or shown for the first time (right button). The experiment lasted 2 hours as planned. At the end of experiment, participants were debriefed concerning the study.

## 2.5. Data Analysis

### 2.5.1. Behavioural Data Analysis

Behavioural data were analysed, by calculating positive and negative responses in Phase 1, correct and incorrect recognition responses in Phase 2 and mean reaction times (RTs) of these responses for each participant. And then, statistical techniques were performed on these dependent variables.

A Pearson product-moment correlation coefficient was used to assess the relationships among ECR-R Attachment Anxiety and Avoidance and other self-report measures (STAI Trait and State Anxiety scores, DASS Depression, Anxiety and Stress subscale scores and DERS Awareness, Clarity, Non-acceptance, Strategies, Impulse and Goals). Also, a Pearson product-moment correlation coefficient was used to assess the relationships between self-report measures and cognitive measures on Facial Expression Task.

Separate multivariate analysis of variances (MANOVAs) were conducted for each phases of task to examine whether the participants' responses and mean RTs on both phases differs across attachment groups. The homogeneity of covariance assumption for all MANOVAs was assessed using Box's M test. Wilk's criterian was also used to interpret significance. In order to assess univariate homogeneity of variance across attachment anxiety and attachment avoidance groups, Levene's test was used.

Providing a global perspective on the effect of attachment orientation on interpretation processing and face recognition, separate mixed-design ANOVAs were performed for both phases of task. For the Phase 1, both positive and negative responses were subjected to 2x3x2 mixed-design ANOVA with attachment group (anxiety and avoidance) as between-subjects factor and emotion type (anger, happy, and surprise) and valance rating (positive and negative) as within-subjects factors. It should be highlighted that mean RTs data in Phase 1 were not sufficient to perform mixed design ANOVA due to sample size. Therefore, mean RTs data in Phase 1 was analysed, using only MANOVA. For the Phase 2, due to sample size, separate 2 x 3 x 2 mixed-design ANOVAs were performed on dependent variables of both correct and incorrect recognition responses and mean RTs with attachment group (anxiety and avoidance) as between-subjects factor and emotion type (surprise, happy and angry) and recognition type (correct and incorrect) as within-subjects factors. In addition to this, in order to examine the effect of old/novel items on face recognition among attachment groups, 2 x 3 x 2 x 2 mixed-design ANOVAs were performed on the dependent variables of correct and incorrect recognition responses to old and new stimuli and mean RT with attachment group (anxiety and avoidance) as between-subjects factor and emotion type (surprise, happy and angry), recognition type (correct and incorrect) and stimulus type (old and novel items) as within-subjects factors. In all mixed-design ANOVAs, the homogeneity of covariance assumption assessed using Box's M test. Wilk's criterian used to interpret significance of main and interaction effects. When the assumption of homogeneity of (co)variance matrices has not been met, the Pillai trace test statistics was used to interpret significance. Regarding to assumption of sphericity, Greenhouse Geisser corrections for repeated measures were used when data violated the sphericity assumption. In order to assess univariate homogeneity of variance across attachment anxiety and attachment avoidance groups, Levene's test was used.

### 2.5.2. Electrophysiological Data Analysis

For electrophysiological data analysis was performed for midline electrodes only (Fz, Cz, and Pz) in the following time windows: N100, 70–150 ms; P200, 165–195 ms; N200, 185–275 ms; P300, 260-435 and FN400, 400–495 ms.

Amplitude and latency values were subjected to a mixed design variance analysis (ANOVA) separately with attachment group as between-subjects variable and emotion type, component and electrode site as within-subjects variables. In all mixed-design ANOVAs, the homogeneity of covariance assumption assessed using Box's M test. Wilk's criterian used to interpret significance of main and interaction effects. When the assumption of homogeneity of (co)variance matrices has not been met, the Pillai trace test statistics was used to interpret significance. Regarding to assumption of sphericity, Greenhouse Geisser corrections for repeated measures were used when data violated the sphericity assumption. In order to assess univariate homogeneity of variance across attachment anxiety and attachment avoidance groups, Levene's test was used.

# CHAPTER 3

# RESULT

## 3.1. Descriptive Statistics

Demographic characteristics of participants by attachment group were presented in Table 3.1. There were 21 participants with attachment anxiety (15 female, 71.4%; 6 male, 28.6%) and 18 participants with attachment avoidance (13 female, 72.2%; 5 male, 28.8%). The mean age was 22.0 ± 2.7 years (mean±SD) for attachment anxiety group and 21.11±1.5 years (mean±SD) for attachment avoidance group. A vast majority of participants at both groups (attachment anxiety and attachment avoidance group) spent most of their life in city, N= 20 (95.2%) and *N*=16 (88.9%) respectively. Regarding to romantic relationship, 11 participants with attachment anxiety were single while the rest (*N*=10) were in the relationship. Of the 10 participants who had currently romantic relationship, 8 participants (38.1 %) were flirting and 2 participants (9.5 %) were engaged. The mean length of romantic relationship was 38 ±16.2 months (mean± SD). On the other hand, 55.6 per cent (*N*=10) of participants with attachment avoidance were single and 44.4 per cent (*N*=8) of participants with attachment avoidance were in the relationship. 7 participants (38.9%) were flirting and 1 participant (5.6 %) was engaged. The mean length of romantic relationship was .50±.62 months (mean±SD). Detailed information concerning participants' education level, place of residence, family relationship status, income and education levels of their parents was also presented in Table 3.1.

**Table 3.1. Demographic Characteristics of Attachment Anxiety (N= 22) and Avoidance (N=18) Groups**

| | Attachment Anxiety | | | | | Attachment Avoidance | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Variable | N | % | Mean | SD | Range | N | % | Mean | SD | Range |
| Gender | | | | | | | | | | |
| Female | 15 | 71.4 | | | | 13 | 72.2 | | | |
| Male | 6 | 28.6 | | | | 5 | 27.8 | | | |
| Age (years) | | | 22,0 | 2,7 | 18-28 | | | 21.1 | 1.50 | 19-24 |
| Education Level | | | | | | | | | | |
| First-year student | 2 | 9.5 | | | | 2 | 11.1 | | | |
| Second-year student | 4 | 19.0 | | | | 4 | 22.2 | | | |
| Third-year student | 9 | 14.3 | | | | 8 | 44.4 | | | |
| Final-year student | | | | | | 4 | 22.2 | | | |
| Master | 2 | 9.5 | | | | | | | | |
| Doctorate | 1 | 4.8 | | | | | | | | |
| Romantic Relationship | | | | | | | | | | |
| Single | 11 | 52.4 | | | | 10 | 55.6 | | | |
| In a Relationship | | | | | | | | | | |
| Flirt | 8 | 38.1 | | | | 7 | 38.9 | | | |
| Engaged | 2 | 9.5 | | | | 1 | 5.6 | | | |
| Romantic Relationship Length (monthly) | | | 38.0 | 16.2 | 12-58 | | | 17.0 | 20.8 | 3-67 |
| Place of living | | | | | | | | | | |
| Village | | | | | | | | | | |
| Town | | | | | | | | | | |
| District | 1 | 4.8 | | | | 2 | 11.1 | | | |
| City | 20 | 95.2 | | | | 16 | 88.9 | | | |
| Place of Residence | | | | | | | | | | |
| Alone at home | 2 | 9.5 | | | | 4 | 22.2 | | | |
| With friends at home | 3 | 14.3 | | | | 4 | 22.2 | | | |
| With friends at dormitory | | | | | | 1 | 5.6 | | | |
| With family | 16 | 76.2 | | | | 9 | 50 | | | |
| Family Relationship Status | | | | | | | | | | |
| Living together | 16 | 76.2 | | | | 14 | 77.8 | | | |
| Divorced | 4 | 19.0 | | | | 2 | 11.1 | | | |
| Living separately while married | 1 | 4.8 | | | | 1 | 5.6 | | | |
| Mother is not alived | | | | | | | | | | |
| Father is not alived | | | | | | 1 | 5.6 | | | |
| Mother Education Level | | | | | | | | | | |
| Literate | 1 | 4.8 | | | | | | | | |
| Primary School | 2 | 9.5 | | | | | | | | |
| Secondary School | | | | | | | | | | |
| High School | 10 | 47.6 | | | | 9 | 50 | | | |
| University | 8 | 38.1 | | | | 8 | 44.4 | | | |
| Postgraduate | | | | | | 1 | 5.6 | | | |
| Father Education Level | | | | | | | | | | |
| Literate | | | | | | | | | | |
| Primary School | 1 | 4.8 | | | | | | | | |
| Secondary School | 1 | 4.8 | | | | 1 | 5.6 | | | |
| High School | 10 | 47.6 | | | | 4 | 22,2 | | | |
| University | 7 | 33.3 | | | | 8 | 44.4 | | | |
| Postgraduate | 2 | 9.5 | | | | 5 | 27.8 | | | |
| Income level of family | | | | | | | | | | |
| Low | | | | | | | | | | |
| Low-Middle | | | | | | | | | | |
| Middle | 7 | 33.3 | | | | 3 | 16.7 | | | |
| Middle-High | 13 | 61.9 | | | | 12 | 66.7 | | | |
| High | 1 | 4.8 | | | | 3 | 16.7 | | | |

## 3.2. Behavioural Results

### 3.2.1. Attachment-style-specific Correlation Analyses

#### 3.2.1.1. Correlation Analysis of Subscale of ECR-R Questionnaire and Subscales of Other Self-reports (DASS, DERS, STAI)

A Pearson product-moment correlation coefficient was run to examine the relationships among ECR-R Attachment Anxiety and Attachment Avoidance and other self-report measures (State Anxiety and Trait Anxiety scores, DASS Depression, Anxiety and Stress subscale scores and DERS Awareness, Clarity, Non-acceptance, Strategies, Impulse and Goals subscale scores).

As shown in Table 3.2, significant correlations were found between attachment anxiety and other self-report subscales variables, excluding awareness and state anxiety. However, correlations between attachment avoidance and subscale variables of STAI, DASS and DERS did not reveal statistical significance. Results showed that there were significant positive correlations between attachment anxiety and clarity, $r(37)= .34, p < .05$; attachment anxiety and non-acceptance, $r(37)= .36, p < .05$; attachment anxiety and strategies, $r(37)= .70, p <.001$; attachment anxiety and impulse, $r(37)= .48, p <.001$; attachment anxiety and goals, $r(37)= .42, p < .001$; attachment anxiety and depression, $r(37)= .36, p <.05$; attachment anxiety and anxiety (subscale of DASS), $r(37)= .44, p < .001$;attachment anxiety and stress, $r(37)= .46, p < .001$; attachment anxiety and trait anxiety, $r(37)= .40, p < .05$. Inter-correlation result of ECR-R questionnaire revealed negative relationship between attachment anxiety and attachment avoidance, *r*(37)= -.54, *p* <.001. A positive correlation was found among clarity awareness, *r*(37)= .37, *p* <.05. The other inter-correlations among subscale variables of STAI, DERS and DASS presented in Table 3.2.

**Table 3.2. Intercorrelations of Attachment Anxiety, Attachment Avoidance, State Anxiety(STAI), Trait Anxiety (STAI), Subscale of DASS (Depression, Anxiety, Stress) and Subscale of DERS (Awareness, Clarity, Non-acceptance, Strategies, Impulse and Goals).**

| Variable/Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Awareness | 1 | | | | | | | | | | | | |
| 2. Clarity | .37* | 1 | | | | | | | | | | | |
| 3. Non-Acceptance | .17 | .49** | 1 | | | | | | | | | | |
| 4. Strategies | -.09 | .46** | .52** | 1 | | | | | | | | | |
| 5. Impulse | -.16 | .36* | .40* | .81** | 1 | | | | | | | | |
| 6. Goals | -.17 | .40* | .36* | .57** | .62** | 1 | | | | | | | |
| 7. Depression | .04 | .18 | .38* | .65** | .52** | .35* | 1 | | | | | | |
| 8. Anxiety | -.07 | .36* | .45** | .61** | .59** | .56** | .63** | 1 | | | | | |
| 9. Stress | -.22 | .18 | .33* | .67** | .72** | .49** | .72** | .83** | 1 | | | | |
| 10. State Anxiety | -.05 | .09 | .05 | -.14 | -.10 | -.20 | -.19 | -.03 | -.10 | 1 | | | |
| 11. Trait Anxiety | .17 | .39* | .55** | .40* | .38* | .42** | .27 | .29 | .31 | .03 | 1 | | |
| 12. Attachment Anxiety | -.02 | .34* | .36* | .70** | .48** | .42** | .36* | .44** | .46** | -.26 | .40* | 1 | |
| 13. Attachment Avoidance | .24 | 0.11 | -.06 | -.31 | -.27 | -.29 | -.17 | -.19 | -.30 | .22 | -.09 | -.54** | 1 |

Note. ** $p < .01$; * $p < .05$

#### 3.2.1.2. Correlation Analyses of Attachment Anxiety, Attachment Avoidance and Cognitive Variables of Facial Expression Task

In order to examine the relationship among ECR attachment categories (Attachment Anxiety, Attachment Avoidance) and cognitive variables (interpretation and recognition), A Pearson product-moment correlation coefficient was run for each phase of task. In phase1, the correlation analysis was performed to assess whether there were relationships between ECR-R attachment categories and cognitive variables on Phase 1 (positive response, negative response and their mean RTs). However, neither attachment anxiety nor attachment avoidance were statistically correlated with positive response, negative response and their mean RTs. The same statistic technique was also performed to examine relationship between cognitive variables on Phase 2 (total correct recognition response and incorrect recognition response and mean RTs for both response types) and ECR-R attachment categories. The results revealed that neither attachment anxiety nor attachment avoidance were significantly correlated with total correct recognition responses, total incorrect recognition responses and their mean RTs for both type of responses. However, according to correlation analysis done by emotion type, a negative correlation was found between correct recognition responses for happy facial expressions and attachment avoidance, indicating that correct recognition of happy facial expressions tended to decrease as the avoidance characteristics increased, $r(37) = -.32$, $p < .05$.

### 3.2.2. Comparisons between Attachment Anxiety and Attachment Avoidance on Facial Expression Task

#### 3.2.2.1 Comparisons between Attachment Anxiety and Attachment Avoidance on Interpretation Phase for Total Positive and Negative Responses and Reaction Times of Total Positive and Negative Responses

In interpretation phase (Phase 1), in order to examine attachment group differences in interpretation of facial expressions, multivariate analysis of variances (ANOVA) was performed on the dependent variables of total positive response and total negative responses. Box's test of equality of covariance matrices supported the assumption of homogeneity of variance for multivariate analysis, indicating that observed covariance matrices dependent variables were equal across avoidant and attachment groups, $p$ = .212. The results revealed the combined DV's were not significantly influenced by attachment group, $p$ =.14. Levene's Test revealed that assumption of equal variance has been assumed for both total positive and total negative responses, $F(1,37) = 2.85$, $p$ = .10 and $F(1,37) = .74$, $p$ = .40 respectively.

**Table 3.3. Mean and Standard Deviation on the Measure of Overall Positive and Overall Negative Responses to Different Facial Expressions by Attachment Group**

| | Attachment Group | | | |
|---|---|---|---|---|
| | Attachment Avoidance | | Attachment Anxiety | |
| | M | SD | M | SD |
| Overall Positive Response | 23.83 | 4.72 | 21.23 | 3.34 |
| Overall Negative Response | 22.11 | 5.20 | 25.10 | 4.64 |

*Note.* Attachment Avoidance group, *N*=18; Attachment Anxiety group, *N*=21

The univariate ANOVA analysis revealed a significant effect of attachment group on overall positive responses, $F(1,38) = 4.62$, $p = .038$, $\eta^2 = .11$, suggesting that participants with attachment avoidance ($M = 23.83$, $SD = 4.72$) were more likely to interpret facial expressions in positive fashion than anxious participants ($M = 21.23$, $SD = 3.34$) (see Table 3.3). Also, a significant effect of attachment group on overall negative responses was found, $F(1,37) = 3.60$, $p = .05$, $\eta^2 = .06$. As show in Table 3.3, participants with attachment anxiety ($M = 25.10$, $SD = 4.64$) were more likely to interpret facial expressions in negative fashion compared to participants with attachment avoidance ($M = 22.11$, $SD = 5.20$).

In similar fashion, the same data-analytic strategy was performed on the dependent variables of mean total RTs in Phase 1. However, results did not obtain statistical significance.

#### 3.2.2.2. Comparisons between Attachment Anxiety and Attachment Avoidance on Interpretation Phase for Positive and Negative Responses and Reaction Times of Positive and Negative Responses

In interpretation phase (Phase 1), a 2 (attachment group: anxiety and avoidance) x 3 (emotion type: anger, happy and surprise) x 2 (valance rating: positive and negative) mixed design ANOVA was performed on dependent variables of positive and negative responses with attachment group as between-subjects variable and emotion type and valance rating as within-subjects variables. Box's Test of equality of covariance matrices did not supported the assumption of homogeneity of covariance for multivariate analysis, $p < .001$. The result with use of Pillai's Trace criteria revealed that combined DVs were significantly affected by emotion type, Pillai's Trace=.43, $F(2,36) = 13.15$, $p < .001$, $\eta^2 = .43$, interaction between valance rating and attachment group, Pillai's Trace =.10, $F(2,36) = 4.18$, $p < .05$, $\eta^2 = .10$ and also interaction between emotion type and valance rating, Pillai's Trace=.93, $F(2,36) = 220,29$, $p < .001$, $\eta^2 = .93$. However, the main effect of valance rating, the interaction between emotion type and attachment group and the interaction between emotion type, valance rating and attachment group did not reach statistical significance, $p_s > .05$. Mauchly's test indicated that the assumption of sphrecity had been met for interaction of emotion type and valance rating, $p = .87$, not for main effects, $p_s < .05$. Therefore, Greenhouse–Geisser correction was used to correct for violations of sphericity.

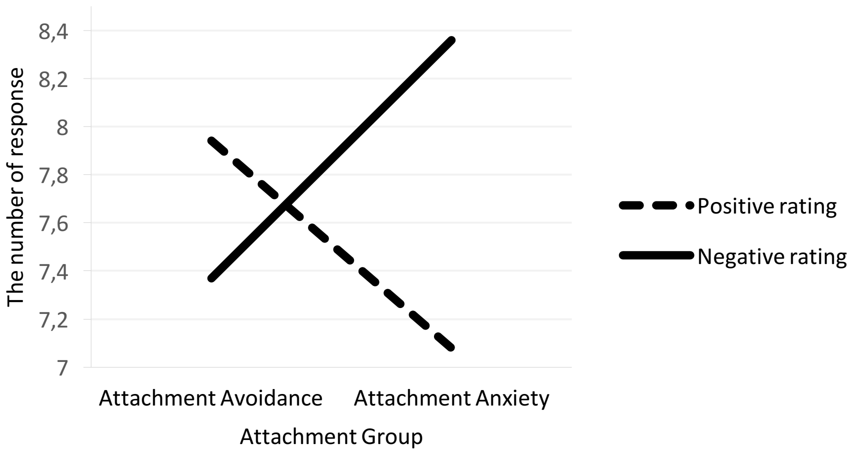



**Figure 3.1. Comparison of positive and negative ratings on Phase 1 across attachment groups**

Follow-up ANOVA on each dependent variable indicated significant main effect of emotion type, $F(2, 48.3) = 3.74$, $p = .05$, $\eta^2 = .10$. and interaction of valance rating and attachment group, $F(1,37)=4.18$, $p = .05$, $\eta^2 = .10$. As can be see in Figure 3.1. Attachment avoidance group were more likely to interpret facial expressions in positive fashion ($M = 7.94$, $SD = 4{,}91$) whereas attachment anxiety group were more likely to interpret those expressions as a negative ($M = 8.37$, $SD = 2.5$).

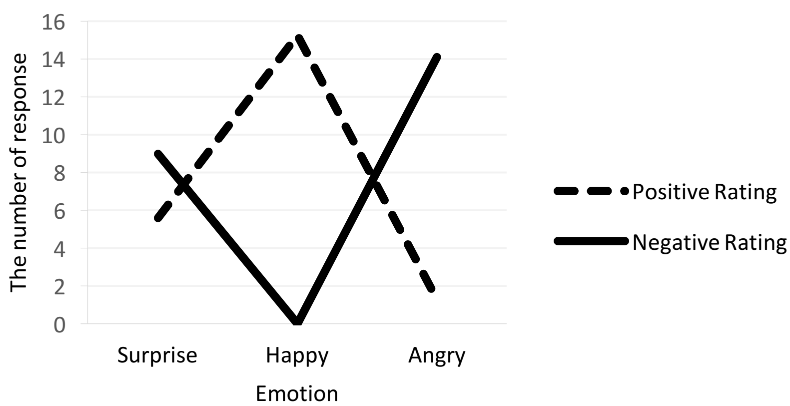



**Figure 3.2. Significant interaction between emotion and valance rating on Phase 1 across by positive and negative responses**

Also, significant interaction of emotion type and valance rating on responses was found, $F(2, 74) = 230.18$, $p < .001$, $\eta^2 = .90$.The highest positive interpretation were shown to happy facial expressions ($M = 15.23$, $SD = 2.06$). On the other hand, angry facial expressions were more likely to be interpreted as a negative ($M = 14.1$, $SD = 3.2$), compared to other facial expressions, (see Figure 3.2). For the between-subjects factor, Levene's Test indicated that the assumption of homogeneity of variance had been met for all dependent variables, $p_s > .05$, (positive rating responses to surprised facial expression, negative rating responses to surprised facial expressions, positive rating responses to happy facial expressions, negative rating responses to happy facial expressions and positive rating responses to angry facial expressions), excluding negative rating responses to angry facial expressions, $F(1,37) = 4.74$, $p = .04$. However, the result revealed no significant effect of attachment orientation on these variables, $p >.05$. In addition to this, the analysis for RTs in interpretation phase did not reveal significant results.

#### 3.2.2.3. Comparisons between Attachment Anxiety and Attachment Avoidance on Recognition Phase for Correct and Incorrect Responses and Reaction Times of Correct and Incorrect Responses

In recognition phase **(**Phase 2), 2 (attachment group: anxiety and avoidance) x 3 (emotion type: surprise, happy and angry) x 2 (recognition type: correct and incorrect) mixed-design ANOVA was performed on dependent variables of correct and incorrect recognition responses. Box's Test of equality of covariance matrices did not support the assumption of homogeneity of covariance for multivariate analysis, $p < .001$. The result with use of Pillai's Trace criteria revealed that combined DVs were significantly affected by recognition type, Pillai's Trace=.93, $F(1,37) = 496,44$, $p$ <.001, $\eta^2$ =.93. Other effects did not reach statistical significance. Mauchly's test indicated the sphrecity assumption was violated for emotion type and recognition type ($p_s < .05$), not for other effects. Therefore, Greenhouse–Geisser correction was used to correct for violations of sphericity.

**Table 3.4. Mixed-design ANOVA Analyses of Correct and Incorrect Responses and Reaction Times for Correct and Incorrect Responses on Recognition Phase**

| Facial Expression Task | Dependent variables | Effects | Results | | |
|---|---|---|---|---|---|
| | | | *F* | *p* | *Partial η²* |
| Recognition Phase (Phase 2) | Response | A | 2.30 | .13 | .10 |
| | | AxC | .53 | .52 | .01 |
| | | B | 496.44 | **.001** | .93 |
| | | BxC | .02 | .90 | .00 |
| | | AxB | 2.40 | .10 | .10 |
| | | AxBxC | 1.80 | .20 | .10 |
| | Response time (RT) | A | 5.14 | **.01** | .12 |
| | | AxC | 1.20 | .31 | .03 |
| | | B | 39.01 | **.001** | .51 |
| | | BxC | .61 | .44 | .02 |
| | | AxB | 3.00 | .10 | .07 |
| | | AxBxC | 1.35 | .30 | .04 |

*Note.* Emotion type (A) includes surprised, happy and angry faces. Recognition type (B) includes correct and incorrect responses. Attachment group (C) includes attachment anxiety and attachment avoidance. Significant *p*-values ($p_s < .05$) are shown in bold

The results of univariate analysis of variance (ANOVA) revealed a significant main effect of recognition type, $F(1,37) = 496.44$, $p < .001$, $\eta^2 = .93$. Other effects were not significant, $p_s > .05$. For the between-subjects factor, the assumption of equal variance has been assumed for all dependent variables, $p_s > .05$ (correct recognition scores for surprised faces, incorrect recognition scores for surprised faces, correct recognition scores for happy faces, incorrect recognition scores for happy faces, correct recognition scores for angry faces and incorrect recognition scores for angry faces). However, the results revealed that attachment group did not have effect on these dependent variables, $p = .32$.

In similar fashion, the same data-analytic strategy in Phase 2 was performed on dependent variables of mean RTs. Box's Test of equality of covariance matrices supported the assumption of homogeneity of covariance for multivariate analysis, $p = .35$.The result with use of Wilks' Lambda criteria revealed that combined DVs were significantly affected by emotion type, Wilks' Lambda= .77, $F(2,36) = 5.53$, $p = .01$, $\eta^2 = .24$, recognition type, Wilks' Lambda=.49, $F(1,37) = 39{,}01$, $p < .001$, $\eta^2 = .51$ and also interaction of emotion type and recognition type,Wilks' Lambda=.85, $F(2,36) = 3.28$, $p = .05$, $\eta^2 = .15$. Mauchly's Test indicated that the assumption of sphrecity had been met for all effects ($p_s > .05$). The result of univariate analysis of variance (ANOVA) revealed a significant main effects of emotion type, $F(2,74)=5.14$, $p = .01$, $\eta^2 = .12$, recognition type, $F(1,37)=39{,}01$, $p < .001$, $\eta^2 = .51$. Other effects were not significant, $p_s > .05$. For the between-subjects factor, the assumption of equal variance has been assumed for all dependent variables (RTs of correctly recognised surprised faces, RTs of incorrectly recognised surprised faces, RTs correctly recognised happy faces, RTs of incorrectly recognised happy faces, RTs of correctly recognised angry faces and RTs of incorrectly recognised angry faces) However, the results revealed that attachment group did not have effect on these dependent variables, $p$ =.53.

#### 3.2.2.4 Comparisons between Attachment Anxiety and Attachment Avoidance on Recognition Phase for Correct and Incorrect "Old/New Face" Responses

In order to assess the effect of old/novel items on face recognition among attachment groups, 2 (attachment group: anxiety and avoidance) x 3 (emotion type: surprise, happy and angry), x 2 (recognition type: correct and incorrect) x 2 (stimulus type: old and novel items) mixed-design ANOVA was performed on the dependent variables of correct and incorrect recognition responses for old and new faces.

**Table 3.5. A Mixed-design ANOVA Analysis for Correct and Incorrect Old/New Face Responses on Recognition Phase**

| Facial Expression Task | Dependent variables | Effects | Results | | |
|---|---|---|---|---|---|
| | | | *F* | *p* | *Partial* $\eta^2$ |
| Recognition Phase (Phase 2) | Response | A | 2.30 | .13 | .10 |
| | | AxD | .53 | .60 | .01 |
| | | B | 2.00 | .17 | .10 |
| | | BxD | 3.00 | .09 | .10 |
| | | C | 496.44 | **.001** | .93 |
| | | CxD | .02 | .90 | .00 |
| | | AxB | 3.21 | .06 | .10 |
| | | AxBxD | 1.60 | .22 | .04 |
| | | AxC | 2.40 | .10 | .10 |
| | | AxCxD | 1.80 | .20 | .10 |
| | | BxC | 8.50 | **.01** | .20 |
| | | BxCxD | .70 | .42 | .02 |
| | | AxBxC | 9.83 | **.001** | .21 |
| | | AxBxCxD | 3.70 | **.04** | .10 |

*Note.* Emotion type (A) includes surprised. happy and angry faces. Stimulus type (B) includes old and new faces. Recognition type (C) includes correct and incorrect responses. Attachment group (D) includes attachment anxiety and attachment avoidance. Significant p-values ($p_s < .05$) are shown in bold.

Box's Test of equality of covariance matrices did not supported the assumption of homogeneity of covariance for multivariate analysis, $p$=.01. The result with use of Pillai's Trace criteria revealed that combined DVs were significantly affected by recognition type, Pillai's Trace=.93, $F(1,37) = 496.44$, $p < .001$, $\eta^2$ =.93; interaction of emotion type and stimulus type,Pillai's Trace=.20, $F(2,36) = 4{,}58$, $p = .02$, $\eta^2$ =.20; interaction of recognition type and stimulus type,Pillai's Trace=.19, $F(1,37)$ = 8.,50, $p$ =.06, $\eta^2$ =.19 and interaction of emotion type, recognition type and stimulus type, Pillai's Trace=.40, $F(2,36) = 12.20$, $p < .001$, $\eta^2$ =.40. However, other effects did not reach statistical significance, $p_s$>.05. The assumption of sphericity had been met for the interaction of emotion type and recognition type, $p$ =.36, not for other effects ($p_s$<.05), Greenhouse-Geisser correction was used to correct for violations of sphericity. The result revealed a significant effect of recognition type, $F(1,37) = 496{,}44$ $p < .001$, $\eta^2$ =.93. A significant interaction of stimulus type and recognition type, $F(1,37) = 8.50$, $p = .01$, $\eta^2$ =.20, was found; indicating that old faces were more likely to be incorrectly recognised ($M$ = 4.12, $SD$ = 2.71) whereas new faces were more likely to be correctly recognised ( $M$ = 12.81, $SD$ = 2.30). The results also revealed three and four way interactions.

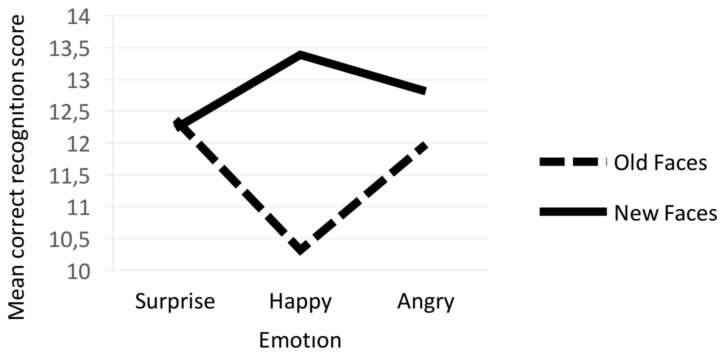



**Figure 3.3. Mean of correct recognition scores of emotional faces by stimulus type**

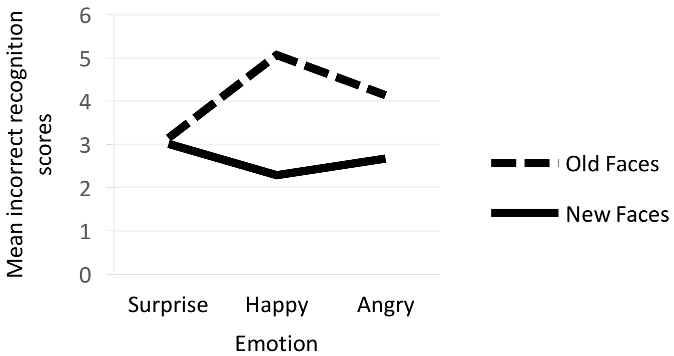



**Figure 3.4. Mean of incorrect recognition scores of emotional faces by stimulus type**

The interaction of emotion type, stimulus type and recognition type, $F(1.53,56.62) = 9.83$, $p < .001$, $\eta^2 = .21$ was found to be significant. As illustrated in Figure 3.3, no stimulus type difference was found for correctly recognised surprised faces. The largest mean correct recognition score differences between old and new faces were found for happy faces. New happy faces (M = 13.4, *SE* = .35) were more accurately recognised, compared to old happy faces (*M* = 10.32, *SE* = .51). In similar way, old angry faces (*M* = 11.98, *SE* = .45) were less correctly recognised, compared to new ones (*M* = 12.81, *SE* = .41). As well as this, Figure 3.4 indicated reverse pattern for all types of incorrectly recognised emotional faces.

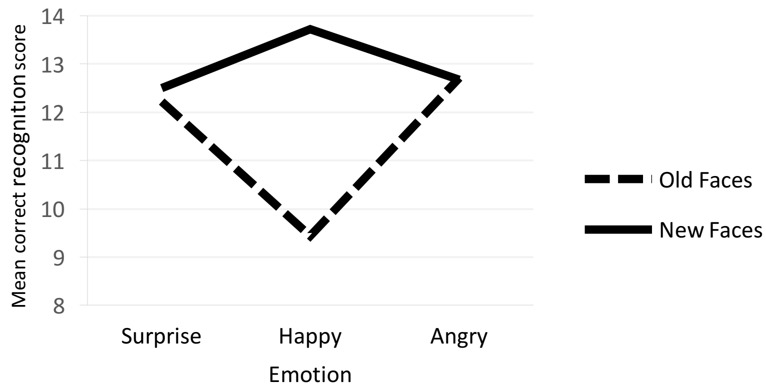



**Figure 3.5. Mean of correct recognition scores of emotional faces by stimulus type in attachment avoidance group**

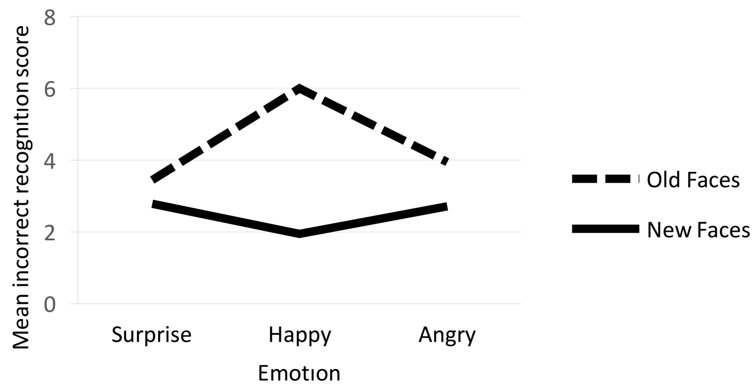



**Figure 3.6. Mean of incorrect recognition scores of emotional faces by stimulus type in attachment avoidance group**

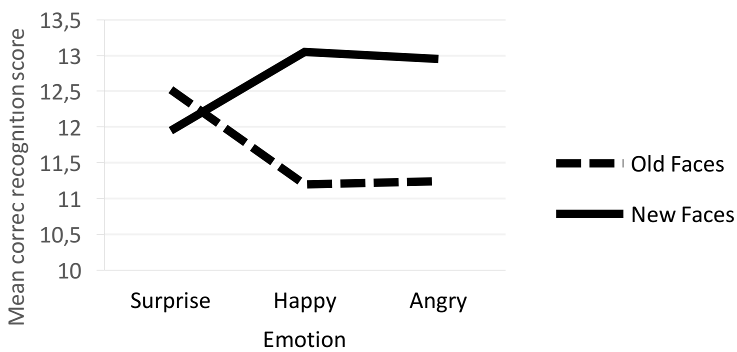



**Figure 3.7. Mean of correct recognition scores of emotional faces by stimulus type in attachment anxiety group**


**Figure 3.8. Mean of incorrect recognition scores of emotional faces by stimulus type in attachment anxiety group**

In addition this, a significant interaction of emotion type, stimulus type, recognition type and attachment group was found, $F(1.53,56.62) = 3.70$, $p = .04$, $\eta^2 = .10$. Follow-up analysis showed that all types of new faces (see Figure 3.5 and Figure 3.7) were more accurately recognised by both attachment avoidance and attachment anxiety groups, excluding the correct recognition performance of attachment anxiety group for surprised new faces.

In attachment avoidance group, the largest mean recognition score differences were found for correctly recognised new happy faces, as Figure 3.5 illustrated. New happy faces ($M = 13.72$, $SE = .51$) were more accurately recognised, compared to old ones ($M = 9.44$, $SE = .75$). Other correctly recognised emotional faces did not differ in the attachment avoidance group. In attachment anxiety group, as Figure 3.7 showed, old surprised faces ($M = 12.52$, $SE = .48$) were slightly more correctly recognised than new ones ($M = 11.95$, $SE = .48$). However, new happy and angry faces were more correctly recognised. Attachment anxiety group (see Figure 3.7) correctly recognised new happy faces ($M = 13.10$, $SE = .47$) and new angry faces

($M$ = 12.95, $SE$ = .56) compared to the same category of old faces (old happy faces, $M$ = 11.2, $SE$ = .70; old angry faces, $M$ = 11.24, $SE$ = .61). Incorrect face recognition performance of both attachment groups showed reverse pattern, compared to correct face recognition performance of these groups (see Figure 3.5 and Figure 3.6; Figure 3.7 and Figure 3.8). For the between-subjects factor, the assumption of equal variance has been assumed for all dependent variables, $p_s > .05$. However, the results revealed that attachment group did not have effect on these dependent variables, $p = .32$.

#### 3.2.2.5 Comparisons between Attachment Anxiety and Attachment Avoidance on Recognition Phase for Reaction Times of Correct and Incorrect "Old/New Face" Responses

The same data-analytic strategy was performed on dependent variables of mean RTs for correct response and incorrect response separately. In the analysis of RTs for correctly recognised old/new emotional faces, Box's Test of equality of covariance matrices did support the assumption of homogeneity of covariance for multivariate analysis, $p = .89$. The result with use of Pillai Trace revealed significant main effect of stimulus type, Pillai's Trace=.17, $F(1,37) = .8.20$, $p = .01$ , $\eta^2 = .20$ . However, other effects were not statistically significant, $p_s > .05$. Mauchly's test indicated the assumption of sphrecity had been met for all effects, $p_s > .05$.

**Table 3.6 Mixed-design ANOVA Analyses for Reaction Times of Correct and Incorrect "Old/New Face" Responses**

| Facial Expression Task | Dependent variables | Effects | Results | | |
|---|---|---|---|---|---|
| | | | *F* | *p* | *Partial* $\eta^2$ |
| Recognition Phase (Phase 2) | Response time for correct recognition (RT) | A | .90 | .42 | .02 |
| | | AxC | .04 | 1.00 | .00 |
| | | B | 8.20 | **.01** | .20 |
| | | BxC | .40 | .60 | .01 |
| | | AxB | .70 | .50 | .02 |
| | | AxBxC | .90 | .43 | .02 |
| | Response time for incorrect recognition (RT) | A | 3.30 | **.05** | .13 |
| | | AxC | .83 | .44 | .04 |
| | | B | .40 | .60 | .02 |
| | | BxC | .04 | .84 | .00 |
| | | AxB | .30 | .74 | .01 |
| | | AxBxC | 4.60 | **.02** | .17 |

*Notes:* Emotion type (A) includes surprised. happy and angry face; Stimulus type (B) includes old and new faces; Attachment group (C) includes attachment anxiety and attachment avoidance; Significant p-values ($p_s$< .05) are shown in bold

The result revealed significant main effect of Stimulus Type, $F(1,37) = 8.20$, $p = .01$ , $\eta^2 = .20$. Other effects were not statistically significant, $p_s > .05$. For the between-subjects factor, the assumption of equal variance has been assumed for all dependent variables, $p_s > .05$ (RT for correctly recognised old surprised faces, RT for correctly recognised new surprised faces, RT for correctly recognised old happy faces, RT for correctly recognised new happy faces, RT for correctly recognised old angry faces and RT for correctly recognised new angry faces). However, the results revealed that attachment group did not have effect on these dependent variables, $p = .70$.

In the analysis of RTs for incorrectly recognised old/new emotional faces, Box's Test of equality of covariance matrices did support the assumption of homogeneity of covariance for multivariate analysis, $p = .91$. The result with use of Pillai Trace revealed significant main effect of emotion type, Pillai's Trace=.24, $F(2,22) = 3.60$, $p = .05$, $\eta^2 = .24$, and interaction of emotion type, stimulus type and attachment group, Pillai's Trace=.42, $F(2,22) = 8.10$, $p = .002$, $\eta^2 = .42$. Other effects were not statistically significant, $p_s > .05$. Mauchly's test indicated the assumption of sphrecity had been met for all effects, $p_s > .05$. The result revealed significant main effect of emotion type, $F(2,46) = 3.30$, $p < .05$, $\eta^2 = .13$, and interaction of emotion type, stimulus type and attachment group, $F(2,46) = 4.60$, $p = .02$, $\eta^2 = .17$. However, other effects were not statistically significant, $p_s > .05$.

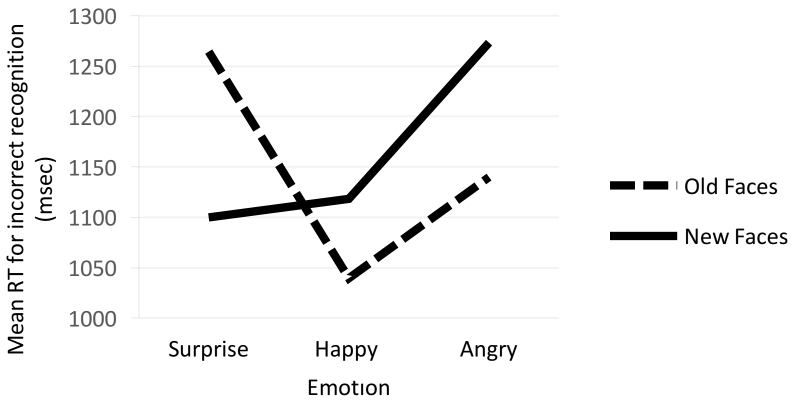



**Figure 3.9. Mean RT to incorrect responses for each emotional faces, as a function of stimulus type, in attachment avoidance group**

In attachment avoidance group (see Figure 3.9), new happy (*M* = 1118.2, *SE* = 89.63) and angry faces (*M* = 1273.6, *SE* = 57.40) were recognised incorrectly with higher RTs, compared to the same category of old emotional faces (happy faces, *M* = 1039.8, *SE* = 85.8); angry faces *M* = 1140.12, *SE* = 88.8). On the other hand, old surprised faces (*M* = 1118.2, *SE* = 89.63) were recognised incorrectly with higher RTs than new surprised faces (*M* = 1100.1, *SE* = .85.94).

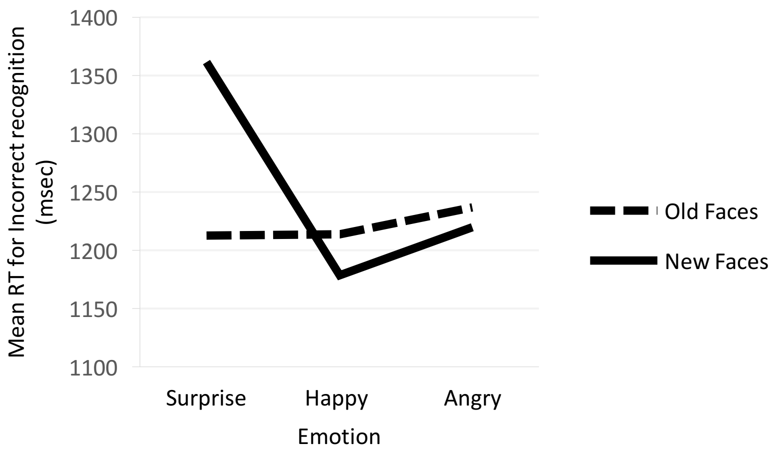



**Figure 3.10. Mean RT to incorrect responses for each emotional faces, as a function of stimulus type, in attachment anxiety group**

In attachment anxiety group (see Figure 3.10), new surprised faces (*M* = 1361.4, *SE* = 83.0) were recognised incorrectly with higher RTs, compared to old surprised ones *(M* = 1213, *SE* = 68.0). Other types of emotional faces differed slightly in terms of stimulus type. New happy *M* = 1179, *SE* = 86.1) and angry faces *M* = 1220, *SE* = 55.1) were recognised incorrectly with slightly lower RTs, compared to the same categories of old emotional faces (happy faces, *M* = 1214, *SE* = 82.4; angry faces, *M* = 1237.1, *SE* = 85.3). For the between-subjects factor, the assumption of equal variance has been assumed for all dependent variables, $p_s$ >.05 (RT for incorrectly recognised old surprised faces, RT for incorrectly recognised new surprised faces, RT for incorrectly recognised old happy faces, RT for incorrectly recognised new happy faces, RT for incorrectly recognised old angry faces and RT for incorrectly recognised new angry faces). However, the results revealed that attachment group did not have effect on these dependent variables, *p* =.32.

## 3.3. Electrophysiological Results

### 3.3.1. Visual Analysis of ERPs

#### 3.3.1.1. Visual Analysis of Interpretation Phase

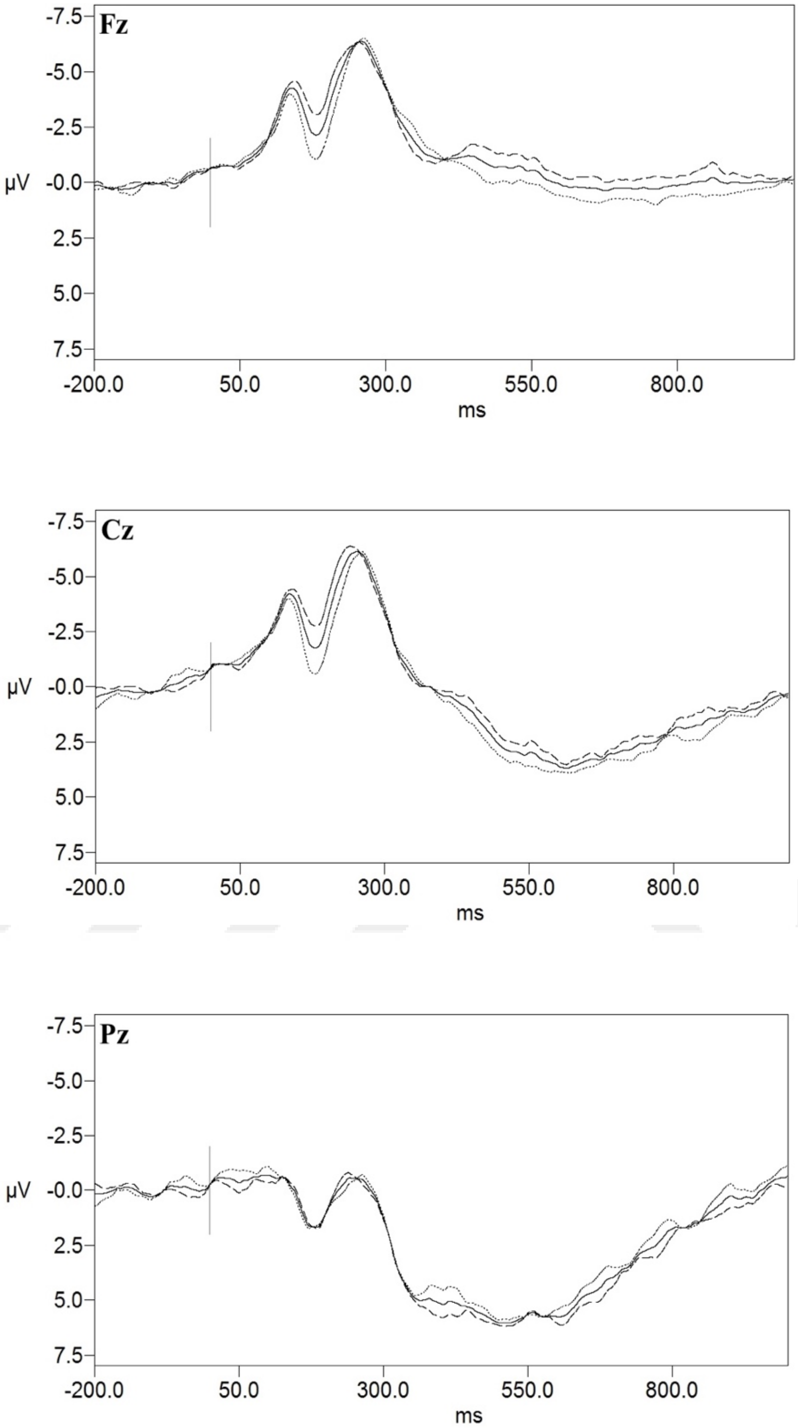



**Figure 3.11. Grand average ERP waveforms of attachment for both groups (solid line), anxiety (dashed line) and avoidance (dotted line) groups in response to all stimuli at Fz, Cz and Pz electrode locations during interpretation phase**

The overall visual ERP analysis demonstrated that interpretation bias produce N100-P200-N200 waveforms across all stimulus at both Fz and Cz electrode locations as illustrated in Figure 3.11. The amplitude of N100 was larger for attachment anxiety than for attachment avoidance group. The amplitude of P200 was larger in attachment avoidance than attachment anxiety group. On the other hand, the amplitude differences in N200 peaks were not observed among attachment groups. In addition to this, as visual analysis revealed, the latency differences were not observed at both Fz and Cz electrode locations. At Pz electrode location, very small N100 amplitude was observed in overall. Attachment avoidance group displayed relatively larger N100 amplitude compared to attachment anxiety group. On the other hand, P200 and N200 was observed at Pz electrode for neither latencies nor amplitudes between attachment anxiety and attachment avoidance groups.

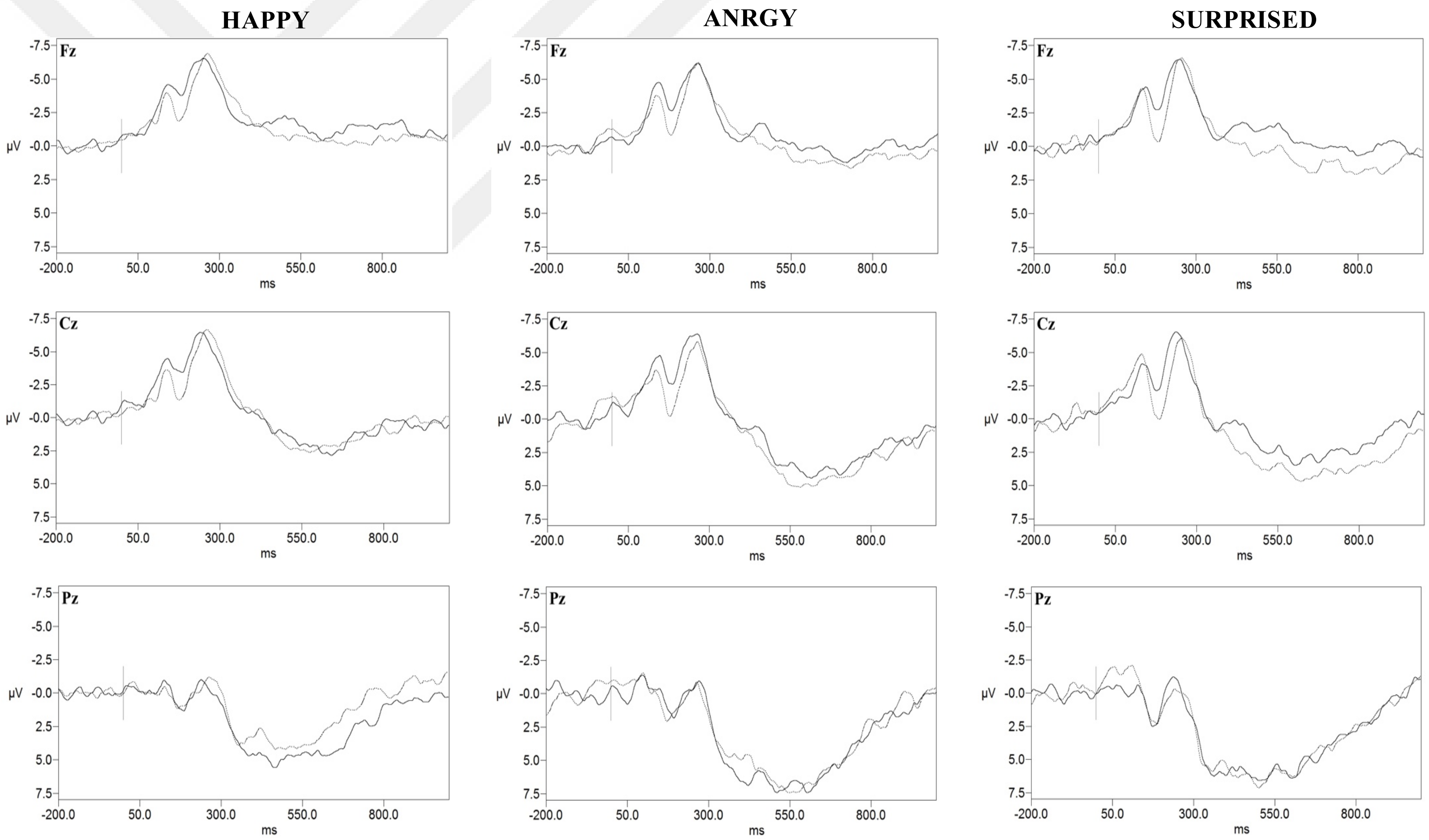
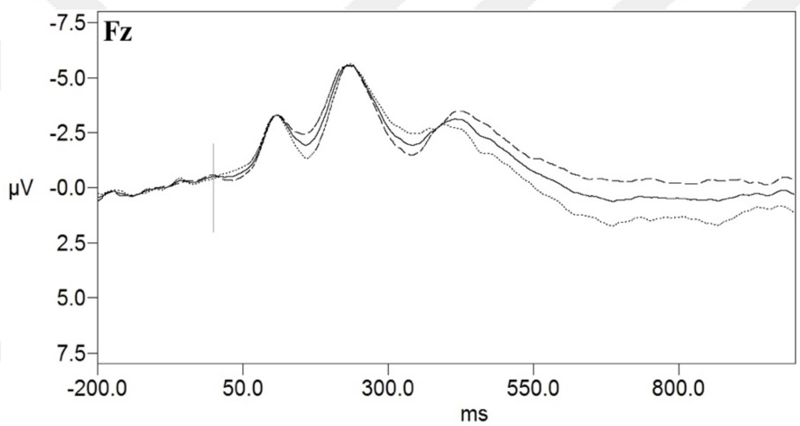


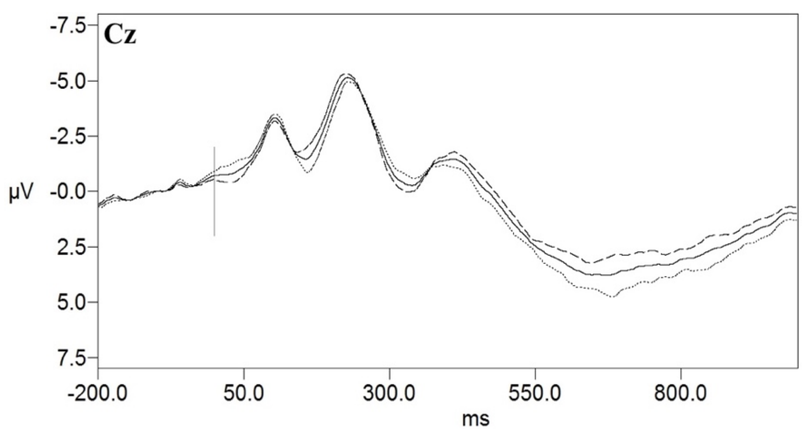

**Figure 3.12. Grand average ERP waveforms of attachment anxiety (solid line) and the attachment avoidance (dotted line) groups in response to happy, angry and surprised facial expressions at Fz, Cz and Pz electrode locations during interpretation phase**

The visual analyses were also performed for emotion type. The analysis revealed that happy, angry and surprised facial expressions did not produce same N100-N200-P200 waveforms at both Fz and Cz electrode locations that observed in overall visual ERP analysis (see Figure 3.12). Yet, significant latency and amplitude differences were observed at these electrode locations for attachment groups. Happy, angry and surprised facial expressions modulated larger N100 amplitudes at Fz and Cz electrodes in attachment anxiety compared to attachment avoidance group, excluding N100 amplitude to surprised facial expressions at Cz electrode. On the contrary to N100 differences among attachment groups in response to happy and angry facial expressions, attachment avoidance group was observed to display a larger N100 amplitude to surprised facial expressions at Cz electrode. In addition to this, the larger P200 amplitudes at both Fz and Cz electrodes were observed in attachment avoidance group for all types of facial expressions compared to attachment anxiety group. For N200 peaks, happy facial expressions produce larger N200 amplitudes at Fz and Cz electrodes in attachment avoidance group than in attachment anxiety group. It should be highlighted that happy facial expressions modulated larger N200 amplitudes at Fz electrode in overall. However, in response to angry and surprised facial expressions, same N200 amplitude effects that observed for happy facial expressionswere not observed at Fz electrode for angry and surprised facial expressions. In addition to the findings of N200 peaks at Fz electrode, N200 amplitudes to angry and surprised facial expressions were smaller at Cz electrodes in attachment avoidance group than attachment anxiety group. Also, at Cz electrode location, the P200 amplitudes to all types of emotional expressions were larger in attachment avoidant group than attachment anxiety group. On the other hand, Pz electrode waveforms found noisy due to small sweep numbers. Nevertheless, some

ERP waveforms were observed like waveforms at both Cz and Fz electrode locations. Clearly, significant N200 amplitude differences between attachment avoidance and attachment anxiety groups were observed, revealing a larger N200 amplitude in attachment anxiety than attachment avoidance group. Interestingly, angry facial expressions elicited earlier P200 latencies at Pz electrode location in attachment avoidance group, compared to attachment anxiety groups.

#### 3.3.1.2. Visual ERP Analysis of Recognition Phase



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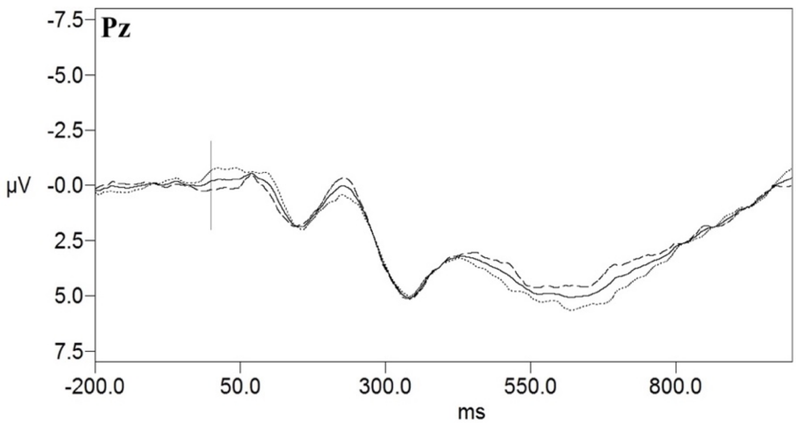



**Figure 3.13. Grand average ERP waveforms of attachment for both groups (solid line), anxiety (dashed line) and avoidance (dotted line) groups in response to correctly recognised old and new faces at Fz, Cz and Pz electrode locations during recognition phase.**

The overall visual analysis was performed based on ERP waveforms to correctly recognised old and new faces during Recognition Phase. N100-P200-N200-P300 waveforms and small late positive potential (LPP) were observed, as shown in Figure 3.13. The P200 amplitudes were larger at Fz and Cz electrode for attachment avoidance than for attachment anxiety group. On the other hand, P300 amplitudes were larger at these electrode locations for attachment anxiety than for attachment avoidance group.

### 3.3.1.2.1. Visual ERP Analysis for Old Faces

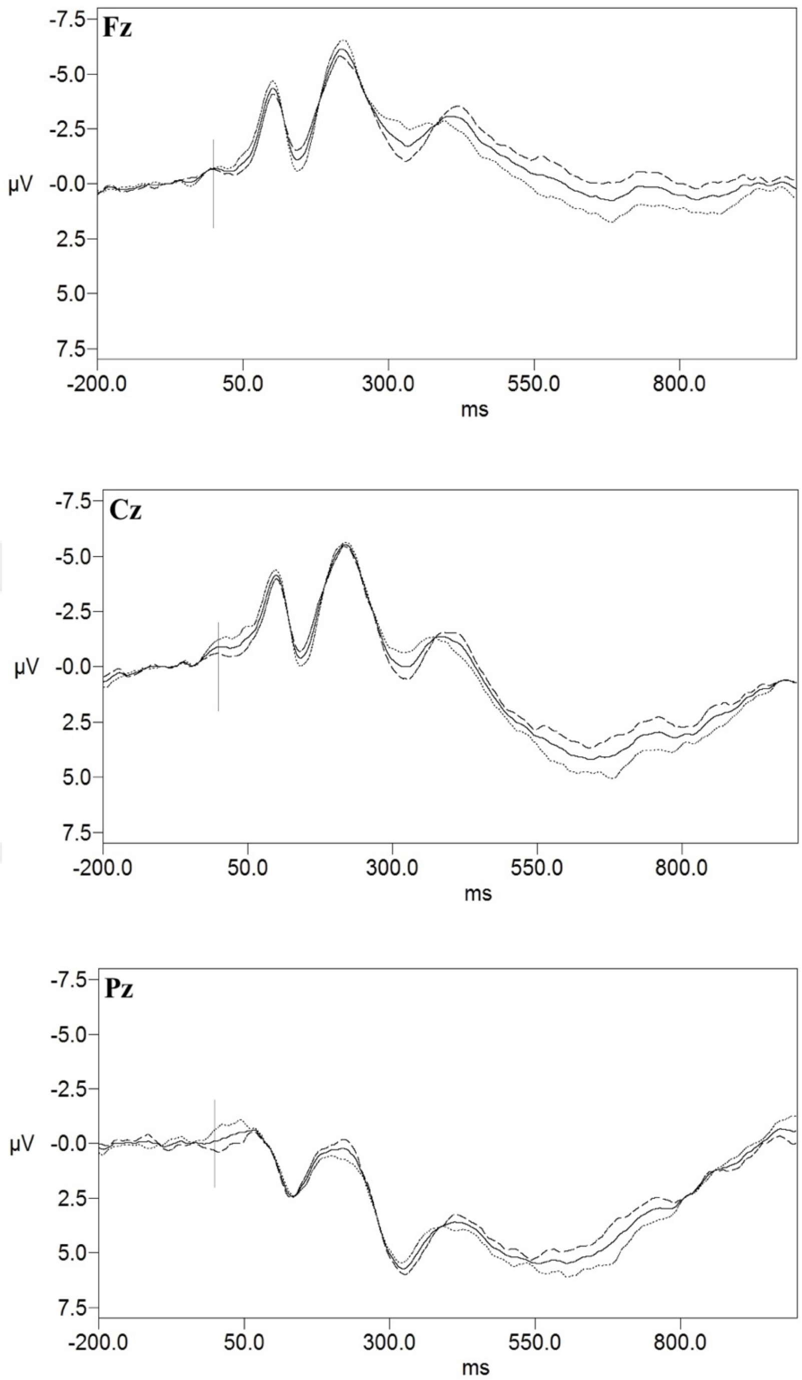



**Figure 3.14. Grand average ERP waveforms of attachment for both groups (solid line), anxiety (dashed line) and avoidance (dotted line) groups in response to correctly recognised old faces at Fz, Cz and Pz electrode locations during recognition phase.**

As overall visual analysis for old faces revealed, N100-P200-N200-P300 waveforms and small late positive potential (LPP) were observed (see Figure 3.14). However, clear differences were seen for P200 and P300 amplitudes at both Fz and Cz electrode locations. The P200 amplitudes were larger at Fz and Cz electrode for attachment avoidance than for attachment anxiety group. P300 amplitudes were larger at these electrode locations for attachment anxiety than for attachment avoidance group. Also, N200 amplitude differences were observed at Fz electrode locations, indicating larger N200 amplitudes in attachment avoidance group than in attachment anxiety group.

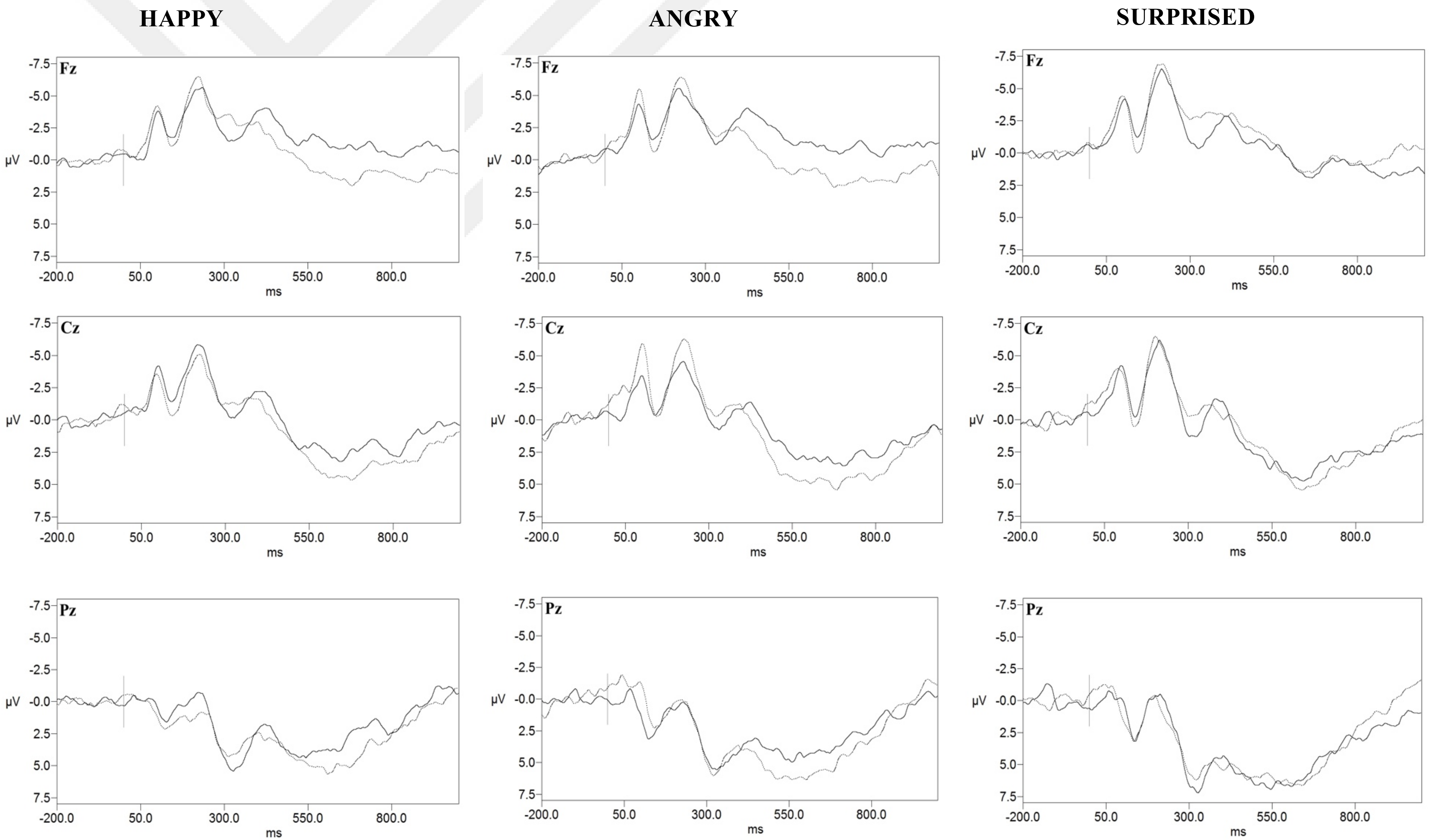


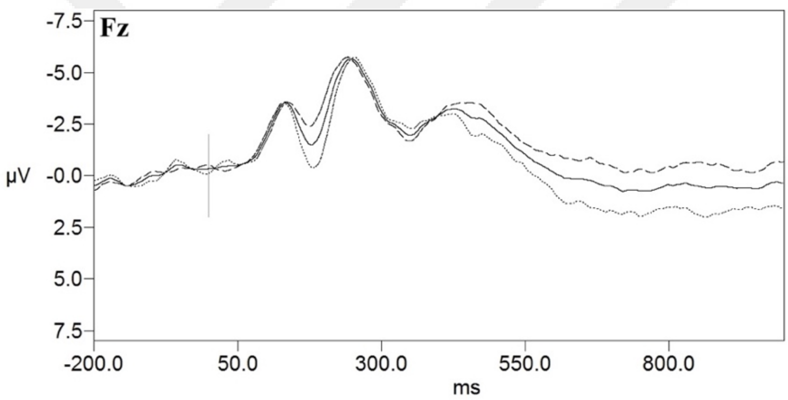

**Figure 3.15. Grand average ERP waveforms of attachment anxiety (solid line) and the attachment avoidance (dotted line) groups in response to correctly recognised old emotional faces at Fz, Cz and Pz electrode locations during recognition phase**

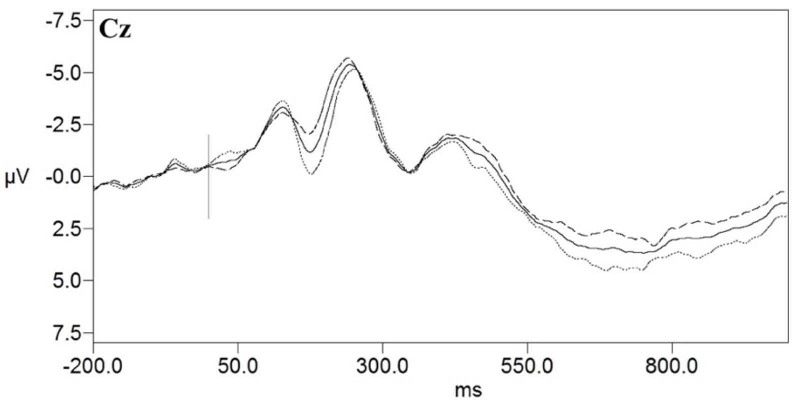
Further visual old-face ERP analysis were performedfor emotion type. The visual analysis, shown in Figure 3.15, have indicated some ERP waveforms (N1, P200, N200 and P300-FN400). In response to old happy faces, attachment avoidance group displayed larger N100, P200 and N200 amplitudes at Fz electrode locations, compared to attachment anxiety group. On the other hand, at Cz electrode locations, attachment anxiety group exhibited larger N100, P200 and N200 amplitudes to old happy faces compared to attachment avoidance group. The amplitudes of P300 and FN400 were also larger at both Fz and Cz electrode locations for attachment anxiety group. In a similar way, at Pz electrode location, P300 amplitude was larger for attachment anxiety group. However, other ERP waveforms differences among attachment groups were not observed for happy facial expressions at Pz electrode locations.

In response to old angry faces, the amplitudes of N100, P200 and N200 were larger at all three electrode locations for attachment avoidance group than for attachment anxiety group. On the other hand, at both Fz and Cz electrode locations, P300 amplitudes to old angry faces were larger for attachment anxiety group than for attachment avoidance group. In addition to these, attachment-group differences were observed in both amplitude and latency of FN400. In response to old angry faces, FN400 latencies at all three electrode locations were earlier in attachment avoidance group than in attachment anxiety group. However, the amplitudes of FN400 at these electrode locations were larger in attachment anxiety group than in attachment avoidance group. Beside, a distinct FN400 amplitude difference was observed at Fz electrode location.

Old surprised faces also elicited some ERP differences among attachment groups. Compared to attachment anxiety group, attachment avoidance group had larger N100, P200 and N200 amplitudes at all three electrode locations in response to old surprised faces. On the other hand, attachment anxiety group had larger P300 amplitudes at all three electrode locations and larger FN400 amplitude at Cz electrode location in response to old surprised faces.

#### 3.3.1.2.2. Visual ERP Analysis for New Faces



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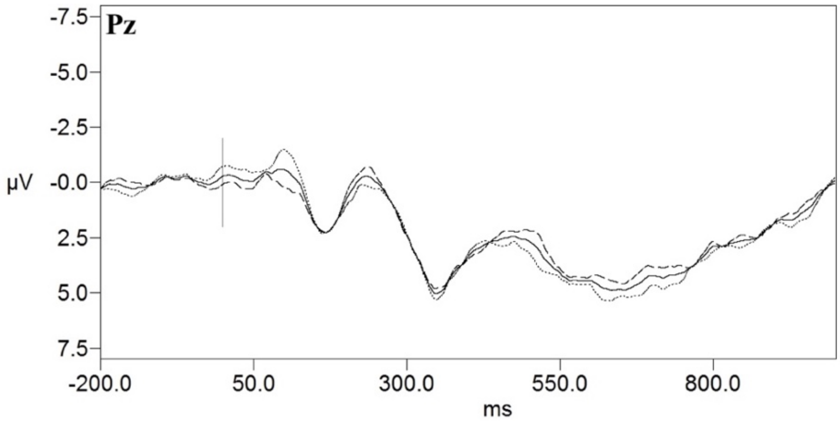


**Figure 3.16. Grand average ERP waveforms of attachment for both groups (solid line), anxiety (dashed line) and avoidance (dotted line) groups in response to correctly recognised new faces at Fz, Cz and Pz electrode locations during recognition phase.**

The overall analysis revealed that new faces produced N200-P200-N200-P300 waveforms. However, clear differences were only observed for P200 at Fz and Cz electrode locations, indicating larger P200 amplitudes in attachment avoidance group than in attachment anxiety group. Other ERP peak differences were found small. It should be highlighted that visual ERP analysis for new faces were presented above to give general picture concerning Recognition Phase.ERP peaks to new faces did not take into consideration for statistical analysis considering the incongruent with the aim of the study.

### 3.3.2. Statisticaly Analysis of ERP Components

Primary ERP analyses focused on the N100, P100, N200, P200 and P300 components during the task. Additionally, during recognition phase (Phase 2), ERP analyses also focused on the FN400 component. However, it was not obtained enough sample size for the statistically analyses of P200 and P300 electrodes.

#### 3.3.2.1. Analysis of Interpretation Phase

**N100 Latency**

Box's Test of equality of covariance matrices did not supported the assumption of homogeneity of covariance for multivariate analysis, $p < .001$. The result with use of Pillai's Trace criteria revealed that combined DVs were significantly affected byemotion type, Pillai's Trace=.20, $F(2,36)= 4.40$, $p= .02$,$\eta^2 =.20$; electrode location, Pillai's Trace=.30, $F(2,36)=5.84$, $p=.01$, $\eta^2 = .30$; the interaction of emotion type and electrode location, Pillai's Trace=.26, $F(4,34)= 3.02$, $p=.03$, $\eta^2 = .26$. Other effects were not significant, $p_s > .05$. Mauchly's Test indicated that the assumption of sphericity had been met for the effect of emotion type, $p =.80$. However, the assumption of sphericity had been violated for the main effect of Electrode and also the interaction effect of emotion type and electrode location, $p_s < .05$. Therefore, degrees of freedom were corrected, using Greenhouse-Geisser estimates of sphericity.

**Table 3.7. Latency values of N100 according to emotional expressions and electrode locations**

| Main effect | | Mean | Std. Error |
|---|---|---|---|
| Emotion | Happy | 130.0 | 3.03 |
| | Angry | 119.22 | 3.20 |
| | Surprised | 121.02 | 3.12 |
| Electrode | Pz | 114.63 | 3.30 |
| | Fz | 129.22 | 2.80 |
| | Cz | 126.40 | 2.95 |

The result of univariate analysis of variance (ANOVA) revealed significant main effect of emotion type, $F(2,74)= 5.0$, $p = .01$, $\eta^2 = .12$, indicating that angry facial expressions *(M* = 119.22, *SE* = 3.20) elicited earlier N1 latency than surprised *(M* = 121.02, *SE* = 3.12) and happy *(M* = 130.0, *SE* = 3.03) facial expressions respectively (see Table 3.7*)*. The main effect of electrode location was also significant, $F(1.32,49.0)=10.10$, $p = .001$, $\eta^2 =.21$ with earlier N1 latency at Pz *(M* = 114.63, *SE* = 3.30) than at Cz *(M* = 126.40, *SE* = 2.95) and Fz *(M* = 129.22, *SE* = 2.80) electrodes respectively.

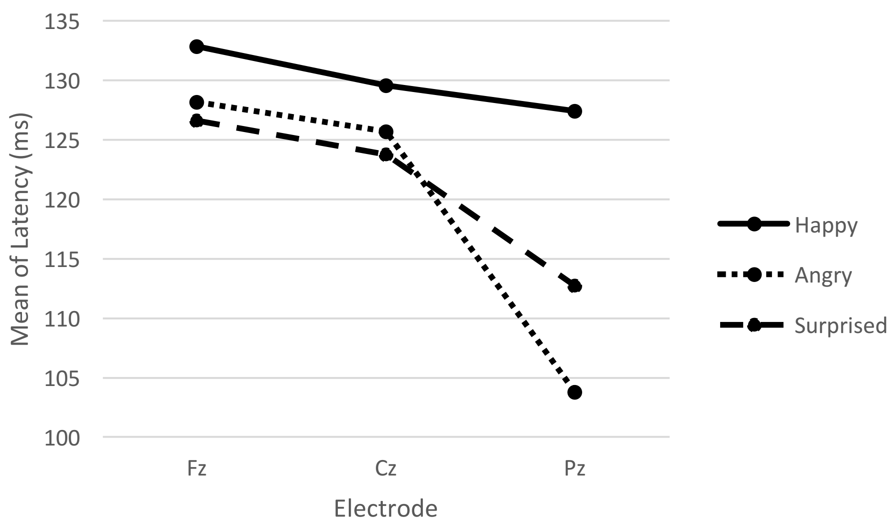


**Figure 3.17. Significant interaction between emotion type and and electrode locations on N100 latency**

In addition to these, a significant interaction effect of emotion type and electrode location was found, $F(2.60, 96.0) = 4.20$, $p = .01$, $\eta^2 = .10$. For three emotion types, earlier N100 latency was observed at Pz than at Cz and Fz respectively. The N100 latencies for angry and surprised faces produced earlier latency than happy faces. On the other hand, this differences were smaller at Cz and Fz electrodes (see Figure 3.17). However, neither other main effects nor interaction effects were significant, $p_s > .05$. For the between-subjects factor, the assumption of equal variance has been assumed for all dependent variables, $p_s > .05$ (N100 latency responses for happy facial expressions at Fz, Cz and Pz electrodes, N100 latency responses for angry facial expressions at Fz, Cz and Pz electrodes and N100 latency responses for surprised facial expressions at Fz, Cz and Pz electrodes). However, the results revealed that attachment group did not have effect on these dependent variables, $p =$. 55.

**N100 Amplitude**

Box's Test of equality of covariance matrices did not supported the assumption of homogeneity of covariance for multivariate analysis, $p$<.001.The result with use of Pillai's Trace criteria revealed that combined DVs were significantly affected byelectrode location, Pillai's Trace=.40, $F(2,36) = 11.13$, $p < .001$, $\eta^2 = .40$. Other effects were not significant, $p_s > .05$. Mauchly's Test indicated that the assumption of sphericity had been met for the effect of emotion type, $p$ =. 90. However, the assumption of sphericity had been violated for the main effect of electrode location and also an interaction effect of emotion type and electrode location, $p_s < .05$. Therefore, degrees of freedom were corrected, using Greenhouse-Geisser estimates of sphericity for these effects

**Table 3.8. Amplitude values of N100 for electrode locations**

| Main effect | | Mean | Std. Error |
|---|---|---|---|
| Electrode | Pz | -4.16 | 0.29 |
| | Fz | -5.84 | 0.43 |
| | Cz | -6.12 | 0.50 |

The result of univariate analysis of variance (ANOVA) revealed significant main effect of electrode location, $F(1.54,57.10) = 15.10$, $p < .001$, $\eta^2 = .30$, indicating that N100 at Cz electrode ($M$ = -6.12, $SE$ = .50) was higher in amplitude than that at Fz ($M$ = -5.84, $SE$ = .43) and Pz electrodes ($M$ = -4.20, $SE$ = .30) respectively (see Table 3.8). However, other effects were not statistically significant, $p_s > .05$. For the between-subjects factor, the assumption of equal variance has been assumed for all dependent variables, $p_s$>.05 (N100 amplitude responses for happy facial expressions at Fz, Cz and Pz electrodes, N100 amplitude responses for angry facial expressions at Fz, Cz and Pz electrodes and N100 amplitude responses for surprised facial expressions at Fz, Cz and Pz electrodes). However, the results revealed that attachment group did not have effect on these dependent variables, $p$ = .23

**N200 Latency**

Box's Test of equality of covariance matrices did not supported the assumption of homogeneity of covariance for multivariate analysis, $p$ =.002. The result with use of Pillai's Trace criteria revealed that combined DVs were significantly affected by emotion type, Pillai's Trace=.30, $F(2,36) = 7.0$, $p$ =.003, $\eta^2$ = .30, electrode location, Pillai's Trace=.21, $F(2,36) = 4.70$, $p$ =.02, $\eta^2$ = .21.Other effects were not significant, $p_s$ > .05.Mauchly's Test indicated that the assumption of sphericity had been met for the main effects of emotion type, $p$ =.20, and electrode location, $p$ = .06. However, the assumption of sphericity had been violated for the interaction effect of emotion type and electrode location, $p$ = .01. Therefore, degrees of freedom were corrected, using Greenhouse-Geisser estimates of sphericity for this effect.

**Table 3.9. Latency values of N200 for emotional expressions and electrode locations**

| Main effect | | Mean | Std. Error |
|---|---|---|---|
| Emotion | Happy | 240.40 | 3.70 |
| | Angry | 248.70 | 2.81 |
| | Surprised | 240.0 | 2.90 |
| Electrode | Pz | 240.40 | 3.14 |
| | Fz | 247.61 | 2.70 |
| | Cz | 241.11 | 3.80 |

The result of univariate analysis of variance (ANOVA) revealed significant main effect of emotion type, $F(2,74) = 5.82$, $p = .004$, $\eta^2 = .14$, denoting that angry facial expressions *(M* = 248.70, *SE* = 2.81) elicited later N2 latency than happy *(M* = 240.40, *SE* = 3.70) and surprised *(M* = 240.0, *SE* = 2.90) facial expressions (see Table 3.9*)*. Also, a significant main effect of Electrode, $F(2,74) = 3.33$, $p = .04$, $\eta^2 = .10$, was found by indicating that stimulus produced later N2 latency at Fz electrode *(M* = 247.61, *SE* = 2.70), compared to Pz *(M* = 240.40, *SE* = 3.14) and Cz electrodes *(M* = 241.11, *SE* = 3.80) (see Table 3.9*)*. On the other hand, effects were not statistically significant, $p_s > .05$. For the between-subjects factor, the assumption of equal variance has been assumed for all dependent variables, $p_s > .05$ (N200 latency responses for happy facial expressions at Fz, Cz and Pz electrodes, N200 latency responses for angry facial expressions at Fz, Cz and Pz electrodes and N200 latency responses for surprised facial expressions at Fz, Cz and Pz electrodes). However, the results revealed that attachment group did not have effect on these dependent variables, $p = .30$

**N200 Amplitude**

Box's Test of equality of covariance matrices supported the assumption of homogeneity of covariance for multivariate analysis, $p$ =.08.The result with use of Wilks' Lambda criteria revealed that combined DVs were significantly affected by emotion type, Wilks' Lambda= .83, $F(2,36) = 3.74$, $p = .03$, $\eta^2 = .83$; electrode location, Wilks' Lambda=.62, $F(2,36) = 29.50$, $p<.001$, $\eta^2 = .62$. Mauchly's Test indicated that the assumption of sphericity had been met for the main effect of Emotion, $p$ =.08, and interaction effect of emotion type and electrode location, $p$ = .11. However, the assumption of sphericity had been violated for the effect of electrode location, $p = .04$. Therefore, degrees of freedom were corrected, using Greenhouse-Geisser estimates of sphericity for this main effect.

**Table 3.10. Amplitude values of N200 for emotional expressions and electrode locations**

| Main effect | | Mean | Std. Error |
|---|---|---|---|
| Emotion | Happy | -6.80 | .50 |
| | Angry | -6.51 | .50 |
| | Surprised | -7.71 | .53 |
| Electrode | Pz | -4.80 | .40 |
| | Fz | -8.10 | .60 |
| | Cz | -8.20 | .60 |

The result of univariate analysis of variance (ANOVA) revealed a significant main effect of emotion type, $F(2,74) = 4.0$, $p = .02$, $\eta^2 =. 10$ indicating larger N200 amplitude to surprised facial expressions *(M* = -7.71, *SE* = .53) compared to happy *(M* = -6.80, *SE* = .50) and angry facial expressions *(M* = -6.51, *SE* = .50) (see Table 3.10*)*. The main effect of electrode location was also significant. The amplitude of N200 was smaller at Pz *(M* = -4.80, *SE* = .40) than at Fz electrodes *(M* = -8.10, *SE* = .60) and Cz *(M* = -8.20, *SE* = .60) respectively as shown in *Table 3.10*. However, other effects were not statistically significant, $p_s > .05$. For the between-subjects factor, the assumption of equal variance has been assumed for all dependent variables, $p_s > .05$ (N2 amplitude responses for happy facial expressions at Fz, Cz and Pz electrodes, N200amplitude responses for angry facial expressions at Fz, Cz and Pz electrodes and N200amplitude responses for surprised facial expressions at Fz, Cz and Pz electrodes). However, the results revealed that attachment group did not have effect on these dependent variables, $p = .60$.

#### 3.3.2.2. Analysis of Recognition Phase

**N100 Latency**

Box's Test of equality of covariance matrices did not supported the assumption of homogeneity of covariance for multivariate analysis, $p =.01$. The result with use of Pillai's Trace criteria revealed that combined DVs were significantly affected by neither main nor interaction effects, $p_s >. 05$. Mauchly's Test indicated that the assumption of sphericity had been met for the main effect of emotion type, $p =.30$, not for other effects, $p_s < .05$. Therefore, degrees of freedom were corrected, using Greenhouse-Geisser estimates of sphericity for these effects. The result of univariate analysis of variance (ANOVA) revealed no significant main and interaction effects, $p_s > .05$. For the between-subjects factor, the assumption of equal variance has been assumed for all dependent variables, $p_s > .05$ (N100 latency responses for happy faces at Fz, Cz and Pz electrodes, N100 latency responses for angry faces at Fz, Cz and Pz electrodes and N100 latency responses for surprised faces at Fz, Cz and Pz electrodes). However, the results revealed that attachment group did not have effect on these dependent variables, $p = .32$.

**N100 Amplitude**

Box's Test of equality of covariance matrices supported the assumption of homogeneity of covariance for multivariate analysis, $p = .84$.The result with use of Wilks' Lambda criteria revealed that combined DVs were significantly affected by electrode location, Wilks' Lambda=.50, $F(2,36) = 16.50$, $p < .001$, $\eta^2 = .50$. However, other effects were not significant, $p_s > .05$. Mauchly's Test indicated that the assumption of sphrecity had been met for only interaction effect of emotion type and electrode location, $p < .05$ not for main effects. Therefore, degrees of freedom were corrected, using Greenhouse-Geisser estimates of sphericity for this main effects.

**Table 3.11. Amplitude values of N100 for electrode locations**

| Main effect | | Mean | Std. Error |
|---|---|---|---|
| Electrode | Pz | -3.70 | .30 |
| | Fz | -5.90 | .40 |
| | Cz | -6.00 | .50 |

The result of univariate analysis of variance (ANOVA) revealed a significant effect of electrode location, $F(1.72,63.70) = 227.93, p < .001, \eta^2 = .39$ denoting that the amplitude of N100 was smaller at Pz *(M* = -3.70, *SE* = .30) than at Fz (*M* = -5.90, *SE* = .40), and Cz electrodes *(M* = -6.0, *SE* = .50) (see Table 3.11*)*. On the other hand, other effects were not found to be significant, $p_s > .05$. For the between-subjects factor, the assumption of equal variance has been assumed for all dependent variables, $p_s >.05$ (N100 amplitude responses for happy faces at Fz, Cz and Pz electrodes, N100amplitude responses for angry faces at Fz, Cz and Pz electrodes and N100 amplitude responses for surprised faces at Fz, Cz and Pz electrodes). However, the results revealed that attachment group did not have effect on these dependent variables, $p = .86$

**N2 Latency**

Box's Test of equality of covariance matrices did not supported the assumption of homogeneity of covariance for multivariate analysis, $p =.01$. The result with use of Pillai's Trace criteria revealed that combined DVs were significantly affected by emotion type, Pillai's Trace=.40, $F(2,36) = 11.60$, $p < .001$, $\eta^2$=.40, electrode location, Pillai's Trace=.20, $F(2,36) = 4.10$, $p$ =.03, $\eta^2$ =.20.

Mauchly's Test indicated that the assumption of sphrecity had been met for the effect of emotion type, $p$ = .20, and also interaction effect of emotion type and electrode location, $p$ = .30. However, the assumption of sphericity had been violated for the effect of Electrode, $p$<.001. Therefore, degrees of freedom were corrected, using Greenhouse-Geisser estimates of sphericity for this main effect.

**Table 3.12. Latency values of N2 for emotion type**

| Emotion | Mean | Std. Error |
|---|---|---|
| Happy | 224.98 | 2.84 |
| Angry | 225.84 | 2.75 |
| Surprised | 214.80 | 3.12 |

The result of univariate analysis of variance (ANOVA) revealed a significant main effect of Emotion, $F(2,74) = 11.11$, $p < .001$, $\eta^2$ = .23, indicating that surprised faces *(M* = 214.80, *SE* = 3.12) produced relatively earlier latency, compared to happy *(M* = 224.98, *SE* = 2.84) and angry faces *(M* = 225.84, *SE* = 2.75) (see Table 3.12*)*. No significant results were found for other effects, $p_s$ > .05. For the between-subjects factor, the assumption of equal variance has been assumed for all dependent variables, $p_s$ > .05, (N200 latency responses for happy faces at Fz, Cz and Pz electrodes, N200 latency responses for angry faces at Fz, Cz and Pz electrodes and N200 latency responses for surprised faces at Fz, Cz and Pz electrodes). However, the results revealed that attachment group did not have effect on these dependent variables, $p$ = 1.0.

**N2 Amplitude**

Box's Test of equality of covariance matrices supported the assumption of homogeneity of covariance for multivariate analysis, $p$ =.40.The result with use of Wilks' Lambda criteria revealed that combined DVs were significantly affected byelectrode location, Wilks' Lambda=.53, $F(2,36) = 1.20$, $p < .001$., $\eta^2$ =.53. On the other hand, other effects were not statistically significant, $p_s > .05$. Mauchly's Test indicated that the assumption of sphrecity had been met for the effect of emotion type, $p = .63$, and also interaction effect of Emotion and electrode location, $p = .20$. However, the assumption of sphericity had been violated for the effect of electrode location, $p = .01$. Therefore, degrees of freedom were corrected, using Greenhouse-Geisser estimates of sphericity for this main effect.

**Table 3.13. Amplitude values of N200 for electrode locations**

| Electrode | Mean | Std. Error |
|---|---|---|
| Pz | -4.92 | .48 |
| Fz | -7.69 | .56 |
| Cz | -7.94 | .60 |

The result of univariate analysis of variance (ANOVA) revealed a significant main effect of electrode location, $F(1.61,59.40) = 17.80$, $p < .001$, $\eta^2 = .33$. The amplitude of N2 was significantly smaller at Pz ($M$ = -4.92, $SE$ = .48) than at Fz ($M$ = -7.69, $SE$ = .56) and Cz ($M$ = -7.94, $SE$ = .60) electrodes respectively, as shown in Table 3.13. On the other hand, other effects were not statistically significant, $p_s > .05$. For the between-subjects factor, the assumption of equal variance has been assumed for all dependent variables, $p_s$ >.05, (N200 amplitude responses for happy faces at Fz, Cz and Pz electrodes, N200 amplitude responses for angry faces at Fz, Cz and Pz electrodes and N200 amplitude responses for surprised faces at Fz, Cz and Pz electrodes). However, the results revealed that attachment group did not have effect on these dependent variables, $p = .92$.

**FN400 Latency**

Box's Test of equality of covariance matrices did not supported the assumption of homogeneity of covariance for multivariate analysis, $p = .001$. The result with use of Pillai's Trace criteria revealed that combined DVs were significantly affected by electrode location , Pillai's Trace=.53, $F(2,36)=20.60$ $p <.001$, $\eta^2=.53$; interaction of emotion type and electrode location , Pillai's Trace=.30, $F(4,34)= 2.80$, $p = .04$, $\eta^2 = .30$ and interaction of emotion type and attachment group, Pillai's Trace=.20, $F(2,36) = 3.90$, $p = .03$, $\eta^2 = .20$. Mauchly's Test indicated that the assumption of sphrecity had been met for the effect of emotion type, $p = .41$, and also interaction effect of emotion type and electrode location, $p = .11$. However, the assumption of sphericity had been violated for the effect of electrode location, $p = .03$. Therefore, degrees of freedom were corrected, using Greenhouse-Geisser estimates of sphericity for this main effect.

**Table 3.14. Latency values of FN400 for electrode locations**

| Electrode | Mean | Std. Error |
|---|---|---|
| Pz | 434.94 | 2.04 |
| Fz | 429.02 | 3.05 |
| Cz | 420.20 | 1.90 |

The result of univariate analysis of variance (ANOVA) revealed a significant effect of electrode location, $F(1.70,63) = 13.31$, $p<.001$, $\eta^2 = .30$ withdelayed FN4 latency at Pz *(M* = 434.94, *SE* = 2.04) compared to Fz *(M* = 429.02, *SE* = 3.10) and Cz electrodes *(M* = 420.20, *SE* = 1.90) (see Table 3.14*)*.

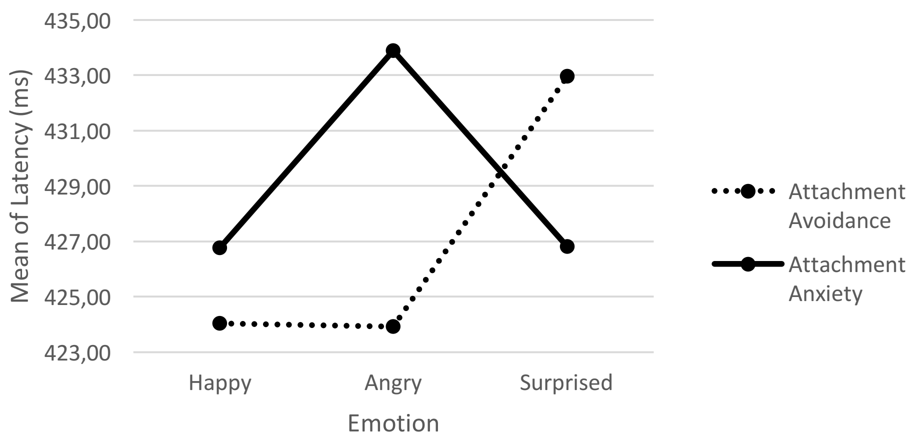


**Figure 3.18. Mean FN400 latency showing significant interaction between emotion and attachment group**

In addition to this, a significant interaction of emotion type and attachment group was found, indicating happy and angry faces elicited later FN400 latencies in attachment anxiety group, compared to attachment avoidance group. However, surprised faces produced earlier FN400 latency in attachment anxiety as demonstrated in Figure 3.18**.** On the other hand, other effects were not statistically significant,

$p_s$>.05. For the between-subjects factor, the assumption of equal variance has been assumed for all dependent variables, $p_s > .05$, (FN400 latency responses for happy faces at Fz, Cz and Pz electrodes, FN400 latency responses for angry faces at Fz, Cz and Pz electrodes and FN400 latency responses for surprised faces at Fz, Cz and Pz electrodes). However, the results revealed that attachment group did not have effect on these dependent variables, $p = .53$.

**FN400 Amplitude**

Box's Test of equality of covariance matrices did not supported the assumption of homogeneity of covariance for multivariate analysis, $p = .02$. The result with use of Pillai's Trace criteria revealed that combined DVs were significantly affected by electrode location, Pillai's Trace=.40, $F(2,36)=11.23$, $p<.001$, $\eta^2=.40$, interaction of emotion type and electrode location , Pillai's Trace=.60, $F(4,34) = 10.91$, $p < .001$, $\eta^2 = .60$. No other effects were significant, $p_s > .05$. Mauchly's Test indicated that the assumption of sphrecity had been met for the main effects of emotion type, $p = .60$, and electrode location, $p = .24$. However, the assumption of sphericity had been violated for the interaction effect of emotion and electrode, $p = .003$. Therefore, degrees of freedom were corrected, using Greenhouse-Geisser estimates of sphericity for this interaction effect.

**Table 3.15. Amplitude values of FN400 for electrode locations**

| Electrode | Mean | Std. Error |
|---|---|---|
| Pz | -3.61 | 0.17 |
| Fz | -5.44 | 0.36 |
| Cz | -4.57 | 0.40 |

The result of univariate analysis of variance (ANOVA) revealed a significant main effect of electrode, $F(2,74)= .34$, $p< .001$, $\eta^2 = .71$ with less negativity at Pz ($M$ = -3.61, $SE$ = .17) than at Cz ($M$ = -4.57, $SE$ = .40) and Fz electrodes ($M$ = -5.44, $SE$ = .36) (see Table 3.15).

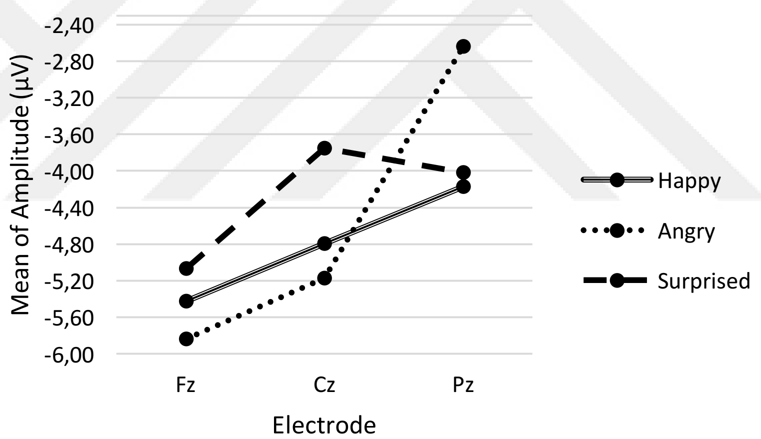


**Figure 3.19. Significant interaction between emotion type and and electrode locations on FN400 amplitude**

A significant interaction effect of emotion type and electrode location was also found, $F(3,110.82) = 8.40$, $p < .001$, $\eta^2 = .20$. The largest FN400 amplitude was observed for angry faces at the Fz electrode but the same emotional faces produced the smallest FN4 amplitude at the Pz electrode, as shown in Figure 3.19. On the other hand, happy and surprised faces modulated relatively similar FN400 amplitudes at the Fz and Pz electrodes. However, these differences were larger at the Cz electrode, showing that a larger FN400 amplitude at Cz electrode was observed for happy faces than surprised faces.

On the other hand, other effects were not statistically significant, $p_s > .05$. For the between-subjects factor, the assumption of equal variance has been assumed for all dependent variables, $p_s > .05$, (FN400 amplitude responses for happy faces at Fz, Cz and Pz electrodes, FN400 amplitude responses for angry faces at Fz, Cz and Pz electrodes and FN400 amplitude responses for surprised faces at Fz, Cz and Pz electrodes). However, the results revealed that attachment group did not have effect on these dependent variables, $p = .40$.

**Table 3.16. Electrophysiological Results of Interpretation Phase (Phase 1)**

| ERP Component | Effects | *F* | *p* | *Partial* $\eta^2$ |
|---|---|---|---|---|
| N100 Latency | A | 4.88 | **.01** | .12 |
| | Ax C | .22 | .80 | .01 |
| | B | 10.10 | **.001** | .21 |
| | BxC | .50 | .60 | .01 |
| | AxB | 4.15 | **.01** | .10 |
| | AxBxC | .11 | .94 | .003 |
| N100 Amplitude | A | 2.40 | .10 | .10 |
| | Ax C | .90 | .42 | .02 |
| | B | 15.10 | **.001** | .30 |
| | BxC | .60 | .54 | .02 |
| | AxB | 1.40 | .30 | .04 |
| | AxBxC | .80 | .52 | .02 |
| N200 Latency | A | 5.82 | **.004** | .14 |
| | Ax C | .50 | .64 | .01 |
| | B | 3.33 | **.04** | .10 |
| | BxC | .30 | .80 | .01 |
| | AxB | .90 | .50 | .02 |
| | AxBxC | 1.00 | .41 | .03 |
| N200 Amplitude | A | 4.00 | **.02** | .10 |
| | Ax C | .21 | .81 | .01 |
| | B | 36.73 | **.001** | .50 |
| | BxC | 0.30 | .71 | .01 |
| | AxB | 0.92 | .50 | .02 |
| | AxBxC | 1.90 | .12 | .10 |

*Note.* *N*=39 (18 AVO, 21 ANX); Emotion type (A) includes happy, angry and surprised facial expressions; Electrode location (B) includes Fz, Cz and Pz electrode locations respectively; Attachment group (C) includes attachment anxiety and avoidance groups; Significant p-values ($p_s$< .05) are shown in bold

**Table 3.17. Mean and Standard Error of ERP Components for Siginificant Main Effects**

| ERP Component | Main Effect | | Mean | Std. Error |
|---|---|---|---|---|
| | Emotion type | Happy | 129.95 | 3.03 |
| | | Angry | 119.22 | 3.15 |
| N100 Latency | | Surprised | 121.02 | 3.12 |
| | Electrode location | Pz | 114.63 | 3.25 |
| | | Fz | 129.22 | 2.80 |
| | | Cz | 126.35 | 2.95 |
| N100 Amplitude | Electrode location | Pz | -4.16 | 0.29 |
| | | Fz | -5.84 | 0.43 |
| | | Cz | -6.12 | 0.46 |
| | Emotion type | Happy | 240.38 | 3.67 |
| | | Angry | 248.70 | 2.81 |
| N200 Latency | | Surprised | 239.98 | 2.90 |
| | Electrode location | Pz | 240.35 | 3.14 |
| | | Fz | 247.61 | 2.65 |
| | | Cz | 241.11 | 3.76 |
| | Emotion type | Happy | -6.80 | 0.50 |
| | | Angry | -6.51 | 0.50 |
| N200 Amplitude | | Surprised | -7.71 | 0.53 |
| | Electrode location | Pz | -4.80 | 0.40 |
| | | Fz | -8.10 | 0.60 |
| | | Cz | -8.20 | 0.60 |

**Table 3.18. Electrophysiological Results of Recognition Phase (Phase 2)**

| ERP Component | Effects | *F* | *p* | *Partial* $\eta^2$ |
|---|---|---|---|---|
| N100 Latency | A | 2.20 | .12 | .06 |
| | Ax C | 1.84 | .17 | .05 |
| | B | 3.00 | .10 | .07 |
| | BxC | .12 | .82 | .003 |
| | AxB | .10 | .96 | .002 |
| | AxBxC | .52 | .70 | .01 |
| N100 Amplitude | A | .63 | .51 | .02 |
| | Ax C | .82 | .43 | .02 |
| | B | 23.61 | **.001** | .40 |
| | BxC | .80 | .44 | .02 |
| | AxB | .44 | .80 | .01 |
| | AxBxC | .92 | .44 | .02 |
| N200 Latency | A | 11.11 | **.001** | .23 |
| | Ax C | .12 | .90 | .001 |
| | B | 3.42 | .10 | .09 |
| | BxC | .20 | .78 | .001 |
| | AxB | 1.59 | .20 | .04 |
| | AxBxC | 1.00 | .43 | .03 |
| N200 Amplitude | A | 1.70 | .20 | .04 |
| | Ax C | 1.06 | .40 | .03 |
| | B | 17.80 | **.001** | .33 |
| | BxC | 1.40 | .30 | .04 |
| | AxB | .80 | .54 | .02 |
| | AxBxC | .40 | .81 | .01 |

***Table 3.18. (continued)***

| *ERP Component* | *Effects* | *F* | *p* | *Partial $\eta^2$* |
|---|---|---|---|---|
| FN400 Latency | A | 1.10 | .40 | .03 |
| | Ax C | 3.13 | **.05** | .08 |
| | B | 13.31 | **.001** | .30 |
| | BxC | 0.30 | .72 | .01 |
| | AxB | 2.20 | .10 | .10 |
| | AxBxC | 2.00 | .10 | .10 |
| FN400 Amplitude | A | 1.41 | .30 | .04 |
| | Ax C | 0.34 | .71 | .01 |
| | B | 13.10 | **.001** | .30 |
| | BxC | 0.10 | .90 | .001 |
| | AxB | 8.40 | **.001** | .20 |
| | AxBxC | 1.80 | .20 | .10 |

*Note. N*=39 (18 AVO, 21 ANX); Emotion type (A) includes happy, angry and surprised facial expressions; Electrode location (B) includes Fz, Cz and Pz electrode locations respectively; Attachment group (C) includes attachment anxiety and avoidance groups; Significant p-values ($p_s$< .05) are shown in bold.

**Table 3.19. Mean and Standard Error of ERP Components for Siginificant Main Effects**

| ERP Component | Main Effect | | Mean | Std. Error |
|---|---|---|---|---|
| N100 Amplitude | Electrode location | Pz | -3.67 | 0.29 |
| | | Fz | -5.87 | 0.38 |
| | | Cz | -5.95 | 0.48 |
| N200 Latency | Emotion type | Happy | 224.98 | 2.84 |
| | | Angry | 225.84 | 2.75 |
| | | Surprised | 214.80 | 3.12 |
| N200 Amplitude | Electrode location | Pz | -4,92 | 0,48 |
| | | Fz | -7,69 | 0,56 |
| | | Cz | -7,94 | 0,60 |
| FN400 Latency | Electrode location | Pz | 434.94 | 2.04 |
| | | Fz | 429.02 | 3.05 |
| | | Cz | 420.20 | 1.90 |
| FN400 Amplitude | Electrode location | Pz | -3.61 | 0.17 |
| | | Fz | -5.44 | 0.36 |
| | | Cz | -4.57 | 0.40 |

*Note.* N100 Latency did not reveal significant results, $p_s > .05$.

# CHAPTER 4

# DISCUSSION

## 4.1 Overview

Investigating both behavioural and neurobiological correlates of emotional information processing in individuals with different attachment styles, the present study aimed to clarify the issue concerning whether information processing biases are present in adult attachment. In line with this purpose, individuals with different attachment style were given the facial expression task measuring an interpretation of facial expressions (Phase 1) and recognition memory for emotional faces (Phase 2). Both behavioural and ERP measures were recorded during the facial expression task.

In the following sections, behavioural and electrophysiological findings of the study are presented respectively. The section of behavioural findings (see section 4.2) begins with discussions on the findings of emotional regulation difficulties and psychopathological tendencies in different attachment styles and is then followed by discussions on the findings of interpretation of facial expressions and recognition memory in adult attachment. Another section that involves electrophysiological findings of facial expression task (see section 4.3) discusses neural mechanisms of adult attachment during both interpretations of facial expressions and recognition memory. Finally, this chapter concludes with discussions on study limitations, future directions for research and clinical implications of the study.

## 4.2. Behavioural Findings

### 4.2.1 Inter-correlations of Attachment Anxiety, Attachment Avoidance, STAI, DASS and DERS

In line with previous research on emotion regulation in adult attachment (Mikulincer et al., 2007, 2008; Marganska et al., 2013), the findings revealed that individuals with attachment anxiety tended to struggle with regulating their emotions, indicating the maladaptive ways of responding to emotions such as a lack of emotional clarity, non-acceptance of emotions, difficulties controlling impulsive behaviours. Also, these individuals reported limited access to emotional regulation strategies or, even if they had access, they reported some difficulties engaging in goal directed-behaviour. As Mikulincer et al. (2007, 2008) stated, hyperactivating strategies of attachment anxiety that serve to keep the attachment system activated intensify individuals' negative emotions (e.g anger and fear), feelings (e.g vulnerability and incompetent) and also thoughts concerning threat-related concerns. In congruent with the goals of attachment anxiety, hyperactivating strategies also promote individuals to remain vigilant concerning threat or threat-related cues, to exaggerate threat-related distress and to ruminate on these concerns. That is why, on the basis of hyperactivating strategies, individuals with attachment anxiety may display reduced emotional clarity, emotional acceptance and control of behaviours when experiencing distress. Moreover, in such conditions, Shaver and Mikulincer

(2007) mentioned that hyperactivation system interfere with seeking problem-solving and maintaining goal-directed behaviours due to its primary aim that serves to pursue sense of neediness and dissatisfaction. Therefore, individuals with attachment anxiety tend to experience difficulties in both developing emotion regulation strategies and maintaining goal-directed behaviours.

In addition to this, in this study, individuals with attachment anxiety reported tendencies for trait anxiety (e.g stable tendency to experience distress, worry and tension across many situations), anxiety, stress and depression. These findings are consistent with previous studies suggesting links between attachment anxiety and depression/anxiety/stress (Gilbert et al. 2008; Levit-Binun et al., 2014; Wei et al., 2007); attachment anxiety and trait anxiety (Suslow et al., 2010; Tsagarakis et al., 2008). Also, there are some evidence indicating some mechanism that mediate the relationship between attachment anxiety and the depression/anxiety such as dependence and self-criticism (Cantazaro & Wei, 2010); hopelessness (Hankin et al., 2005), low self-esteem (Lee & Hankin, 2009), mental rumination (Burnette et al., 2009); problem coping styles (Wei et al., 2005), difficulties in problem solving (Wei et al., 2003) and difficulties in emotion regulation (Marganska et al., 2013). For example, Wei et al. (2003) found that perceived coping fully mediated the relationship between attachment anxiety and psychological distress (e.g depression and anxiety. In addition to this, Cantazano and Wei (2010) suggested the dependence and self-criticism fully mediated relationship between attachment anxiety and depressive symptoms. Taken as a whole, the current findings indicate that intense negative feelings (e.g anger, helplessness, neediness) and maladaptive emotion strategies (e.g self-blame,self-critism and mental ruminations) serving to goals of attachment anxiety might be caught individuals in a vicious cycle in which they become more vulnerable to develop the symptoms of depression and anxiety (see part 4.6 clinical implications)

On the other hand, the findings of attachment avoidance revealed non-significant results, reflecting negative correlation between attachment avoidance and subscales of DERS (except Awareness and Clarity subscale). This may be interpreted in light of the characteristics of attachment avoidance. Some researchers (Shaver& Mikulincer, 2007; Gillath et al., 2005) emphasized that individuals with attachment avoidance tend to supress or ignore the events inducing distress and they consider such feelings as weakness or vulnerability that damage to a sense of self-reliance. Thereby, these individuals may inhibit their display of emotions (Kobak et al., 1993; Mikulincer & Shaver, 2003; Shaver & Mikulincer, 2007) and show behavioural withdrawal from others (Shaver & Mikulincer, 2007). On the basis of this notions, participants with attachment avoidance may ignore their existing problems or avoid to self-disclosure, while completing DERS. Similar impression might be stated for the findings of DASS. There was no significant correlation between attachment avoidance and depression/ anxiety/ stress. Although some research has shown that attachment avoidance is related to symptoms of psychopathologies such as depression (Desrosiers et al., 2014), Dozier and Kobak (1992) mentioned that individuals with attachment avoidance were reluctant to report their depressive symptoms. In similar way, participants with attachment avoidance may underreport their experience of distress and psychopathological symptoms by either ignoring them or avoiding self-disclosure. Lastly, in line with previous studies (Tsagarakis et al., 2007; Ditzen et al., 2008; Cooper et al., 2009), other findings revealed no significant association between attachment avoidance and state/trait anxiety.

Taken as a whole, these findings show that individuals with attachment anxiety appear to have a difficulty regulating their emotions and vulnerability to developing a psychopathology such as depression and anxiety. On the other hand, it would be difficult to reach firm conclusion for attachment avoidance. Yet, as mentioned earlier, the individuals with attachment avoidance seem to underreport their emotion regulation difficulties and psychopathological symptoms in line with their attachment characteristics. Thus, these findings supported discriminant validity of our attachment measure (ECR-R) through appropriate relationships with measures of depression, anxiety, emotion regulation difficulties and attachment styles.

### 4.2.2 Attachment and Interpretation of Facial Expressions

The main findings failed to satisfy the hypothesis that anxiety and avoidant attachment groups were differentiated on the interpretations of happy, angry, and surprised facial expressions. It can therefore be assumed that individuals in both attachment groups displayed similar patterns in interpretation of each emotional expression. However, note that these may be due to small sample size or ecological validity of the faces that used in the paradigm. To our knowledge, there is no behavioural study that directly investigating interpretation of facial expressions in different attachment styles. However, similar to the present findings, a study by Chavis and Kisley (2012) revealed that attachment groups may not differ in terms of valance category of emotional images.

On the other hand, individuals with different attachment styles differed in the interpretation of emotional facial expressions regardless of valance. Surprisingly, individuals with attachment avoidance were prone to interpret emotional facial expressions in a more positive manner compared to individuals with attachment anxiety. A few studies provided evidence concerning the attachment-insecurity-related differences in interpretation biases. Contrary to current finding, individuals with attachment avoidance has been associated with reduced positive affect for supportive events (Campbell, Simpson, Boldry & Kashy, 2005), reduced pleasantness rating for positive social images (Vrticka, Sander & Vuilleumier, 2012) and negative interpretations for ambiguously supportive messages (Collins & Feeney, 2004). On the other hand, in the present data, a positive interpretation of individuals with attachment avoidance in response to all emotional facial expressions may reflect a protective marker of deactivating strategies, particularly under the conditions that induce ambiguity (i.e. surprised) and aggression (i.e. angry). This protective effect of positive interpretations can be seen as a buffer against potential stressors that are incongruent with the goals of deactivating strategies. However, it should be highlighted that this inference may remain speculative due to a lack of evidence. Therefore, more investigations of interpretation of emotional stimuli in adult attachment are needed.

Also, our findings showed that individuals with attachment anxiety were prone to interpret emotional facial expression in more negative manner, compared to individuals with attachment avoidance.  There is no direct study showing the interpretation patterns of attachment anxiety. Yet, Collins and Feeney (2004, Study 1) found that individuals with attachment anxiety had tendency to evaluate the ambiguously support messages in negative fashion (e.g mood or feeling of support in the relationship), compared to secure individuals. Also, Pereg and Mikulincer (2004) have found that individuals with high level attachment anxiety in negative mood condition displayed negative attributions concerning hypothetical partner’s behaviour, compared to participants in neutral mood condition. In support of Pereg and Mikulincer's (2004) findings, Gillath et al. (2016) suggested that contextual factors influenced negative interpretations or attributions of attachment anxiety. On the basis of these findings (Collins and Feeney, 2004; Gillath et al., 2016; Pereg & Mikulincer, 2004), angry and surprised faces that dominantly activate hyper-vigilance system may have motivated individuals with attachment anxiety in order to interpret all types of emotional faces in more negative manner, in line with the goals of attachment system. Thereby, overall negative interpretations in response to emotional facial expressions can be seen as an activation of hyperactivating strategies in attachment anxiety.

In addition to response-based interpretation performance of attachment groups, surprisingly, individuals with different attachment styles did not significantly differ in reaction times during the interpretation of facial expressions. This may indicate that individuals with both attachment groups display similar reaction-time patterns for interpretation of facial expressions. It is quite complicated to compare the current findings with previous studies due to incongruence of study tasks but other studies (e.g. Fraley et al., 2006; Maier et al., 2005; Niedenthal et al., 2002) using threshold tasks in perceptual vigilance in the context of adult attachment may provide insight to argue the current findings. For instances, some studies (Maier et al., 2005; Niendenthal et al., 2002) found that attachment avoidance is associated with increased perceptual vigilance to emotional stimuli, indicating lower perceptual thresholds (i.e. quick response) for emotional stimuli. On the other hand, Fraley et al. (2006) indicated that individuals with attachment anxiety detected both onset and offset of positive and negative emotional facial expressions at early-time point, compared to individuals with less attachment anxiety. Taken as a whole, there is no consensus concerning interpretation differences in adult attachment on the basis of reaction-time. The current findings revealed non-significant differences in reaction times of attachment groups during the interpretation of facial expressions but it should be noted that small sample size and/ or characteristics of the pictures may lead to these results.

### 4.2.3 Attachment and Recognition Memory

The findings partially supported the hypothesis that individuals with attachment anxiety would be more accurate to recognise happy, angry and surprised facial expressions, displaying lowest RTs, compared to individuals with attachment avoidance. A four-way interaction (emotion type, stimulus type, recognition type and attachment group) was found, showing the old and new emotional face differences within each attachment group. Individuals with attachment avoidance recognised new happy faces more accurately than old ones. However, other correctly recognised emotional faces did not differ across old/new stimulus among individuals with attachment avoidance. This can be interpreted in two ways. First, individuals with attachment avoidance may show a memory bias for only new happy faces. Alternatively, these individuals may have correctly recognised new happy faces by reflecting a perceptual vigilance to them during the presentation of happy-face stimuli. In addition to this, the findings also revealed that individuals with attachment avoidance had retrieval difficulties for old emotional faces. In support of the current finding, Mikulincer and Orbach (1995) found participants with attachment avoidance displayed poor memory performance in recalling negative emotional experiences (i.e sadness and anxiety themes) with longest recall latencies. Fraley and colleagues

(2000, 2007) suggest that retrieval difficulties in attachment avoidance may derive from attention and/or encoding processes, indicating the defensive strategies, especially pre-emptive based defensive strategies. Also, regarding to happy stimuli, Cassidy (1994, cited in Mikulincer & Shaver, 2007) emphasized that joy and happiness, as sign of interpersonal closeness, may lead to distress for individuals with attachment avoidance. On the basis of these evidences (Cassidy, 1994; Fraley, Garner, & Shaver, 2000; Fraley & Brumbaugh 2007), pre-emptive based defensive strategies appear to limit implicit learning of emotional faces (happy, angry and surprised faces) in line with the goal of keeping the attachment system deactivated. Thus, individuals with attachment avoidance ignore previously seen emotional faces (old face) at recognition phase.

On the other hand, individuals with attachment anxiety recognised old surprised more accurately than new ones and also recognised new happy and angry faces more accurately than the same category of old faces. These findings revealed retrieval difficulties in attachment anxiety for both happy and angry faces. Some indirect evidence may help to argue the current findings. Edelstein (2006) found attachment anxiety was not related working memory performance. On the other hand, Mikulincer and Orbach (1995) showed that individuals with attachment anxiety, in other words insecure anxiety/ambivalence, displayed better accessibility to emotional memories (i.e. happy, sad, angry and anxious themes) with short recall latencies, regardless of valance. Contrarily to these previous studies, the current findings revealed that individuals with attachment anxiety displayed emotion-specific memory bias to surprised faces and experienced some difficulties in retrieval of both happy and angry faces.

Surprised faces that implicitly emphasize the ambiguity-related thoughts or experiences appear to have more dominant emotional content to serve to keep attachment system activated, compared to emotional contents of other faces. Thereby, individuals with attachment anxiety may have selectively recognized previously seen surprised faces during the recognition phase. On the other hand, a difficulty in retrieval of both happy and angry faces indicated that the emotional content did not facilitate implicit learning during the interpretation phase of facial expression task. There is neither direct nor indirect evidence to make happy-face-specific inferences for attachment anxiety. However, it should be highlighted that a difficulty in retrieval of angry faces appears to be contradict to an activation of hyperactivating strategies because negative emotions are considered by individuals with attachment anxiety as congruent with the goals of attachment system (Mikulincer & Shaver, 2003). On the basis of Mikulincer and Shaver's (2003) notion, it might have been expected that angry faces implicitly learned in interpretation phase would be recognised more accurately than new angry faces. However, both angry and happy faces appear not to activate hyperactivating strategies at the initial stage of memory (i.e. implicit learning of emotional faces). On the other hand, surprisingly, individuals with different attachment styles did not differ in reaction times of correct old/new face responses, indicating similar pattern of reaction times to recognition of emotional face. To our knowledge, previous studies (Edelstein, 2006; Fraley & Brumbaugh, 2007; Mikulincer & Orbach, 1995) on attachment and memory primarily focused on responses of individuals rather than their RTs. Therefore, it is complicated to compare current finding with previous ones but small sample size and/or characteristics of the pictures may lead to non-significant differences in reaction times of attachment groups.

## 4.3 Electrophysiological Findings

### 4.3.1 Electrophysiological Findings of Interpretation Phase

#### 4.3.1.1 ERP Differences between Attachment Avoidance and Attachment Anxiety Groups During Interpretation of Facial Expressions

The main findings failed to satisfy the hypothesis that attachment anxiety and attachment avoidance groups were significantly differentiated on amplitudes and latencies of specific ERP components in response to emotional stimuli during interpretation phase of facial expression task. The interpretation of emotional facial expressions did not significantly produce N100 and N200 differences (amplitude and latency) between attachment anxiety and attachment avoidance groups, as the findings revealed. Although these findings did not reach statistical significance level due to relatively small sample size, visual ERP analysis predicted some considerable N100 and N200 amplitude differences among attachment groups during interpretation of emotional facial expressions.

Different type of faces produced different N100 component related with attentional resources. In details, compared to individuals with attachment anxiety, individuals with attachment avoidance showed reduced attentional resources to happy and angry facial expressions, as reflected in the smaller N100 amplitudes at both frontal and central locations. Conversely, individuals with attachment anxiety showed enhanced attentional resources to happy and angry facial expressions, as reflected in the larger N100 amplitudes at both frontal and central locations. These findings are consistent with previous research (Zhang et al., 2008). Zhang et al. (2008) found attachment-related differences on N100 amplitude in response to emotional expressions (happy, fearful and neutral). They demonstrated that individuals with attachment avoidance displayed smaller N100 amplitudes to these emotional faces over posterior and frontal sites than individuals with attachment anxiety and attachment security. Regarding to N100 differences among attachment groups in response to surprised facial expressions, the current findings revealed that surprised facial expressions elicited larger N100 amplitude over central sites and smaller N100 amplitude over frontal sites in attachment avoidance group than in attachment anxiety group. Such differentiation may derive from the involvements of distinct cortical networks associated with frontal and central electrode locations. As is known, Fz electrode is placed near intentional and motivational areas of the frontal lobe whereas Cz electrode is placed near to sensory and motor areas of the cortex (Teplan, 2002). In general, emotional faces are motivationally salient stimuli that activate either appetitive or defensive motivational systems. Also, these motivational systems are thought to mediate attentional processes and facilitate enhanced perceptual processing. Surprised facial expressions, compared to high salient facial expressions such as fear and angry, provide ambiguous information that elicit either pleasant (e.g reward) or unpleasant (e.g threatening) context (Davis, Neta, Kim, Moran &Whalen, 2016). Kim, Somerville, Johnstone, Alexander & Whalen (2003) suggest that surprised facial expressions modulate amygdala activities. In their study, they found that more negative interpretations of surprised faces elicited greater signal changes in the right ventral amygdala whereas more positive interpretations elicited greater signal changes in the ventral medial prefrontal cortex (mPFC). In a fMRI study by Vrticka et al. (2008) found reverse association between activation of striatal reward circuit and attachment avoidance in response to positive emotional signals and also positive association between amygdala activation and attachment anxiety in response to negative emotional signals. Based on these findings, surprised facial expressions could be interpreted as threatening by both attachment groups in line with their attachment-system dynamics. Yet, these two attachment groups appear to adopt different secondary attachment strategies to deal with negative impacts (e.g threat) of surprised facial expressions. As an indication of hypervigiliance toward threat-related information, individuals with anxiety attachment seems to devote more attention to surprised facial expressions by reflecting enhanced N100 amplitude at frontal scalp locations. On the other hand, individuals with attachment avoidance seems to devote less attention to such expressions in order to deactivate potentially source of threat.

In regarding to attachment-related differences in the N200 time-window, the present findings revealed that the interpretations of angry and surprised facial expressions elicited enhanced N200 amplitude over central scalp locations in attachment anxiety group than in attachment avoidance group. On the other hand, the interpretation of happy facial expression modulated enhanced N200 amplitude over fronto-central scalp locations in attachment avoidance group as compared with attachment anxiety group. N200 is related to response inhibition, response conflict, error monitoring and is also sensitive to detection of perceptual novelty or attentional deviation (Patel & Azzam, 2005). The fronto-central N200 has previously been suggested to reflect participants' cognitive control or response monitoring processes during effortful tasks (for a review, see Folstein & van Petten 2008). Despite the absence of explicit response conflict or cognitive control in this study, the fronto-central N200 recorded for anxious attachment individuals during angry and surprised facial expressions that participants were still monitoring their internal responses to the stimuli. On the other hand, the present findings revealed that individuals with attachment avoidance were still monitoring their internal responses to happy facial expressions. This argument is also supported by previous research (Gamer & Berti, 2010; Hu, Pornpattananangkul & Rosenfeld et al., 2013) in which N200 represents cognitive processes rather than recognition, and in which processing a meaningful stimulus would trigger a higher level of response monitoring. Thus, it could be argued that meaning processing of emotional facial expressions differs across attachment styles. These emotional-content differences in attachment styles may be associated with secondary attachment strategies. For example, angry and surprised facial expressions could reflect attachment-related concerns such as disappointment, loss or breakdown. In order to deal with attachment-related concerns, individuals with attachment anxiety, who adopt to hyperactivating strategies, seem to remain vigilant themselves by displaying an enhanced response monitoring to both angry and surprised facial expressions. However, happy facial expressions appear to have reduced effects in order to activate hyper-vigilance system in attachment anxiety. Therefore, these individuals may have exhibited a reduced response monitoring to such facial expressions.  On the other hand, individuals with attachment avoidance who adopt to deactivating strategies seem to limit processing of both angry and surprised facial expressions, displaying a reduced response monitoring. Thus, they keep their attachment system deactivated even at later stages of information processing.

The N200 findings can be also interpreted from (effortful) cognitive control perspective in adult attachment. N200 is also known to reflect cognitive control processes (Correll et al., 2006; Folstein & van Petten, 2008). N200 enhancement has been associated with an increase in attentional control to inhibit emotional processing that may reflect effortful cognitive control (Eldar & Bar-Haim, 2010). On the other hand, Dennis and Chen (2007) suggested that enhanced N200 amplitude may indicate a reduced available cognitive resources for attention performance and a fewer cognitive control resources to inhibit attention toward emotional faces (e.g fear). Regarding to cognitive control processes in adult attachment, in a fMRI study, Gillath et al. (2005) found increased activity in brain areas associated with negative emotion (e.g., anterior temporal pole and dorsal anterior cingulate cortex) and less activity in brain regions (e.g orbitofrontal cortex) associated with the down-regulation of negative emotions for individuals with high level attachment anxiety. More importantly, Gillath et al. (2005) found a negative correlation between activations of anterior temporal pole and orbitofrontal cortex, pointing that individuals with attachment anxiety show stronger recruitment of neural system associated with negative emotional states during the processing of attachment related information and limited regulatory capacities to inhibit this information processing. Thus, their findings suggested a poorer cognitive control in attachment anxiety during the processing of attachment-related information. On the other hand, Edelstein and Gillath (2008) found that individuals with attachment avoidance were able to inhibit attention to threatening-related words as an indication of cognitive effort. In addition, Dewitte (2011) showed stronger inhibition of both sad and angry faces in attachment avoidance, indicating that the regulatory strategies serve to attentional inhibition of negatively valanced stimuli. Dewitte (2011) also emphasized that the regulatory strategies that individuals with attachment avoidance use may not involve attentional inhibition of positively valanced stimuli. Based on these findings (Dennis & Chen, 2007; Dewitte, 2011; Edelstein & Gillath, 2008 Gillath et al., 2005; Gillath, Giesbrecht & Shaver, 2009) the current finding revealed that individuals with attachment anxiety were less successful to recruit cognitive control to inhibit their attentions for angry and surprised facial expressions whereas individuals with attachment avoidance were able to efficiently use their cognitive resources to inhibit attention towards such stimuli. For happy facial expressions, individuals with attachment avoidance were not able to recruit cognitive control to inhibit their attentions to happy facial expressions but individuals with attachment anxiety did. However, it should be highlighted that this interpretation may remain speculative due to our facial expressions task because our task was not fit enough to evaluate participants' cognitive control processes toward emotional stimuli.

In brief, due to relatively small sample size, the main findings did not reveal statistically significant differences in emotional information processing between attachment anxiety and attachment avoidance during interpretation of facial expressions. However, visual analysis of ERPs shows possible differences in emotional information processing among different attachment styles. As the findings indicate, individuals with anxious display initial attentional to happy, angry and surprised, reflecting hypervigiliance towards all types of emotional expressions. At the later stages of information processing, they just sustain their attention to threatening (angry) and/ or ambiguous (surprised) stimuli, not for positively-valanced stimuli (happy). However, individuals with attachment avoidance shows reverse pattern in the emotional information processing. They display limited initial attention to all types of emotional expressions but, at the later stages of information processing, they display attentional engagement to less-threatening stimuli such as happy facial expressions.

#### 4.3.1.2 Topographic Distributions of Interpretation of Facial Expressions

The findings satisfied the hypothesis that amplitude and latency of the ERP peaks varied across electrode locations. As the findings revealed, N100 was earliest at posterior sites and then moved towards central and frontal sites respectively. Previous studies (Zhang et al. 2008; Mark, Geurdes & Bekker, 2012) indicated that emotional stimuli did not elicit N100-latency differences over the scalp of midline locations. Regarding to posterior visual N100, researchers (Gomez-Gonzales, Clark, Fan, Luck, & Hillyard, 1994; Hopf, Vogel, Woodma, Heinze & Luck, 2002) reported that dipoles in lateral extrusive cortex modulate N100 over posterior sites with involvement of parieto-occipital and occipito-temporal areas. As is known, initial perceptual face processing is associated with inferior occipital cortex and middle fusiform gyrus ( Rossion, Caldera, Seghier, Schuller, Lazeyras & Mayer, 2003) with right hemisphere dominance. In addition to this, several research (Allison, Puce & McCarthy, 2000; Engell & Haxby, 2007; Pitcher, 2014) indicates that neural responses to the dynamic aspects of faces (e.g facial expressions stems) stem from superior temporal sulcus. Based on neuroimaging studies (Rossion et al., 2003; Allison, Puce & McCarthy, 2000; Engell & Haxby, 2007; Pitcher,2014), through the involvement of posterior brain regions involved in facial expression processing, the facial expressions stimuli that used in the present study appears to modulate N100 over posterior sites with the earliest latency, compared to fronto-central sites.

In line with previous evidence (Zhang et al., 2008; Bar-Haim, Lamy & Glickman, 2005), the current findings revealed a less N100 negativity on posterior than on frontal and central scalp locations respectively. Both studies using emotional face task found that N100 amplitude were less on posterior (electrode Pz) than on fronto-central (electrodes Fz and Cz) scalp locations. As mentioned above, central locations are responsive for sensory and motor functions (Teplan, 2002). So, the maximal N100 amplitude on central scalp locations may indicate an enhanced sensory specificity towards emotional cues during the interpretation of different facial expressions.

In addition to this, the other findings revealed a delayed N200 latency at frontal scalp locations and greater negativity at fronto-central scalp locations. These frontal-location effects may indicate motivational specificity in interpretation of facial expressions, eliciting more resources for attentional engagement and also attentional control mechanism.

#### 4.3.1.3 Emotion-specific Effects of Interpretation of Facial Expressions

The findings of emotional effects partially satisfied the hypothesis that the amplitude and latency of the ERP peaks varied across types of emotional stimuli. In the N100 time-window, angry facial expressions elicited early N100 latency, compared with surprised and happy facial expressions, as the current findings revealed. On the other hand, surprisingly, the findings showed no emotion-specific differences in N100 amplitudes. N100 that indexes attentional processes (Hillyard et al., 1973) is thought be sensitive to emotional content. In keeping with this notion, the modulations of emotion-specific N100 latency may reflect that negatively valanced facial expressions (e.g angry) initially captured attention, compared to positive and relatively ambiguous facial expressions (e.g happy and surprised). On the other hand, based on the N100-amplitude findings, it seems that these facial expressions elicit an equal amount of cognitive resources devoted to attention.  Also, the findings indicated early-posterior N100 latencies in responses to angry and surprised as compared with happy facial expressions. Emotion specific differences did not reveal over fronto-central scalp locations. Based on a notion that posterior scalp locations are associated with the activities of perception and differentiation (Teplan, 2002), these findings may reflect that negatively valance (e.g angry) or ambiguous facial expressions (e.g surprised) initially captured attention as reflected in earliest N100 latency over posterior scalp locations.

In the N200 time-window, the findings showed that happy facial expressions elicited early N200 latency, compared with angry and surprised facial expressions. This may suggest that positively valanced emotional facial expressions (e.g happy) produce earliest attentional engagement during the interpretation of facial expressions. In line with this finding, Calvo and Nummenmaa (2008) found a rapid detection of happy faces in visual-search paradigm, suggesting that the smile, as a visually conspicuous facial feature, capture attention reflexively. A notion that a salient features of happy faces facilitate for attentional functions has also received empirical support by other researchers (Calvo & Marerro, 2009; Miyazawa & Iwasaki, 2010). Based on previous findings mentioned above, in this present study, a visually conspicuous smile of happy faces may accelerate attentional engagement and thus individuals appear to show early N200 latency to happy faces. On the other hand, compared to other facial expressions, surprised facial expressions demanded more resources of attentional engagement and also required more effortful cognitive control during interpretation of the stimuli, as reflected in larger N200 amplitude. This may indicate that ambiguous facial expressions seems to be relatively more demanding for attentional engagement and attentional control.  There is no direct evidence but some indirect evidence by Kim et al. (2003) and Geday and Gjedde (2009) may help to discuss the present findings. Kim et al. (2003) found that more positive interpretations elicited greater signal changes in the ventral medial prefrontal cortex (mPFC) whereas more negative interpretations of surprised faces elicited greater signal changes in the right ventral amygdala. Also, Geday and Gjedde (2009) suggest that the absence of emotional interference facilitate activation in inferior prefrontal cortex modulated by attentional processes. In keeping with these findings, the present data may reflect that ambiguous feature of surprised faces may lead individuals to use more attentional resources for attentional engagement and attentional control.

Taken as whole, both angry and surprised facial expressions automatically captured attention at initial stages of information processing but, at later stages, surprised and happy faces effectively modulated attentional engagement and attentional control. Thereby, in line with previous studies (MacNamara, Kappenman, Black, Bress & Hajcak, 2014; Lin, Murray & Boynton, 2009), these findings suggest information processing bias in early stages during the interpretation of facial expression, especially for threat-related content.

### 4.3.2 Electrophysiological Findings of Recognition Phase

#### 4.3.2.1 ERP Differences between Attachment Avoidance and Attachment Anxiety Groups During Recognition Memory

The main findings of recognition phase were failed to satisfy the hypothesis that attachment anxiety and attachment avoidance groups were significantly differentiated on amplitude and latency of specific ERP components during face recognition.

The findings revealed that emotional face recognition did not significantly produce N100 and N200 differences between attachment anxiety and attachment avoidance groups, suggesting that both attachment group have similar attentional pattern at initial processing of emotional faces. However, the visual analysis of ERPs revealed that individuals with attachment avoidance displayed more N100 and N200 negativity over midline scalp locations in response to old angry and surprised faces, compared with individuals with attachment anxiety. This indicated that individuals with attachment avoidance devoted more attentional resources and sustain their attention to such faces when compared with attachment anxiety. On the other hand, both attachment groups used attentional sources and sustained their attentions towards happy faces, as reflected in larger N100 and N200 amplitudes over frontal locations (i.e. attachment avoidance) and central locations (i.e. attachment anxiety). More importantly, these findings highlighted that happy faces facilitated both groups' attentional functioning with critical involvement of distinct brain areas modulated by different attachment styles (i.e. regions associated with intentional and motivational systems in attachment avoidance and regions associated with sensory and motor systems in attachment anxiety).

The ERP modulations (N100 and N200) of happy faces over central areas associated with sensory and motor systems, that were observed for attachment anxiety, revealed that happy faces triggered sensory sensitivity in attachment anxiety. In general, there is some evidence (Jerome & Liss, 2005) showing that attachment anxiety was associated with sensory sensitivity. However, to our knowledge, no study, to date, have examined the sensory sensitivity of attachment anxiety towards emotional stimuli. A study by Acevedo, Aron, Aron, Sangester, Collins and Brown (2014) provided indirect evidence, reporting that individuals with greater sensory processing sensitivity showed stronger activations of brain regions (i.e. cingulate and premotor area) involved in attention and action planning in response to emotional faces. More importantly, researchers indicated that a greater sensory processing sensitivity activate brain regions (e.g., cingulate, insula, inferior frontal gyrus middle temporal gyrus and premotor area) involved in awareness, integration of sensory information, empathy, and action planning in response to happy and sad faces. Jagiellowicz, Aron and Aron (2016) suggest that a heightened responsiveness of individuals with high sensory processing sensitivity toward positive emotional stimuli may arise from their susceptibility to both positively and negatively valenced experiences. In keeping with these findings, compared to other emotional faces, individuals with attachment anxiety may show susceptibility toward happy faces and, thus, used attentional resources as efficiently as possible during the recognition.

In addition to these, happy faces enhanced attention functioning in attachment avoidance with involvement of frontal areas including intentional and motivational centres, as mentioned above. This may indicate that individuals with attachment avoidance seem to be sensitive to motivationally relevance of happy faces reflecting an enhanced attention toward such faces. Previous neuroimaging studies (Engelmann, Damaraju, Padmala, Pessoa, 2009; Mohanty, Gitelman, Small and Mesulam, 2008) indicated the critical involvement of several brain regions (i.e. posterior parietal cortex, orbifrontal cortex) in integration of attention and motivation system. However, to date, attachment studies provided limited evidence concerning positive information processing in function of attachment style. Therefore, it could be difficult to make assumptions. In light of motivational relevance of emotional facial expressions, happy faces could be signalling an acceptance and willingness to provide support. Thus, such expressions trigger attentional vigilance (i.e. attentional engagement) in attachment avoidance as an indication of proximity seeking. However, it should be highlighted that this assumption needs to be supported by the evidence. In this regard, future studies should investigate how interaction of attention and motivation influence positively valanced information in attachment avoidance.

Although the main findings did not reveal significant attachment-related differences in both amplitudes and latencies of FN400 peaks, the differences in FN400 latency were significant when attachment style interacted with emotion type. Thus, these findings revealed that individuals with attachment avoidance displayed a delayed FN400 latency for surprised faces. On the other hand, individuals with attachment anxiety showed a delayed FN400 latency for angry faces. The FN400 latency effects of happy faces were similar for both attachment groups who displayed early FN400 latency to such faces. In general, FN400 indexes familiarity-based recognition (Curran & Hacock, 2007). A delayed FN400 latency has been previously described as a longer judgement of familiarity of visual stimuli. (Boucher et al., 2011). Accordingly, a delayed FN400 latency for old surprised faces indicate that individuals with attachment avoidance experienced difficulties to make judgement whether such faces were old or new, as compared with the judgments of other emotional faces. In a similar vein, individuals with attachment anxiety had recognition difficulties while judging the angry faces, reflecting longer latency to such faces.

On the other hand, as mentioned earlier, the findings of FN400 amplitude revealed that both attachment groups did not significantly differ in terms of face recognition. However, the visual analysis of ERPs revealed distinctively enhanced FN400 negativities in response to all emotional faces for individuals with attachment anxiety. This indicated that these individuals were more familiar to all emotional faces for the face recognition than individuals with attachment avoidance, regardless of the valance of emotional stimuli.

However, no study -to be best of our knowledge- has examined neural correlates of information processing in different attachment styles during face recognition. One study (Zheng, Zhang & Zheng, 2015) has focused on the face recognition of individuals with attachment avoidance and found marginally significant findings. Researchers indicated a familiarity-based recognition for neutral faces only in individuals with high-level attachment avoidance, not for emotional faces. Their findings were interpreted as a successfully suppression of already encoded emotional stimuli from recollection. In a similar vein, a study (Zhai et al., 2016), in which both early and parietal old/new effects were evaluated, indicated a vigilance-avoidance dual-process model in attachment avoidance during the recognition of emotional images. In their study, individuals with attachment avoidance displayed enhanced vigilance to previously encoded emotional images and then inhibited the retrieval of such images, using the postemptive strategies. It should be importantly highlighted that these studies did not report latency differences for recognition memory.

Emotion-specific differences in FN400 latencies across attachment styles might be consequence of secondary attachment strategies. The studies investigating behavioural responses of attachment avoidance to ambiguity highlighted the interpretation of ambiguous stimuli in more negative light for attachment avoidance. For instances, Collins and Feeney (2004) found that individuals with attachment avoidance had tendency to interpret the ambiguously support messages of romantic partner in a negative light. In similar way, Mikulincer (1997) indicated avoidance tendencies from ambiguous or novel stimuli as an indication of less tolerant of ambiguity. In keeping with these findings, individuals with attachment avoidance may evaluate surprised faces which are offers to dual valance representations (either positive or negative) (Neta, Davis and Whalen, 2011) in more negative light. In the circumstances, due to deactivating attachment strategies, these individuals may have showed limited processing during the recognition of surprised faces. Also, this finding has confirmed a notion (Niendenthal et al., 2002) that an initial vigilant attention to negative stimuli may prepare individuals with attachment avoidance to successfully avoidance from possible threats.

Regarding to a delayed FN400 latency to angry faces in attachment anxiety, the findings revealed that individuals with attachment anxiety had memory retrieval difficulties while judging the angry faces, reflecting longer latency to such faces. Vrtička et al. (2008) suggest that increased sensitivity to social punishment in attachment attachment anxiety, reporting a left amygdala response evoked by angry faces when associated with negative feedback. Based on the Vrtička et al.'s (2008) findings, angry faces may induce negative feelings or thoughts (i.e. punishment, separation, loss) of individuals with attachment anxiety. Thus, these individuals, who are easily overwhelmed by such feelings and thoughts, may show delayed latency to angry faces to make judgment for recognition.

Taken as whole, the present findings suggest information processing bias in adult attachment during the face recognition. More specifically, in line with *vigilance-avoidance dual-process model* (Zhai et al., 2016) and Fraley, Garner and Shaver's (2000) *-preemptive vs. postemptive- deactivating strategies*, the present findings indicate that individuals with attachment avoidance, who devote more attentional resources to emotional faces at the initial stages of information processing, successfully supress the accessibility of such faces especially ambiguous or threat-related stimuli (i.e surprised), in recognition. Thus, their greater amount of attentional resources at early stages appear to contribute the *postemptive strategies* for suppression of ambiguous or threat-related faces in recognition, as an indication of avoidance.

#### 4.3.2.2 Topographic Distributions of Recognition Memory

Regarding to topographic distributions of recognition memory, it was hypothesized that amplitude and latency of the ERP peaks varied across electrode locations. The findings revealed the enhanced N100, N200 and FN400 amplitudes reached maximum at fronto-central regions. On the other hand, electrode variations emerged in only FN400 time-window, reflecting an early latency over fronto-central regions.

Electrode differences in both N100 and N200 amplitudes reflected that attentional processes (i.e. attentional engagement and attention control) modulated fronto-central regions more dominantly than posterior regions during the recognition of emotional faces. The present findings are consistent with fMRI studies (Cabeza, Dolcos, Prince, Rice, Weissman & Nyberg, 2003; Hopfinger, Buonocore & Mangun, 2000) reporting the relationship between prefrontal regions and attentional processes. Cabeza, Dolcos, Prince, Rice, Weissman and Nyberg (2003) suggested the contributions of fronto-parietal-cingulato-thalamic network during attentional process (e.g sustained attention and attentional shifts) and also during memory retrieval. Also, in a cued spatial-attention task, Hopfinger, Buonocore and Mangun (2000) found superior frontal gyrus activations to attention-directing cues, suggesting that memory processes may activate the regions of superior frontal gyrus during the retrieval of previously attended-location. Taken as whole, the present findings suggest the critical involvement of fronto-central areas in attentional processes at initial stages of information processing during the face recognition.

Consistent with previous studies using memory tasks and/or remember-know paradigm (Curran & Hancock, 2007; Righi, Toscani, Baldassi, Ottonello &Viggiano, 2012), the findings also revealed fronto-central enhancement in FN400 time-window. fMRI studies (Skinner & Fernandes, 2007; Yonelinas et. al., 2005) also suggest that familiarity processes modulate the activity in prefrontal regions such as anterior and dorsolateral prefrontal regions. Similarly, a combined ERP and fMRI study by Herzmann, Jin, Cordes and Curran (2012) indicated that FN400 (240-440 ms) was associated with biletaral prefrontal and right post-central gryi. On the other hand, despite the recognition-memory studies (Righi et al.,2012) reporting a lack of electrode differences in FN400 latency, the present findings revealed an early fronto-central FN400 activation that later spreads toward posterior regions during the correctly recognition of old faces. Based on the neuroimaging studies mentioned above, an early fronto-central FN400 activation appears to be consistent with literature.

Also, as previously mentioned, visual analysis of ERPs indicated visible peaks at later stages of recognition-based information processing. Therefore, *context familiarity* (Addante, Ranganath, & Yonelinas, 2012; Montaldi & Mayes, 2010) could play a role in recognition of non-verbal stimuli such emotional faces, indicating retrieval of contextual features related to a recognized item in the absence of recollection. *As distinguished from* FN400 and LPC of item familiarity and recollection respectively, this phenomenon has also been linked with specific ERP effects observed in different time window (800-1200ms) and in different topographies (Addante, Ranganath, & Yonelinas, 2012; Addante, Ranganath, Olichney & Yonelinas, 2012; Tsivilis et al., 2015). Previous ERP studies have shown that confidence level, rather than awareness, modulates the different ERP components, such as P300 (Eimer & Mazza 2005), FN400 (Woodruff, Hayama & Rugg, 2006), and LPC (Addante, Ranganath, Olichney & Yonelinas, 2012; Curran, 2004). Damasio (1996) also suggested that, during the situations of uncertainty, cognitive processes may become insufficient leading to affective states playing a greater role in decision making, and subjects' confidence levels about their responses or decisions may complicate interpretation of the findings. Based on these findings, neural activation during emotional face recognition between anxious and avoidant attachment individuals may be affected by the valance of the emotional stimuli rather than level of confidence and fronto-central regions seem to play significant role in relationships between late ERP components and emotional face processing. Therefore, further studies will be necessary to shed light on this issue.

Taken as a whole, the present findings identified the role of fronto-central regions involved in both attentional and retrieval processes during emotional face processing. Also, more specifically, these findings suggest that fronto-central regions modulated by attentional processes in initial processing stage contribute memory retrieval of emotional faces.

#### 4.3.2.3 Emotion-specific Effects of Recognition Memory

Concerning the emotional effects of recognition memory, the represent findings revealed no emotion-specific N100 modulation. However, later in the time course, correctly recognised old faces produce emotion-specific differences, reflecting an early N200 negativity for surprised faces than for happy and angry faces. These indicated that emotional faces did capture attention regardless of valance, but, in later stages, the successfully retrieval of surprised faces appear to early engage attention than other emotional faces. Emotional ambiguity of surprised faces might facilitate an early attentional engagement in initial stage of information processing. Also, in memory-related electrophysiology literature, some studies (Lucas, Chiao & Paller, 2011; Righi et al., 2012) suggest that N200 may reflect early subsequent memory effects over fronto-central regions. In keeping with this notion, it was proposed that an early N200 negativity effect on surprised faces may be indication of memory trace for later stages of emotional information processing. As mentioned above, emotion-specific stimuli effects also emerge in the FN400 time range on different scalp distributions. Correctly recognised old angry faces produced an enhanced FN400 negativity at frontal electrode, indicating a strong familiarity-based recognition effect for angry faces with predominant involvement of frontal areas. Similarly, Righi et al. (2012) found that recognition of negative emotional face (fearful face) enhanced FN400 effects over frontal regions, suggesting that strengthening of the memory trace of fearful faces might be associated with potentially treat-related signals. In agreement with Righi et al.'s (2002) findings, angry faces may elicit familiarity-based memory trace over frontal regions involved in intention and motivational systems due to treat-related signals of the stimuli. In addition to this, other findings revealed an enhanced FN400 amplitude over central areas for correctly recognised old happy faces as compared to surprised ones. It can be assumed that sensorial or any physical features of happy faces may be more dominate and apparent than surprised faces. Thus, these features of happy faces may predominantly modulate central areas associated with sensory system in the brain may facilitate familiarity-based recognition.

Briefly, the current findings suggested the retrieval of emotional faces produce emotional specific differences for only surprised faces at initial stages of information processing. However, such faces did not sustain long lasting effects at later recognition related processes. Correctly recognised angry and happy faces elicit familiarity-based recognition effect at recognition-related stages by modulating frontal and central regions respectively.

**4.4 Summary**

The present study aimed to investigate behavioural and neural correlates of emotional information processing in adult attachment, employing the interpretation and recognition phases of facial expression task.

The behavioural findings of interpretation phase revealed that individuals with different attachment styles differed in the interpretation of emotional facial expressions, regardless of valance. These findings suggested that individuals with attachment avoidance may interpret emotional facial expressions in in a more positive manner to establish a buffer against potential stressors (i.e surprised and angry faces) that are incongruent with the goals of deactivating strategies. On the other hand, as other findings indicated, angry and surprised facial expressions that dominantly activate hyper-vigilance system may motivate individuals with attachment anxiety in order to interpret all stimuli in more negative manner. Also, neurobiological findings (see visual analysis of ERPs) revealed differences in emotional information processing between attachment anxiety and attachment avoidance during interpretation of facial expressions. These findings indicated that deactivating strategies reflect themselves at initial stages of information processing in order to protect individuals with attachment avoidance against potential threats (i.e. angry and surprised faces), which are incongruent with the goals of attachment avoidance, for later stages. Thus, individuals with attachment avoidance displayed limited initial attention to all types of facial expressions but, at the later stages of information processing, they display attentional engagement to less-threatening stimuli only (i.e. happy faces). In contrast to this, individuals with anxious showed initial attentional to happy, angry and surprised. At the later stages of information processing, they just sustain their attention to threatening (angry) and/ or ambiguous (surprised) stimuli, not for positively-valanced (happy) stimuli. This indicated that hyperactivating strategies may motivate these individuals to be vigilant to all types of facial expressions stimuli at initial stages of information processing in order to identify the potential source, that are congruent with the goals of attachment anxiety, for the later stages. Thus, they may always keep their system activated during the interpretation of facial expressions.

On the other hand, attachment groups did not significantly differ in behavioural measures (reaction and RTs) of face recognition. Yet, other findings revealed old/new emotional face differences in each attachment groups. Individuals with attachment anxiety had retrieval difficulties for both happy and angry faces, not for surprised faces. This suggest that ambiguity-related stimuli (i.e. surprised faces) may have more dominant emotional content to serve to keep attachment system activated, compared to emotional contents of other faces. Therefore, individuals with attachment anxiety may have selectively recognized previously seen surprised faces during the recognition phase. The electrophysiological findings revealed that individuals with attachment anxiety displayed familiarity-based recognition to all types of emotional faces (happy, angry and surprised faces). However, they appear to easily overwhelmed by angry faces, as reflected in delayed latency to such faces during recognition. In addition to these findings, the behavioural findings also revealed that individuals with attachment avoidance were more accurate at new happy faces than old ones. Other correctly recognised emotional faces did not differ across old/new stimulus in attachment avoidance group. These suggested that individuals with attachment avoidance may have either a memory bias to new happy faces or a perceptual vigilance to them during the presentation of happy-face stimuli. Also, these findings indicated retrieval difficulties in attachment avoidance for old emotional faces due to pre-emptive based defensive strategies that lead to failure in implicit learning of emotional faces. However, as previously mentioned, neural correlates of information processing in attachment avoidance indicated a *postemptive strategies* during recognition–based information processing. Individuals with attachment avoidance, who devote more attentional resources to emotional faces at the initial stages of information processing, successfully supress the accessibility of such faces especially ambiguous or threat-related stimuli (i.e surprised), in recognition.

In addition, there are several noteworthy features of the present study. A major strength of this study is examination of information processing biases in adult attachment, using the direct measures of facial expression task including interpretation and memory of emotional phases. To date, a vast majority of attachment studies have primarily focused on attentional functioning in different attachment styles, adopting the attentional tasks such as Stroop and Oddball paradigms. A few studies investigated interpretation processes of emotional information in adult attachment. The present study further extends the evidence on interpretation-based information processing biases in adult attachment. Also, the present study provided a novel contribution to face recognition processes of different attachment styles.

Second, very few studies have used emotional face stimuli in investigation of either behavioural or neural correlates of information processing biases in adult attachment. Considering the roles of emotional faces on social functioning in adult attachment, this study shed light on activations of secondary attachment strategies in the context of interpersonal relationships.

Finally, while previous studies have limited evidence concerning the implications of surprised faces for attachment system functioning, this study shed light on neuro-behavioural mechanisms of interpretation and recognition of surprised faces. Thus, the current findings may extend the understating of ambiguous-related information processing in different attachment styles.

**4.5 Limitations and Future Directions**

There are some limitations that must be taken into account.  First, the sample size was relatively small for behavioural data. Due to this limitation, attachment-related differences in both interpretation and recognition phases of facial expression task may not have reached statistical significance level although visual analysis of ERPs indicated distinct differences. In this respect, apparently need to be highlighted for future studies that ERP measures provide valuable evidence concerning emotional information processing in adult attachment which would not be observed at behavioural level.

Second, the self-report measure of adult attachment dimensions (ECR-R) may reflect some biases such as social-desirability and inaccurate memory. In addition to this, ECR-R that explicitly focuses on attachment dimensions may not be appreciate measure for the studies in which cognitive processes of different attachment styles were examined. More implicit measures of adult attachment dimensions may work better to reveal distinct attachment-related information processing on both behavioural and neurophysiological levels. For instances, AAI that focuses on implicit processes and measures coherence of mind with respect to attachment might be better predictor to examine the information processing biases of individuals with different attachment styles.  Therefore, future studies may investigate information processing in adult attachment, using implicit measures of adult attachment dimensions.

Final limitation is that interpretations concerning the cognitive control of individuals with attachment anxiety and avoidance during the interpretation of facial expressions remain speculative due to our facial expression task that were not fit enough to evaluate attentional control processing of emotional facial expressions. Future studies could shed light on how emotional content influence cognitive control mechanisms of different attachment styles, adopting the combined paradigm that measures both attention and interpretation performances.

Still, several issues needed to be examined in future research. In this study, the main focus was how individuals with different attachment styles differed at early stages of the information processing during the interpretation and recognition of emotional faces. Future studies should examine the later stages (i.e. late positive potential or LPP for interpretation-related information processing and parietal old/new effect for recognition memory) of information processing in adult attachment, using similar facial expression tasks. Also, future studies may provide better understanding of cognitive and emotional processes underlying adult attachment style by extending the variety of emotional face stimuli (i.e sad, fear and disgust) in facial expression task. Finally, an integration of ERP with fMRI may bring new perspectives concerning neurobiological correlates of information processing biases in adult attachment by providing detailed spatio-temporal information for future studies.

### 4.6 Clinical Implications of the Study

The findings have some important clinical implications. First, the present findings indicated that individuals with different attachment styles display biases in information processing during the interpretation of emotional expressions, adopting the secondary attachment strategies. Such biases that serve to secondary attachment strategies may manifest themselves in therapeutic relationships. Beside, moving one step forward, such biases may influence therapeutic alliance between client and therapist. In support of these assumptions, there are some evidence that individuals with insecure attachment styles displayed poorer therapeutic alliance. On the basis of the present findings, for instances, individuals with attachment anxiety may interpret the therapist's display of warm and empathy in negative manner or interpret signs of care and concern as his/her perceived inadequacy or vulnerability. Thereby, clinicians would benefit the current findings to enhance their knowledge concerning the dynamics of insecure attachment and to gain an insight on potential interpersonal difficulties of individuals with different attachment styles over the course of therapy.

Second, the findings revealed that information processing biases also reflect important cognitive strategies guided by secondary attachment strategies. For instance, individuals with attachment avoidance devote more attentional resources to emotional faces at the initial stages of information processing which promote the use of *postemptive strategies* for suppression of ambiguous or threat-related faces at recognition stage. Thus, therapists may show greater focus on memory-related cognitive strategies, and thus, develop therapeutic interventions based on them.

Third, the findings indicated that intense negative feelings (e.g anger, helplessness, neediness) and maladaptive emotion strategies (e.g self-blame, self-critism and mental ruminations) of attachment anxiety might be caught individuals in a vicious cycle in which they become more vulnerable to develop the symptoms of depression and anxiety. Therapists, therefore, may develop therapeutic interventions on the basis of emotion regulations difficulties in order to weaken psychopathological vulnerabilities in attachment anxiety.

Taken as whole, although general consensus is that attachment dynamics remain relatively stable over the life span, increasing evidence (Muller & Rosenkranz, 2009; Travis, Bliwise, Binder & Horne-Moyer, 2001) showed that therapeutic environment facilitates clients to move from insecure to secure attachment. Hopefully, both behavioural and neurobiological findings of the present study contribute to therapeutic practice, indicating the potential cognitive biases of individuals with different attachment styles.

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# APPENDIX

## EXPERIENCES IN CLOSE RELATIONSHIPS-REVISED

Aşağıdaki maddeler romantik ilişkilerinizde hissettiğiniz duygularla ilgilidir. Bu araştırmada sizin ilişkinizde yalnızca şu anda değil, genel olarak neler olduğuyla ya da neler yaşadığınızla ilgilenmekteyiz. Maddelerde sözü geçen "birlikte olduğum kişi" ifadesi ile romantik ilişkide bulunduğunuz kişi kastedilmektedir. Eğer halihazırda bir romantik ilişki içerisinde değilseniz, aşağıdaki maddeleri bir ilişki içinde olduğunuzu varsayarak cevaplandırınız. Her bir maddenin ilişkilerinizdeki duygu ve düşüncelerinizi ne oranda yansıttığını karşılarındaki 7 aralıklı ölçek üzerinde, ilgili rakam üzerine çarpı (X) koyarak gösteriniz.

1---------------2---------------3---------------4---------------5---------------6---------------7

Hiç katılmıyorum — Kararsızım fikrim yok — Tamamen katılıyorum

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1.Birlikte olduğum kişinin sevgisini kaybetmekten korkarım. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 2.Gerçekte ne hissettiğimi birlikte olduğum kişiye göstermemeyi tercih ederim. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 3. Sıklıkla, birlikte olduğum kişinin artık benimle olmak istemeyeceği korkusuna kapılırım. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 4.Özel duygu ve düşüncelerimi birlikte olduğum kişiyle paylaşmak konusunda kendimi rahat hissederim. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 5.Sıklıkla, birlikte olduğum kişinin beni gerçekten sevmediği kaygısına kapılırım. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 6. Romantik ilişkide olduğum kişilere güvenip dayanmak konusunda kendimi rahat bırakmakta zorlanırım. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 7.Romantik ilişkide olduğum kişilerin beni, benim onları önemsediğim kadar önemsemeyeceklerinden endişe duyarım. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8.Romantik ilişkide olduğum kişilere yakın olma konusunda çok rahatımdır. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 9.Sıklıkla, birlikte olduğum kişinin bana duyduğu hislerin benim ona duyduğum hisler kadar güçlü olmasını isterim. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 10.Romantik ilişkide olduğum kişilere açılma konusunda kendimi rahat hissetmem. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 11.İlişkilerimi kafama çok takarım. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 12.Romantik ilişkide olduğum kişilere fazla yakın olmamayı tercih ederim. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 13.Benden uzakta olduğunda, birlikte olduğum kişinin başka birine ilgi duyabileceği korkusuna kapılırım. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 14.Romantik ilişkide olduğum kişi benimle çok yakın olmak istediğinde rahatsızlık duyarım. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 15.Romantik ilişkide olduğum kişilere duygularımı gösterdiğimde, onların benim için aynı şeyleri hissetmeyeceğinden korkarım. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 16.Birlikte olduğum kişiyle kolayca yakınlaşabilirim. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 17.Birlikte olduğum kişinin beni terkedeceğinden pek endişe duymam. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 18.Birlikte olduğum kişiyle yakınlaşmak bana zor gelmez. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 19.Romantik ilişkide olduğum kişi kendimden şüphe etmeme neden olur. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 20.Genellikle, birlikte olduğum kişiyle sorunlarımı ve kaygılarımı tartışırım. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 21.Terk edilmekten pek korkmam. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 22.Zor zamanlarımda, romantik ilişkide olduğum kişiden yardım istemek bana iyi gelir. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 23.Birlikte olduğum kişinin, bana benim istediğim kadar yakınlaşmak istemediğini düşünürüm. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 24.Birlikte olduğum kişiye hemen hemen her şeyi anlatırım. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 25.Romantik ilişkide olduğum kişiler bazen bana olan duygularını sebepsiz yere değiştirirler. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 26.Başımdan geçenleri birlikte olduğum kişiyle konuşurum. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 27.Çok yakın olma arzum bazen insanları korkutup uzaklaştırır. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 28.Birlikte olduğum kişiler benimle çok yakınlaştığında gergin hissederim. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 29.Romantik ilişkide olduğum bir kişi beni yakından tanıdıkça, “gerçek ben”den hoşlanmayacağından korkarım. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 30.Romantik ilişkide olduğum kişilere güvenip dayanma konusunda rahatımdır. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 31.Birlikte olduğum kişiden ihtiyaç duyduğum şefkat ve desteği görememek beni öfkelendirir. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 32.Romantik ilişkide olduğum kişiye güvenip dayanmak benim için kolaydır. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 33.Başka insanlara denk olamamaktan endişe duyarım | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 34.Birlikte olduğum kişiye şefkat göstermek benim için kolaydır. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 35.Birlikte olduğum kişi beni sadece kızgın olduğumda önemser. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 36.Birlikte olduğum kişi beni ve ihtiyaçlarımı gerçekten anlar. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

# APPENDIX

## DIFFICULTIES IN EMOTION REGULATION SCALE

Aşağıda insanların duygularını kontrol etmekte kullandıkları bazı yöntemler verilmiştir. Lütfen her durumu dikkatlice okuyunuz ve her birinin sizin için ne kadar doğru olduğunu içtenlikle değerlendiriniz. Değerlendirmenizi uygun cevap önündeki yuvarlak üzerine çarpı (X) koyarak işaretleyiniz.

1. Ne hissettiğim konusunda netimdir.
○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman

2. Ne hissettiğimi dikkate alırım.
○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman

3. Duygularım bana dayanılmaz ve kontrolsüz gelir.
○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman

4. Ne hissettiğim konusunda net bir fikrim vardır.
○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman

5. Duygularıma bir anlam vermekte zorlanırım.
○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman

6. Ne hissettiğime dikkat ederim.
○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman

7. Ne hissettiğimi tam olarak bilirim.
○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman

8. Ne hissettiğimi önemserim.
○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman

9. Ne hissettiğim konusunda karmaşa yaşarım.
○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman

| |
|---|
| 10. Kendimi kötü hissettiğimde, bu duygularımı kabul ederim.<br>○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman |

| |
|---|
| 11. Kendimi kötü hissettiğimde, böyle hissettiğim için kendime kızarım.<br>○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman |

| |
|---|
| 12. Kendimi kötü hissettiğimde, böyle hissettiğim için utanırım.<br>○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman |

| |
|---|
| 13. Kendimi kötü hissettiğimde, işlerimi yapmakta zorlanırım.<br>○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman |

| |
|---|
| 14. Kendimi kötü hissettiğimde, kontrolümü kaybederim.<br>○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman |

| |
|---|
| 15. Kendimi kötü hissettiğimde, uzun süre böyle kalacağıma inanırım.<br>○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman |

| |
|---|
| 16. Kendimi kötü hissettiğimde, sonuç olarak yoğun depresif duygular içinde olacağıma inanırım. |
| ○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman |

| |
|---|
| 17. Kendimi kötü hissettiğimde, duygularımın yerinde ve önemli olduğuna inanırım.<br>○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman |

| |
|---|
| 18. Kendimi kötü hissettiğimde, başka şeylere odaklanmakta zorlanırım.<br>○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman |

| |
|---|
| 19. Kendimi kötü hissettiğimde, kendimi kontrolden çıkmış hissederim.<br>○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman |

| |
|---|
| 20. Kendimi kötü hissettiğimde, halen işlerimi sürdürebilirim.<br>○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman |

| |
|---|
| 21. Kendimi kötü hissettiğimde, bu duygumdan dolayı kendimden utanırım.<br>○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman |

22. Kendimi kötü hissettiğimde, eninde sonunda kendimi daha iyi hissetmenin bir yolunu bulacağımı bilirim.
○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman

23. Kendimi kötü hissettiğimde, zayıf biri olduğum duygusuna kapılırım.
○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman

24. Kendimi kötü hissettiğimde, davranışlarımı kontrol altında tutabileceğimi hissederim.
○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman

25. Kendimi kötü hissettiğimde, böyle hissettiğim için suçluluk duyarım.
○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman

26. Kendimi kötü hissettiğimde, konsantre olmakta zorlanırım.
○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman

27. Kendimi kötü hissettiğimde, davranışlarımı kontrol etmekte zorlanırım.
○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman

28. Kendimi kötü hissettiğimde, daha iyi hissetmem için yapacağım hiç bir şey olmadığına inanırım.
○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman

29. Kendimi kötü hissettiğimde, böyle hissettiğim için kendimden rahatsız olurum.
○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman

30. Kendimi kötü hissettiğimde, kendim için çok fazla endişelenmeye başlarım.
○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman

31. Kendimi kötü hissettiğimde, kendimi bu duyguya bırakmaktan başka yapabileceğim birşey olmadığına inanırım.
○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman

32. Kendimi kötü hissettiğimde, davranışlarım üzerindeki kontrolümü kaybederim.
○Neredeyse Hiçbir zaman ○Bazen ○Yaklaşık Yarı yarıya ○Çoğu zaman ○Neredeyse Her zaman

| |
|---|
| 33. Kendimi kötü hissettiğimde, başka bir şey düşünmekte zorlanırım.<br>❍Neredeyse Hiçbir zaman ❍Bazen ❍Yaklaşık Yarı yarıya ❍Çoğu zaman ❍Neredeyse Her zaman |

| |
|---|
| 34. Kendimi kötü hissettiğimde, duygumun gerçekte ne olduğunu anlamak için zaman ayırırım.<br>❍Neredeyse Hiçbir zaman ❍Bazen ❍Yaklaşık Yarı yarıya ❍Çoğu zaman ❍Neredeyse Her zaman |

| |
|---|
| 35. Kendimi kötü hissettiğimde, kendimi daha iyi hissetmem uzun zaman alır.<br>❍Neredeyse Hiçbir zaman ❍Bazen ❍Yaklaşık Yarı yarıya ❍Çoğu zaman ❍Neredeyse Her zaman |

| |
|---|
| 36. Kendimi kötü hissettiğimde, duygularım dayanılmaz olur.<br>❍Neredeyse Hiçbir zaman ❍Bazen ❍Yaklaşık Yarı yarıya ❍Çoğu zaman ❍Neredeyse Her zaman |

## APPENDIX
## DEPRESSION ANXIETY STRESS SCALE

Lütfen her bir ifadeyi bugün dâhil son bir haftayı dikkate alarak size ne kadar uygun olduğuna göre işaretleyiniz. Her sorunun karşısında bulunan; **"0"** bana hiç uygun değil, **"1"** bana biraz uygun, **"2"** bana genellikle uygun ve **"3"** bana tamamen uygun anlamına gelmektedir.

| | | | | | |
|---|---|---|---|---|---|
| 1 | Oldukça önemsiz şeylerden dolayı keyfim kaçtı. | 0 | 1 | 2 | 3 |
| 2 | Ağzımın kuruduğunu fark ettim. | 0 | 1 | 2 | 3 |
| 3 | Hiç olumlu duygu yaşamadım. | 0 | 1 | 2 | 3 |
| 4 | Nefes alıp vermede güçlük yaşadım (örneğin; fiziksel egzersiz yapmamama rağmen çok hızlı nefes alma veya nefes alamama) | 0 | 1 | 2 | 3 |
| 5 | Hiçbir işime başlayamadım. | 0 | 1 | 2 | 3 |
| 6 | Olaylara gereğinden fazla tepki gösterdim. | 0 | 1 | 2 | 3 |
| 7 | Kendimi takatsiz hissettim (örneğin; bacakların tutmaması) | 0 | 1 | 2 | 3 |
| 8 | Rahatlamakta güçlük yaşadım. | 0 | 1 | 2 | 3 |
| 9 | Beni sıkıntıya sokan öyle zamanlar oldu ki, onlar bitince kendimi rahat hissettim. | 0 | 1 | 2 | 3 |
| 10 | Beklediğim veya umduğum hiçbir şey olmadığını hissettim. | 0 | 1 | 2 | 3 |
| 11 | Keyfimin çok kolay kaçtığını hissettim. | 0 | 1 | 2 | 3 |
| 12 | Çok fazla sinirsel enerji kullandığımı hissettim. | 0 | 1 | 2 | 3 |
| 13 | Kendimi üzgün ve karamsar hissettim. | 0 | 1 | 2 | 3 |
| 14 | Herhangi bir nedenden (örneğin; asansör veya trafik ışığında bekletilme) dolayı geciktirildiğimde sabırsızlandığımı hissettim. | 0 | 1 | 2 | 3 |
| 15 | Kendimi yorgun ve zayıf hissettim. | 0 | 1 | 2 | 3 |
| 16 | Neredeyse her şeye olan ilgimin kaybettiğimi hissettim. | 0 | 1 | 2 | 3 |
| 17 | Bir insan olarak değerli olmadığımı hissettim. | 0 | 1 | 2 | 3 |
| 18 | Oldukça hassas ve alıngan olduğumu hissettim. | 0 | 1 | 2 | 3 |
| 19 | Herhangi bir fiziksel çaba harcamama veya fazla sıcak olmamasına rağmen yoğun biçimde terledim (örneğin; ellerin terlemesi) | 0 | 1 | 2 | 3 |
| 20 | Herhangi bir neden olmamasına rağmen korktuğumu hissettim. | 0 | 1 | 2 | 3 |
| 21 | Hayatın değerli olmadığını hissettim. | 0 | 1 | 2 | 3 |
| 22 | Gevşemekte zorlandım. | 0 | 1 | 2 | 3 |
| 23 | Yutkunmakta güçlük yaşadım. | 0 | 1 | 2 | 3 |
| 24 | Yaptığım hiçbir şeyden zevk almadığımı fark ettim. | 0 | 1 | 2 | 3 |
| 25 | Herhangi bir fiziksel çaba harcamadığım halde kalbimin hareketlerini fark ettim (örneğin; kalp atışlarımın hızlanması veya düzensizleşmesi) | 0 | 1 | 2 | 3 |
| 26 | Kendimi perişan ve kederli hissettim. | 0 | 1 | 2 | 3 |
| 27 | Çabuk hırçınlaştığımı fark ettim. | 0 | 1 | 2 | 3 |
| 28 | Kolayca paniğe kapıldığımı hissettim. | 0 | 1 | 2 | 3 |
| 29 | Beni gerginleştiren herhangi bir şeyden sonra rahatlamakta güçlük yaşadığımı fark ettim. | 0 | 1 | 2 | 3 |
| 30 | Basit fakat alışılmadık şeylerin üstesinden gelemeyeceğim diye kaygılandım. | 0 | 1 | 2 | 3 |
| 31 | Herhangi bir şeyi yapmak için heyecanlı ve coşkulu olamadım | 0 | 1 | 2 | 3 |
| 32 | Yaptığım işin bölünmesine tahammül edemediğimi fark ettim. | 0 | 1 | 2 | 3 |
| 33 | Gergin bir durumdaydım. | 0 | 1 | 2 | 3 |
| 34 | Oldukça değersiz olduğumu hissettim. | 0 | 1 | 2 | 3 |
| 35 | Yaptığım işe engel olan hiçbir şeye tolerans gösteremedim. | 0 | 1 | 2 | 3 |
| 36 | Dehşete kapıldığımı hissettim. | 0 | 1 | 2 | 3 |
| 37 | Gelecekte ümit verici hiçbir şey göremedim. | 0 | 1 | 2 | 3 |
| 38 | Yaşamın anlamsız olduğu hissine kapıldım. | 0 | 1 | 2 | 3 |
| 39 | Kışkırtılmaya uygun olduğumu hissettim. | 0 | 1 | 2 | 3 |
| 40 | Gülünç duruma düşme ve paniğe kapılma riski olan durumlardan dolayı endişelendim. | 0 | 1 | 2 | 3 |
| 41 | Vücudumun titrediğimi hissettim (örneğin; ellerimin titremesi) | 0 | 1 | 2 | 3 |
| 42 | Yapacağım şeylere başlamakta güçlük yaşadım. | 0 | 1 | 2 | 3 |

**APPENDIX**

**STATE-TRAIT ANXIETY INVENTORY**

Aşağıda kişilerin kendilerine ait duygularını anlatmada kullandıkları bir takım ifadeler verilmiştir. Her ifadeyi okuyun, sonra da **şu an için kendinizi** nasıl hissettiğinizi, ifadelerin sağ tarafındaki parantezlerden uygun olanını karalamak suretiyle belirtiniz. Doğru ya da yalnış cevap yoktur. Herhangi bir ifadenin üzerinde fazla zaman sarf etmeksizin **şu an için** kendinizi nasıl hissettiğinizi gösteren cevabı işaretleyiniz.

| | **Hiç** | **Biraz** | **Çok** | **Tamamıyl** |
|---|---|---|---|---|
| **1.** Şu anda sakinim | (1) | (2) | (3) | (4) |
| 2. Kendimi emniyette hissediyorum | (1) | (2) | (3) | (4) |
| 3. Şu anda sinirlerim gergin | (1) | (2) | (3) | (4) |
| 4. Pişmanlık duygusu içindeyim | (1) | (2) | (3) | (4) |
| 5. Şu anda huzur içindeyim | (1) | (2) | (3) | (4) |
| 6. Şu anda hiç keyfim yok | (1) | (2) | (3) | (4) |
| 7. Başıma geleceklerden endişe ediyorum | (1) | (2) | (3) | (4) |
| 8. Kendimi dinlenmiş hissediyorum | (1) | (2) | (3) | (4) |
| 9. Şu anda kaygılıyım | (1) | (2) | (3) | (4) |
| 10. Kendimi rahat hissediyorum | (1) | (2) | (3) | (4) |
| 11. Kendime güvenim var | (1) | (2) | (3) | (4) |
| 12. Şu anda asabım bozuk | (1) | (2) | (3) | (4) |
| 13. Çok sinirliyim | (1) | (2) | (3) | (4) |
| 14. Sinirlerimin çok gergin olduğunu hissediyorum | (1) | (2) | (3) | (4) |
| 15. Kendimi rahatlamış hissediyorum | (1) | (2) | (3) | (4) |
| 16. Şu anda halimden memnunum | (1) | (2) | (3) | (4) |
| 17. Şu anda endişeliyim | (1) | (2) | (3) | (4) |
| 18. Heyecandan kendimi şaşkına dönmüş hissediyorum | (1) | (2) | (3) | (4) |
| 19. Şu anda sevinçliyim | (1) | (2) | (3) | (4) |
| 20. Şu anda keyfim yerinde. | (1) | (2) | (3) | (4) |

Aşağıda kişilerin kendilerine ait duygularını anlatmada kullandıkları bir takım ifadeler verilmiştir. Her ifadeyi okuyun, sonra da **genel** olarak nasıl hissettiğinizi, ifadelerin sağ tarafındaki parantezlerden uygun olanını karalamak suretiyle belirtiniz. Doğru ya da yalnış cevap yoktur. Herhangi bir ifadenin üzerinde fazla zaman sarfetmeksizin **genel** olarak nasıl hissettiğinizi gösteren cevabı işaretleyiniz.

| | Hemen hiçbir zaman | Bazen | Çok zaman | Hemen her zaman |
|---|---|---|---|---|
| 1. Genellikle keyfim yerindedir. | (1) | (2) | (3) | (4) |
| 2. Genellikle çabuk yorulurum. | (1) | (2) | (3) | (4) |
| 3. Genellikle kolay ağlarım. | (1) | (2) | (3) | (4) |
| 4. Başkaları kadar mutlu olmak isterim. | (1) | (2) | (3) | (4) |
| 5. Çabuk karar veremediğim için fırsatları kaçırırım. | (1) | (2) | (3) | (4) |
| 6. Kendimi dinlenmiş hissederim. | (1) | (2) | (3) | (4) |
| 7. Genellikle sakin, kendime hakim ve soğukkanlıyım. | (1) | (2) | (3) | (4) |
| 8. Güçlüklerin yenemeyeceğim kadar biriktiğini hissederim. | (1) | (2) | (3) | (4) |
| 9. Önemsiz şeyler hakkında endişelenirim. | (1) | (2) | (3) | (4) |
| 10. Genellikle mutluyum. | (1) | (2) | (3) | (4) |
| 11. Her şeyi ciddiye alır ve endişelenirim. | (1) | (2) | (3) | (4) |
| 12. Genellikle kendime güvenim yoktur. | (1) | (2) | (3) | (4) |
| 13. Genellikle kendimi emniyette hissederim. | (1) | (2) | (3) | (4) |
| 14. Sıkıntılı ve güç durumlarla karşılaşmaktan kaçınırım. | (1) | (2) | (3) | (4) |
| 15. Genellikle kendimi hüzünlü hissederim. | (1) | (2) | (3) | (4) |
| 16. Genellikle hayatımdan memnunum. | (1) | (2) | (3) | (4) |
| 17. Olur olmaz düşünceler beni rahatsız eder. | (1) | (2) | (3) | (4) |
| 18. Hayal kırıklıklarını öyle ciddiye alırım ki hiç unutamam. | (1) | (2) | (3) | (4) |
| 19. Aklı başında ve kararlı bir insanım. | (1) | (2) | (3) | (4) |
| 20. Son zamanlarda kafama takılan konular beni tedirgin eder. | (1) | (2) | (3) | (4) |