ATTACHMENT SECURITY IN ADOLESCENCE AND THE ROLE OF PARENTING: A BEHAVIOURAL GENETIC INVESTIGATION USING SELF-REPORT AND INTERVIEW-BASED MEASURES OF ATTACHMENT

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I, Andrea Dainesi, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

The overall goal of this thesis is to explore the contribution of genetic factors, environmental factors, and the role of parenting on attachment security in adolescence. The thesis comprises three studies based on data from two samples of adolescents (age:15 years ±14 months) collected from the Twins Early Development Study (TEDS), a large longitudinal cohort of same-sex twins born in the UK between 1994 and 1996. The first study was conducted on 599 participants (341 females) and aimed to examine the associations between self-report and interview-based attachment measures by adopting two of the most widely used instruments in the field: The Inventory of Parent and Peer Attachment (IPPA) and the Child Attachment Interview (CAI). This study also aimed to establish whether a dimensional approach (i.e. continuous measures of attachment) or a categorical approach (i.e. attachment classifications) to the IPPA affords a better prediction of attachment security as assessed through the CAI. The second study was conducted on 592 twin pairs (321 females) to investigate the genetic and environmental influences on adolescent attachment security in relation to parents and peers assessed through the IPPA. This study fills a gap in the existing literature by examining the role of genes and environment on adolescent attachment assessed through a self-report measure, and examining the genetic and environmental influences on the covariation between peer and parent attachment. The third and final study, conducted on the same sample as the second study, aimed to firstly test the relative role of genetic and environmental influences on the quality of parenting and secondly examine whether common genetic factors or common environmental factors underlie the covariation between parenting and adolescent attachment security assessed through both the CAI and the IPPA. Results showed that attachment in adolescence and its correlation to parenting are significantly determined by genes, independently of the assessment measures adopted.

Impact statement

Although for decades, psychologists have prioritised the role of nurture in determining psychological traits, more recently behavioural genetics has shown that genes interplay with our environment to shape personality and individual differences. Consequently, interest in disentangling the contribution of genes and environment to individual differences in attachment has been growing exponentially over the years.

The existing literature indicates that adolescents with secure attachment, compared to adolescents with insecure attachment, are more capable of building and maintaining intimate relationships; are more likely to develop desirable personality traits and display better emotion regulation; have higher self-esteem, greater empathic skills and higher competences in social problem solving. Research has also revealed important links between attachment security in adolescence and mental and physical health later in life (for a review, Picardi et al.,2018). Therefore, understanding the genetic and environmental sources of individual differences in adolescent attachment is a crucial research contribution to establishing clinical interventions and prevention programmes.

One of the main findings in recent attachment research is that genetic factors play a progressively more important role in shaping attachment throughout development, while shared environmental effects tend to decrease. However, due to the limited number of behavioural genetic studies on attachment conducted on adolescent samples, and because of the complexity and fluidity of attachment representations in adolescence, it is pivotal to replicate these findings by using different assessment methods.

Prior research (Fearon et al.,2014) explored the genetic and environmental influences on adolescent attachment exclusively through the administration of interview-

based measures. One of the main contributions of the current thesis lies in the investigation on such influences on attachment by using a self-report measure, namely the Inventory of Parent and Peer Attachment (IPPA - Armsden & Greenberg, 1989). The IPPA not only offers advantages in terms of time and costs of administration, but also assesses attachment security in adolescents by focusing on the conscious perception of the quality of relationships with mother, father and peers. Investigating these aspects from a behavioural genetic perspective is innovative, given the current lack of evidence with respect to the differential aetiology of attachment in adolescent-mother relationships compared to adolescent-father relationships. Furthermore, no prior behavioural genetic investigation on adolescent attachment has examined the genetic and environmental influences on this construct in relation to peers. Additionally, in the current thesis the role of genetic and environmental components was tested in relation to the quality of parenting in adolescence, using observational measures assessing a range of parental behaviours.

The studies presented in this thesis add to the understanding of parenting qualities and behaviours and perceived characteristics of peer affiliations that may promote or undermine attachment security in adolescence. Furthermore, understanding the degree to which such qualities in the relationships with parents and peers are determined by genetic and environmental factors can inform the choice of intervention on adolescents experiencing difficulties within their relationships with parents as well as their social contexts.

Directions for future research are also provided, including both twin and adoption studies and research on attachment with diverse populations.

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Chapter 1

Environmental and genetic influences on attachment security. An overview of the main findings from infancy to adolescence.

The overall focus of this thesis is the exploration of the genetic and environmental influences on attachment security and its relationship with parenting in adolescence. This introductory chapter is aimed at providing general information about classic attachment theory and some of the most relevant findings in the field over the last decades. Besides illustrating what is known about genetic and environmental factors contributing to the development of attachment patterns, this chapters will focus on the gaps and inconsistencies of this knowledge, thus leading to an overview of the studies presented in the thesis.

1.0. Introduction

Attachment theory (Bowlby, 1969; 1980) posits that from early in life children develop Internal Working Models (IWM), or representations, of attachment through repeated interactions with their caregivers. These models guide and shape individuals' attachment behaviours, their expectations and strategies for managing interpersonal relationships, regulating emotions and dealing with stressful situations potentially throughout their lifespan.

A key postulate of attachment theory is that the propensity to establish close relationships with attachment figures is innate, both in animals and humans (Bowlby,

1980). However, it is the quality and nature of relationships with caregivers that is traditionally thought to serve as the primary environmental factor shaping individual differences in attachment (Ainsworth, Blehar, Waters & Wall, 1978; Bell & Ainsworth, 1972). Ainsworth and colleagues (1978) developed the Strange Situation procedure to observe typical behaviours of infants at 12 months in interaction with a stranger, following separation and reunion with the main caregiver. This standardised observational procedure allowed the authors to postulate that different attachment styles in infancy develop in association with different degrees of parental sensitivity (Ainsworth et al., 1978). Because a sensitive caregiver can notice their child's cues, interpret them adequately and respond promptly through verbal and non-verbal behaviour, the child gradually becomes confident that the caregiver will be available in times of distress and need. This type of interactions constitutes the foundation for *secure* attachment, based on which the child develops internal working models of self as effective and valued, and of others as reliable and trustworthy. By contrast, children with insecure attachment are likely to have experiences of dismissal, rejection or insensitive responses from their caregivers when attempting to elicit their support in times of need. As a result, these children worry about their caregivers' availability, thus developing a *resistant*/*ambivalent* type of attachment. Alternately, they might gradually disengage with their caregivers, thus developing an *avoidant* attachment style. In addition, *disorganised* attachment was subsequently identified through the Strange Situation (Main & Solomon, 1990) to describe children who exhibited unpredictable and contradictory behaviours when interacting with their caregiver at reunion (e.g. freezing, wandering around, calling the caregiver's attention while backing away). Disorganised attachment has been associated not only to extremely insensitive parenting behaviours (Lyons-Ruth, Bronfman & Parsons, 1999), but also to frightened /frightening parenting behaviour (Hesse & Main, 2006; Main & Hesse, 1990), along with maltreatment, severe neglect

and a great number of socio-economic risk factors (Cyr et al., 2010). Extreme and unpredictable parenting arguably causes the child to fear the attachment figures they are keen to approach in times of distress. While normally imminent threat causes our body to mobilize, thus eliciting fight or flight responses, in traumatic situations a more primitive neural response system is activated, which blocks essential defensive movements, and leads to immobilization, passive avoidance, and freezing in a dissociative state (Lahousen, Unterrainer & Kapfhammer, 2019). When parenting is perceived as threatening, the child therefore lacks the foundations to develop coherent and active strategies to cope with stressful situations, such as communicating their need or seeking others for comfort. These dysfunctional coping mechanisms often lead to development of important internalising and externalising psychopathology throughout the lifespan (Fearon et al., 2010).

According to Ainsworth et al (1978), caregivers who developed a secure attachment with their own parents are more inclined to display adequate levels of sensitivity towards their children compared to caregivers with an insecure attachment. Indeed, one of the most consistent findings in the attachment literature is that of an association between parental attachment security and children attachment security, suggesting an intergenerational transmission of attachment (Verhage et al., 2016; Miljkovitch et al., 2004). Nevertheless, results from meta-analysis by van Ijzendoorn (1995) on 389 mothers and their 12 month-old children showed that maternal sensitivity accounted for only 23% of the variance between maternal attachment security – assessed via the Adult Attachment Interview (George, Kaplan & Main, 1985) - and their children's attachment patterns – assessed via the Strange Situation. Subsequent reviews found that the strength of the association between attachment and maternal sensitivity is moderate, in particular in relation to insecure attachment (Bakermans-Kranenburg, van Ijzendoorn, & Juffer, 2003) and disorganised attachment (van

Ijzendoorn, Schuengel & Bakermans-Kranenburg, 1999). Moreover, correlations of similar strength with attachment security have been found for other aspects linked to maternal behaviours, such as mutuality, synchrony and emotional support (de Wolff & van Ijzendoorn, 1997).

While these findings indicate that parental sensitivity is not the only factor in the caregiver-child relationship contributing to the development of attachment security, the association between parent interactive behaviour and children's attachment styles has been widely supported by experimental and correlational evidence in infancy (e.g. de Wolff & van Ijzendoorn, 1997; Fearon et al., 2006) and in later development (e.g. Brumariu & Kerns, 2010; Scott et al., 2011; Roismam et al., 2011; Joseph et al., 2014).

1.1. Nature and nurture of attachment

Because of the great importance that has originally been attributed to the interactive antecedents of attachment patterns, one could erroneously interpret attachment as an essentially social phenomenon. On the contrary, Bowlby argued that the attachment motivational system is primarily biological and has profound evolutionary roots (Bowlby, 1969; 1970). Indeed, human and animal attachment behaviours are naturally selected through evolution, as their basic purpose is to promote survival through seeking and maintaining proximity to primary caregivers. This means that individuals with greater capacity to develop effective attachment strategies are more protected from environmental dangers than those less able. For these reasons, it is rightful to expect some portion of individual differences in attachment to be genetically influenced.

Over the last decades, several researchers in the field of attachment have directly investigated DNA with the purpose of looking at whether specific genes

(the so-called “candidate genes”) are associated with different patterns of attachment. This line of research has originally provided promising findings. For instance, initial evidence was found of an association between a variant of the precursor gene of the Dopamine D4 receptor and disorganised attachment (Lakatos, et al., 2002). Other studies have investigated the genetic correlates of attachment by looking into possible associations between children’s genetic makeup and their exposure to certain types of environment, termed gene-by-environment interaction (GxE). An important finding from this type of investigation was a GxE effect of parental responsiveness on disorganised attachment in relation to a variant of the genes that codes for the serotonin transporter (5HHTLPR) (Spangler, Johann, Ronai & Zimmermann, 2009). Nevertheless, several subsequent efforts, including large-scale investigations (e.g. Luijk et al., 2011; Bakermans-Kranenburg & Van Ijzendoorn, 2007) failed to replicate any of these findings of single gene associations or gene-by-environment interactions (for a review, see Picardi, Giuliani & Gigantesco, 2020), thus making the line of research on candidate genes responsible for attachment fairly inconclusive.

Studies focusing on the role of constitutional factors, such as temperament, have been present in the literature for many years, also leading to mixed findings (Vaughn, Bost & Van Ijzendoorn, 2008). In a comprehensive review, Groh et al. (2017) found that, across 109 studies, the association between attachment and temperament tends to be very small (effect size of d=-10), except for the association with resistant attachment, which appeared to be moderate (effect size of d= .30). However, because temperament is itself influenced by both genetic and environmental factors, any association between temperament and attachment security cannot be straightforwardly attributed to genetic causes (van Ijzendoorn & Bakerman-Kranenburg, 2012).

Indeed, the possible contribution of genetic factors to individual differences in attachment takes on greater import when one considers that individuals are likely from birth to evoke responses from the environment in a way that at least partially matches their inherited qualities, creating so-called gene-environment correlations, or *r*GE (Plomin & Bergeman, 1991; Scarr & McCartney, 1983). This phenomenon refers to the genetic influence on exposure to certain types of environments, which implies that genetic propensities and individual differences in environmental experiences are to some extent correlated (Kendler & Eaves, 1986). Therefore, putative environmental measures, particularly related to the family environment, are considered to be at least in part heritable (Plomin et al., 2013).

Three possible types of rGE have been described in the literature: passive, evocative and active (Kendler & Baker, 2007; Plomin, DeFries & Loehlin, 1977). *Passive* rGE refers to the association between the genotype a child inherits from their caregivers and the environment in which the child is raised – i.e., the child is a passive recipient of the environment which correlates with heritable characteristics of the caregivers. *Evocative* (or reactive) rGE refers to the association between the child's genetically influenced behaviour and others' reactions to that behaviour –i.e., the child's genes evoke particular responses from the caregivers. *Active* rGE refers to the association between an individual's genetic propensities and the type of environment that the individual selects – i.e., The child seeks out, modifies or manipulates the environment in a way that is consistent with their genetic characteristics.

1.2. Behavioural genetic studies on attachment

Quantitative behavioural genetics currently represents the most valid set of methodologies to examine the contribution of genetic and environmental factors,

enabling researchers to disentangle the role of nature and nurture in the development of complex human traits (Plomin & Colledge, 2001). Environmental factors can be divided into shared and non-shared. Shared environmental factors lead to similarities in a trait between siblings raised within the same family, whereas non-shared environmental factors are child-specific and determine variation in a trait between siblings raised within the same family (Barsky, 2010). One of the most important contributions of behavioural genetics is that these child-specific experiences can include experiences of parenting, insofar as the concept of non-shared environment challenges the idea that caregivers behave in the same way towards all their children, or that the same parenting is perceived in the same way among siblings belonging to the same family (Plomin, 2001; Dunn & Plomin, 1990).

Behavioural genetic studies aim to investigate similarities between different traits and behaviours in related individuals and see how these differences vary depending on how genetically similar these individuals are. For example, twin studies provide a direct measurement of non-shared environmental influences, as any discordance in a certain trait between identical (monozygotic) twin pairs (i.e. who have the same shared environment and share 100% of genetic heritage) is likely to be attributable to child-specific experiences (Reiss et al., 1994; Neale & Cardon, 1992). Similarly, greater similarity on a certain trait in monozygotic twins than dizygotic twins is likely to indicate genetic influence on that trait.

With respect to the behavioural genetics of attachment, the first studies conducted on twin infants and children in the pre-school age using the Strange Situation Procedure have corroborated the primary role of the environment in determining individual differences in attachment security. In these studies, the role of genetic influence on attachment was found to be close to zero at 12 months, (Bokhorst et al.,

2003) and relatively modest at 24 months (17% - Roisman & Fraley, 2008) and 48 months (14% -O'Connor & Croft, 2001), while the contribution of shared environment ranged from 32% to 48%. These findings were surprising, as they indicated quite strong shared environmental influence, something not commonly seen in behavioural genetic studies. These findings were striking in their support of a strong prediction of classic attachment theory, namely that the environment, and particularly the shared environment, plays the primary role in influencing the development of secure and insecure patterns of attachment. Furthermore, the variance of the shared environment in attachment security was found to significantly overlap with the shared environmental variance of maternal sensitivity (Fearon et al., 2006). In other words, these studies confirmed that, at least in the first years of life, attachment is largely determined by a quality of environment that is extensively parent-driven, rather than child-driven. Therefore, in infancy the estimates of the shared-environment component are likely to represent a proxy for a passive rGE, in as much as the association between the young child's attachment patterns and the quality of the environment provided by the parent can significantly be accounted for by a shared genotype between parent and child (Neiderhiser et al., 2004).

Much less is known, however, regarding the genetic and environmental determinants of attachment beyond infancy and early childhood. Although attachment theory would tend to assume a similar pattern of strong shared environmental influence on attachment in later childhood, adolescence or adulthood, evidence of this remains limited. Furthermore, longitudinal studies have shown that continuity of attachment security from infancy across the life span is relatively modest (e.g. Hamilton, 2000; Fraley, Roisman, Booth-LaForce, Owen, Holland, 2013).

Moreover, from the point of view of contemporary behavioural genetics research, one might expect that genetic influences on attachment organisation would increase with development, as it has been

+documented in relation to other domains, such as intelligence (Haworth et al., 2010; Plomin et al., 2018), externalizing behaviours (Button, Lau, Maughan & Eley, 2008; Van der Valk, van den Oord, Verhulst & Boomsma, 2003) and psychopathology (Burt, 2009). In fact, genetic factors do appear to play a predominant role in romantic attachment with partners in adult populations (Picardi et al., 2011; Donnelan et al., 2008; Torgersen et al., 2007; Crawford et al., 2007; Brussoni et al., 2000).

To date, however, the only well powered behavioural genetic study of parent-child attachment security in adolescence was carried out by Fearon, Shmueli-Goetz, Viding, Fonagy and Plomin in 2014. The authors used the Child Attachment Interview (Shmueli-Goetz et al., 2004), a standardized and validated interview-based measure designed to assess parent-child attachment in late childhood and adolescence. Fearon et al. (2014) found the estimates of heritability obtained for the Coherence scale (a dimensional measure of attachment security) and the overall 2-way attachment classification (secure vs insecure) were 38% and 35% respectively, while the influence of shared environmental factors was negligible. Through comparing these findings with previous literature on child attachment security, the authors confirmed that genes might exert a greater influence during a phase of reorganisation of attachment occurring between childhood and adolescence, thus driving a shift from a relational construct to a more cognitive-affective and trait-like one in adolescence. Fearon et al. (2014) also suggested that genetic tendencies might progressively elicit changes in aspects of parental behaviours that are relevant for attachment, thus influencing the children's feelings of security. This explanation would suggest that attachment is increasingly influenced by

processes of evocative rGE (Avinun & Knafo, 2014; Klahr & Burt, 2014; Kendler & Baker, 2007). At the same time, the apparently diminishing role of shared environment on attachment over the course of development can be explained as a result of the decreasing influence of genetic factors and the progressively greater exposure to non-shared environmental factors (including peer groups) that come from greater autonomy, indicating a decreasing passive rGE (Burt, 2009; Plomin et al., 1977).

Nevertheless, it is important to stress that in behavioural genetics the two components of environmental influence (shared and non-shared) do not reflect specific types of environments in any straightforward sense. For instance, the parenting quality may be an important component of the shared environment effect on adolescent attachment. However, the same quality of parenting may also be experienced in different ways between siblings and therefore may be estimated as non-shared environment. This is why it is important for genetically informative studies to comprise the assessment of environmental factors that are likely to be relevant for adolescent attachment, such as peer affiliation, parenting quality and socio-economic status, in order to increase the understanding of the factors coming to play in determining attachment organisation across development.

1.3. Overview of the current thesis

Since security of attachment has been associated with greater social competence and lower risk for psychopathology (Fearon, Bakermans-Kranenburg, van Ijzendoorn, Lapsley, & Roisman, 2010; Lyons-Ruth, Alpern, & Repacholi, 1993), a thorough understanding of the causal environmental and genetic influences of attachment in the critical phase of adolescence is crucial for the advancement of prevention programmes and clinical interventions.

This thesis contains three studies conducted on a sample composed of 599 monozygotic (identical) and dizygotic (non-identical) twin pairs between 13 and 15 years of age. The studies build on the seminal research carried out by Fearon et al. (2014), by addressing important gaps in relation to the genetic and environmental influences on attachment security in adolescence and its association with the quality of parenting.

Importantly, the Child Attachment Interview used in Fearon et al.'s (2014) study represents only one of several approaches to measuring attachment in adolescence. While in infancy the Strange Situation Procedure is considered as the "gold standard" measure of attachment security, the assessment of attachment in later development – especially adolescence – presents some important limitations. Furthermore, different measurement methods and assessment tools have been shown to lead to contradictory findings (e.g. Jewell et al., 2019). These aspects will be described in detail in the next chapter.

In this thesis, the study by Fearon et al. (2014) was extended by looking into different approaches to measuring attachment security in adolescence, namely self-report and interview-based approaches, in an attempt to tackle the complexity of adolescent attachment organisation by examining the phenomenon from different angles, to test and possibly implement generalizability of the results to date.

The first study of this thesis represents a preliminary investigation aimed to compare two of the most widely used instruments in the attachment field (Jewell et al., 2019): the Child Attachment Interview and the Inventory of Parent and Peer Attachment (IPPA -Armsden & Greenberg, 1989). The latter is a well-validated self-report scale designed to test the adolescents' conscious perception of the quality of relationship with their main attachment figures expressed in terms of trust, communication and alienation. In most studies, the IPPA parental subscales (i.e. Trust, Communication and Alienation)

and the IPPA total scales (obtained by summing the scores of Trust and Communication, and subtracting the scores of Alienation) have been used to measure attachment security in a dimensional continuum, with higher total scores being indicative of higher attachment security (e.g. Borelli, Somers, West, Coffey, De Los Reyes and Shmueli-Goetz, 2016). However, a series of studies have also tested different ways to classify attachment security by means of a categorical approach, some attempting to distinguish between attachment styles (e.g. Vivona, 2000) and some providing a quantification of attachment security (i.e. low, medium and high) based on scores distribution (e.g. Andretta et al., 2015). The first study included in this thesis aimed to establish whether a dimensional or a categorical approach to scoring the IPPA affords a better prediction of attachment status as assessed through the CAI.

This investigation led to the second study of this thesis, in which behavioural genetics of attachment were explored through the administration of the IPPA. In so doing, findings from Fearon et al. (2014) were replicated by adopting a different methodology of assessing and conceptualising adolescent attachment security. Administration of the IPPA also allowed the examination of crucial aspects of adolescent attachment which have not yet been explored from a behavioural genetic perspective, namely adolescent attachment security to peers and its association with maternal and paternal attachment assessed separately.

In addition, Fearon et al (2014) hypothesised that increasing genetic influences on attachment organisation could be accounted for by increasing evocative rGE effects on the correlation between attachment security and parenting. This would indicate that children's heritable traits are likely to increasingly elicit attachment related behaviours in their caregivers, leading to a conceptualisation of attachment that is primarily adolescent-driven. In the third study presented in this thesis, the role of genetic and

environmental components was tested in relation to the quality of parenting in adolescence, using observational measures assessing a range of parental behaviours considered as relevant for attachment security, such as parental sensitivity, positivity and mutuality. Furthermore, the study aimed to examine if common genetic and environmental components could account for the covariation between adolescent attachment security (assessed via both the CAI and the IPPA) and parenting quality, thus testing whether this correlation could be determined by genes influencing both traits. This work is innovative in that it includes observational measurements of environmental factors accounting for the variance in attachment security in adolescence. This aspect may take behavioural genetic research on attachment to a higher level, thus increasing the understanding of how attachment security (or insecurity) is transmitted and how it is affected by current experiences in close relationships.

Finally, based on findings from the three studies presented in the thesis, the last chapter illustrates reflections of the author as well as overall conclusions and indications for future research.

Chapter 2 - Study 1

Measuring attachment security in adolescence: a comparison between the Child Attachment Interview and the Inventory of Parent and Peer Attachment

2.1. Introduction

2.1.1. Assessment of attachment security from infancy to adolescence

While humans have a general disposition to develop and maintain attachment bonds with significant figures, there are considerable individual differences in the modalities in which these processes take place. These differences, which begin to emerge in early childhood, depend on internal working models (IWM) of self and others that develop in interaction with attachment figures in combination with biological factors. These IWMs, which shape expectations of future relationships and the associated emotional and behavioural responses, are theorised to persist throughout childhood, adolescence and adulthood, although they might be susceptible to be revised on the basis of ongoing experiences (Bowlby, 1969, 1970).

In the last decades, researchers have validated a series of tools to measure attachment security and its correlates adopting different age-appropriate approaches. From 9 to 18 months, the Strange Situation is considered the “gold standard” measure of attachment. This instrument aims to directly measure children’s attachment behaviours in a situation where attachment-related stress is elicited. Ainsworth, Belhar, Waters and Wall (1978) identified three main attachment styles based on observations of the behaviours exhibited by infants in the moment of reunion with the caregiver after

separation: secure (B), insecure avoidant (A) and insecure ambivalent (C). Children classified with secure attachment exhibited patterns of concern at separation and calmed down relatively quickly during reconciliation with their caregivers. Children with avoidant attachment appeared indifferent to the return of their caregiver, while children classified with ambivalent attachment exhibited acute levels of distress at separation that endured after reunion with the caregiver. This initial classification was subsequently revised by adding the category of Disorganized - Disoriented attachment (D) (Main and Solomon, 1990). This category indicated children who exhibited behavioural disorganization at reunion with caregiver in the form of wandering, freezing, undirected movements, or contradictory patterns of interaction (see previous chapter).

Children aged from 2 to 6 years old can also be assessed in their attachment organization through observation-based measures adopting the ABCD classification paradigm, such as the Main-Cassidy Attachment Classification (Main and Cassidy, 1988), or alternatively through different tools not reliant on Ainsworth's classification system. For instance, the Attachment-Q Set (Waters, 1995) was designed for infants to 5- year- old children to evaluate secure-base behaviours at home, based on appropriate balance of proximity seeking and exploration. Furthermore, by the preschool years, children are thought to encode knowledge about their relationships with significant figures in representational forms, which can be evaluated through measures reliant on symbolic representations of internal working models of attachment, such as responses to pictures (e.g. Slough and Greenberg, 1990), doll play (e.g. George and Solomon, 1990, 1996, 2000) or drawings (e.g. Clarke, Ungerer, Chahoud, Johnson and Stiefel, 2002).

In later childhood and adolescence, the assessment of attachment security must take account of important transformations taking place with respect to attachment

relationships and related intrapsychic processes and competencies. On one hand, researchers can no longer rely only on behavioural measures, as language has become increasingly predominant throughout development. On the other hand, the ability of children to communicate their attachment representations through coherent verbal language is still underway (Picardi, Giuliani, Gigantesco, 2020). Because of the increasing complexity and number of factors contributing to attachment re-organisation from childhood to adolescence, the validation of reliable age-appropriate measurements tackling the “moving target” of attachment security represents an important challenge for researchers in the field.

One of the main transformations in the relationship with caregivers occurring throughout development consists in the challenge of negotiating between habitual patterns of attachment responses and the struggle for individuation and behavioural autonomy (Allen and Manning, 2007). Nonetheless, even in adolescence parents continue to be used as fundamental attachment figures and the attachment system continues to be activated in conditions of separation distress or danger (Rosenthal and Kobak, 2010).

At the same time, children tend to gradually extend their sources of attachment beyond their relationship with caregivers, with peer groups and friends playing an increasingly important role throughout development (e.g. Bosmans & Kerns, 2015; Freeman and Brown, 2001). Especially during the transition from late childhood to adolescence, individuals are impelled to adjust and adapt their consolidated IWMs around caregivers to a more extended network, through the implementation of effective interpersonal strategies which will converge into adult patterns of attachment and romantic relationships. The development of formal operational thinking and the increase in cognitive differentiation between self and other (Keating, 1990; Inhelder & Piaget,

1958) make the adolescent able to integrate diverse attachment-relevant experiences and begin to re-evaluate thoughts, memories and affective reactions in relation to attachment relationships more objectively. In the transition from childhood to adolescence, these changes are thought to underlie the re-organisation of attachment from a behavioural and relational construct to one centred around the individuals' ability to think about attachment in in its generality, rather than in association to specific relationships, and to operate in a metacognitive way on this thinking (Fearon et al., 2014). As a result, adolescence can be considered as the period during which individuals begin to reconstruct their own *state of mind with regard to attachment* (Cassidy & Shaver, 2018).

This construct is based upon Main, Kaplan, and Cassidy's (1985) concept of attachment *representations*, which the authors defined as a set of conscious and unconscious rules for the organization of information regarding attachment related experiences, feelings, and ideations. Attachment representations are normally evaluated through psycholinguistic qualities of narratives in relation to attachment experiences (see next section).

Beyond infancy and childhood, a key difference between attachment *representation* and attachment *style* is that the latter is conceptualized as a singularly conscious approach -that may reflect a personality trait- to engaging in intimate relationships while the former may operate at both conscious and unconscious levels (Fraley & Roisman, 2018; Fraley & Shaver, 2000). Attachment styles can be classified based on the seminal work by Ainsworth et al. (1978) by focusfing on how the individual conceptualizes attachment relationships through examining cognitive, emotional, and behavioural reactions to separation, intimacy, and perceived abandonment (Hazan & Shaver, 1987).

2.1.2. Interview methodology versus self-reports in the assessment of attachment in adolescence and adulthood

Tools assessing attachment security in late childhood and adolescence no longer rely on the evaluation of exhibited behaviours or symbolic representations of attachment relationships like in earlier phases (Picardi, Giuliani, Gigantesco, 2020). The current available attachment measures in adolescence and adulthood have been developed within two distinct methodological cultures which, despite stemming from the same theoretical tradition, focus on different attachment processes and relationships.

The first culture, better represented in developmental psychology, relies on the Adult Attachment Interview (AAI -George, Kaplan and Main, 1985), a semi-structured interview which was designed to assess the individual's representations of attachment relationships. The use of narratives to assess attachment through the AAI is based on the idea that after childhood, behavioural, cognitive and affective processes are reflected in organized and coherent patterns of thought and emotion that are in turn reflected in discourse. Through the AAI, attachment security is assessed on the basis of the individual's recollection of experiences with parents, the qualities of the language used by the individual and the individual's ability to give an integrated and coherent account of attachment experiences and their meaning. Attachment categories as assessed through the AAI – i.e. *Secure, Dismissing, Preoccupied and Disorganized* - are conceptualized as paralleling the ABCD classifications identified by Ainsworth (1978) and Main and Solomon (1990). A secure (or *autonomous*) classification is characterized by highly coherent explanations of one's attachment history and a high value on attachment relationships. Secure attachment is thus reflected in the interviewee's ability to provide an internally consistent narrative about attachment experiences without becoming

emotionally entangled or preoccupied while doing so. By contrast, dismissive representations devalue attachment relationships, while preoccupied representations have a childlike quality to them and tend to be verbose, vague, or filled with irrelevant details. Finally, the unresolved classification is characterised by narratives containing affective disruptions that contaminate the coherence of attachment recollections. These attachment representations are thought to form during late childhood and are based upon the internal working models developed within the context of parent-child interactions. However, these attachment representations have been shown to extend to peer relationships (Fonagy & Target, 1996), romantic relationships in adulthood (Crowell et al., 2002) and client–therapist relationships in adolescence (Tyrell, Dozier, Teague, & Fallot, 1999; Zegers et al., 2006).

More recently, a revised version of the AAI, the Child Attachment Interview (Shmueli-Goetz, Target, Datta and Fonagy, 2004) has become the most popular interview-based tool to assess attachment security in children and adolescents. This measure will be illustrated more in detail later in this chapter.

The second culture, better represented in personality and social psychology, has relied on self-report questionnaires designed to assess individuals' direct endorsement or perception of their current attachment relationships and their feelings and behaviours within them (Crowell, Fraley and Shaver, 2008). On one hand, self-reports administered to adult populations mainly focus on the perception about self as worthy of love and others as available and dependable in the context of romantic relationships (Roisman, 2009). The available measures –e.g. the Experiences in Close Relationship (ECR) questionnaire (Brennan et al., 1998), the Attachment Styles Questionnaire (ASQ- Feeney et al., 1994) or the Relationships Scale Questionnaire (RSQ- Griffin & Bartholomew, 1994)– tackle the latent structure of attachment in terms of anxiety and

avoidance: two dimensions that mark individual differences in attachment security that resemble those observed in infancy (Fraley & Speaker, 2003)[1]. On the other hand, the existing self-report questionnaires of attachment in adolescence involve quite different operational definitions of attachment security and arguably tap into different components of attachment (Jewell et al., 2019). This is primarily due to the increasing complexity and number of factors contributing to attachment re-organisation from childhood to adolescence. This aspect will be addressed more in detail throughout this chapter.

2.1.3. Dimensional versus categorical approaches to measuring attachment in adolescence

One of the central controversial aspects of attachment measurement in adolescence is whether attachment organization can be classified in the same ways as in earlier life phases (Fraley and Roisman, 2014). Although the four-category ABCD paradigm has held a central place in attachment theory, according to a recent extensive review by Jewell, Gardner, Susi, et al. (2019) aiming to evaluate the psychometric properties of attachment measures in middle childhood and adolescence, interviews

[1] In adult populations, individual differences in attachment styles are marked by different emotion regulation abilities, perception and beliefs about self and others, and patterns of relating to significant others. The two dimensions of anxiety and avoidance refer to the fear of being abandoned or not loved enough and the discomfort with intimacy and emotional expression, respectively (Brennan, Clark & Shaver, 1998). The most popular categorical model of attachment styles in adult populations consists of four categories: *secure* attachment, characterised by low levels of anxiety and avoidance; *dismissing* attachment, with high avoidance but low anxiety; *preoccupied* attachment, with high anxiety and low avoidance; and *fearful avoidant* attachment, characterised by high levels of both anxiety and avoidance. (Mikulincer & Shaver, 2016).

based on this paradigm (the CAI and the AAI) reported sub-optimal inter-rater reliability (kappa < 0.7), whereas adequate structural validity in the CAI was obtained only when assessed using the two dimensions of “Security-Dismissal” and “Preoccupation-Idealization” (Zachrisson et al., 2011). At the same time, most self-report measures yielding continuous scales of attachment being evaluated in the same review (Jewell et al., 2019) also demonstrated sub-optimal structural validity, despite exhaustive factor analysis using large samples. The authors argued that the lack of structural validity may either reflect problems with the measures themselves, or the fact that the attachment construct in middle childhood and adolescence is inherently difficult to measure reliably, given the fluidity of attachment representations at this age (Jones et al., 2018).

As a consequence, the underlying structure of attachment in middle childhood and adolescence remains unclear, with neither the ABCD model for interview/projective measures, nor the two factor avoidance- anxiety structure measured in adult attachment (Brennan, Clark & Shaver, 1998) showing adequate validity in this age group (Jewell et al., 2019). Nonetheless, some researchers (e.g. Crowell, Fraley & Roisman, 2016) have suggested that continuous measures of attachment (hence reflecting an operationalisation of attachment security along a continuum) may have benefits over attachment classifications in adolescence, as placing scores into categories could mask important individual differences which otherwise would not be captured.

Notwithstanding the aforementioned difficulties and controversies, among the several self-reports designed to measure attachment in adolescence, the Inventory of Parent and Peer Attachment (IPPA; Armsden and Greenberg, 1987; 1989) has been shown to have optimal construct validity and adequate convergent validity with interview-based measures across a number of studies (e.g. Borelli et al., 2016), alongside

practical advantages in terms of its time and costs of administration. This inventory is designed to assess adolescents' relationships with both their parents and peers and has been increasingly used in recent years in international research on adolescents.

Given the important advantages and characteristics of the IPPA, the next section will illustrate the implications of different paradigms and methodologies of assessment based on this measure.

2.1.4. The Assessment of Attachment Security Using the Inventory of Parents and Peer Attachment

The IPPA was designed to assess the perception of affective and cognitive dimensions of relationships with parents and close friends in adolescents aged between 12 and 19 years of age (Armsden and Greenberg, 1987). Attachment security is assessed by investigating how well these figures represent sources of psychological well-being and safety. The structure of the IPPA has been modified numerous times from its original version (Greenberg, Siegel and Leitch, 1984), which consisted of two forms for assessing attachment security towards parents (28 items) and peers (25 items). Later, Armsden and Greenberg (1989) proposed a revised version of the inventory, allowing respondents to rate their relationship with their mother and father separately (for a review, Pace, San Martini and Zavattini, 2015). Currently, the most frequently used versions of the IPPA use a three-factor model in which the following dimensions are assessed: 1) "Trust", interpreted as understanding, respect and mutual trust; 2) "Communication", interpreted as the perceived extent and quality of communication within the relationship and 3) "Alienation", interpreted as the negative affective experiences of anger or hopelessness resulting from unresponsive or inconsistently responsive attachment figures. Although one-factor (attachment security -

Greenberg et al., 1984) and two-factor (trust-communication vs alienation, - Johnson, Ketring and Abshire, 2003) models have been proposed, the three-factor structure has repeatedly been shown to have the best fit as compared to other models (e.g. Andretta, McKay, Harvey and Perry, 2017; Pace, San Martini and Zavattini, 2015; Vignoli and Mallet, 2004).

Importantly, the IPPA was not designed to differentiate among the attachment styles identified by Ainsworth et al. (1978). As Armsden and Greenberg (1987) wrote: “It is not clear what the developmental manifestations of "avoidant" or "ambivalent" attachment would be in adolescence, or if other conceptualizations of insecure attachment would be more appropriate” (p.447). As a result, in most studies the parental scales of the IPPA have been used to measure attachment security in a dimensional continuum, with higher total scores being indicative of higher attachment security (e.g. Borelli, Somers, West, Coffey, De Los Reyes and Shmueli-Goetz, 2016; Venta, Shmueli-Goetz and Sharp, 2014; Pace et al., 2015). However, a series of studies have also tested different ways to classify attachment security by means of a categorical approach.

For instance, Armsden and Greenberg (1987) originally administered the IPPA to 179 college students aged between 16 and 20 years old and designated scores for each subscale (Trust, Communication and Alienation) as “low”, “medium” or “high”. Individuals reporting low scores of Alienation and medium-high scores of Trust and Communication were classified as Highly Secure, whereas those who reported low scores of Trust and Communication and medium-high scores of Alienation were assigned to the Low Security group (this classification system is explained more in detail in the methods section). Participants who did not fit into either group were classified as “Midrange”. The authors found that students in the High Security group reported higher self-satisfaction,

greater proclivity to seek support and lower levels of distress in response to negative events compared to students in the Low Security group.

Vivona (2000) attempted to implement this classification system by administering the IPPA to a sample of 159 adolescents between 18 and 23 years of age. The author's intent was to test if the IPPA could be suitable to identify the three attachment styles proposed by Ainsworth (1978), in contrast with the original assumptions by Armsden & Greenberg (1987). Alongside Armsden & Greenberg's (1987) High Security category, Vivona (2000) proposed two different subcategories of Low Security. Firstly, higher scores in Alienation than Trust and Communication would indicate Avoidant attachment, characterized by anger and lack of trust towards the parent. Secondly, lower scores in Trust than Communication and Alienation were thought to indicate Ambivalent attachment, characterized by active engagement and lack of trust toward the parent, reflecting a strong yet conflicting parent-child relationship. Results showed that this type of classification was associated with the subscales of the Parent Attachment Questionnaire (Kenny, 1990), which is also based on Ainsworth's conceptualization of attachment styles. Moreover, individuals with secure attachment manifested lower levels of anxiety, depression and worry compared to the categories of insecurely attached individuals.

Nevertheless, the attachment classification system proposed by Vivona (2000) presented noteworthy limitations, as it was based on the definition of secure attachment as exclusively characterized by high scores of Trust and low scores of Alienation. This restrictive parameter has two main implications. Firstly, although Bowlby (1969) originally emphasized the role of trust toward the main attachment figures as a crucial element characterizing secure attachment, the role of communication is arguably of no lesser importance in the parent-child relationship, especially in adolescence. According

to Armsden & Greenberg (1987) the quality of communication with parents as reported in the IPPA is a crucial indicator of attachment security as it reflects the decreasing frequency of behaviours promoting proximity - typical of early childhood - which are gradually replaced by symbolic strategies to seek comfort as age increases. Secondly, Vivona's (2000) method leads to a relatively large number of unclassifiable participants, considered as those cases that do not fall into any identified profile due to the strict classification criteria. Specifically, the author (2000) could not classify 20% of the original sample. The rest of the sample was classified as follows: 50% as secure, 31% as avoidant and 19% as ambivalent. [2]

For these reasons, whether the IPPA could be considered as a useful measure for the study of individual differences in *attachment styles* in relation to parents and peers remains debatable.

A different method to classify attachment security via the IPPA consists of identifying clusters through model-based clustering analysis, as proposed by Andretta, Ramirez, Barnes, Odom and Woodland (2015). The authors administered the version of

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[2] In a different study, Guarnieri, Ponti & Tani (2010) found even lower percentages of secure participants with the aim to compare the classification proposed by Vivona (2000) with the one proposed by Armsden and Greenberg (1987) on a normative sample of adolescents. The authors classified as secure 33.5% and 35.6% of the total sample in the mother and the father versions of the IPPA respectively. However, the authors did not use Vivona's parameter to classify secure participants (i.e. high scores in Trust and low scores in Alienation), rather they applied Armsden & Greenberg's (1987) criteria to establish High Security (i.e. if Alienation scores were not high and if Trust and Communication were at least medium) for this category in both classifications. The authors found 33% unclassifiable participants, despite the use of non-restrictive parameters for the classification of secure attachment.

the IPPA (Laible, Carlo and Raffaelli, 2000) to 213 African American teenagers aged 11 to 18 years old involved in the Juvenile Justice System. Model-based clustering is a statistical technique that identifies homogeneous clusters or subgroups in a multivariate dataset. Using this approach, the authors identified four attachment profiles: a) Low Security; b) Moderately Low Security; c) Moderately High Security and d) High Security. Subsequently, Andretta and colleagues (2017) administered the revised version of the IPPA (Gullone and Robinson, 2005) to a normative sample of 1126 adolescents between 12 and 16 years of age. Through the application of the model-based clustering method, in this sample the authors identified a fifth profile, Average Security, in which the scores for each subscale were very close to the mean of the entire sample. The identified profiles were found to correlate significantly with different levels of perceived self-efficacy as measured in the sample (i.e. Self-esteem, academic, emotional and social self-efficacy). In the context of a developmental phase where differences in attachment organization among individuals seem to become more pronounced (Allen, Porter, McFarland, McElhaney and Marsh, 2007), Andretta et al. (2015) hypothesized that adolescents with moderate profiles might be in transition to more “extreme” profiles. According to the authors, these individuals are more inclined to adjust their attachment organization and thus would benefit from family- focused therapy more than their peers with consolidated attachment patterns.

Although the studies illustrated above have provided evidence in support of possible ways to extract different categories of attachment security from scores of the IPPA in different samples, an important issue facing efforts to validate different operationalisations of the IPPA and related measures is the need for some independent criterion or benchmark to judge whether one form of scaling or categorisation scheme is better than another. Although there is no gold standard reference point one can use, the Child Attachment Interview (CAI; Shmueli-Goetz, Target, Datta and Fonagy, 2004) was

selected for this study, as this tool has the advantages of being well-validated and rated independently based on the quality of attachment narratives.

2.1.5. The Assessment of Attachment Security Using the Child Attachment Interview

The Child Attachment Interview (CAI; Shmueli-Goetz et al., 2004) is a well-validated tool which was originally devised for children aged between 8 and 12 years but has subsequently been adapted and administered to adolescents up to 17 years of age. The CAI has been adapted for adolescence and represents a preferable tool for measuring attachment in adolescence compared to the the Adult Attachment Interview (AAI –George, Kaplan and Main, 1985). Indeed, although many studies exploring attachment in adolescence (e.g. Marsch, McFarland, Allen, McElahaney and Land, 2003) have relied upon adult attachment classification, the administration of the AAI in non-adult populations may not be appropriate for adolescent populations (Ammaniti, van Ijzendoorn, Speranza and Tambelli, 2000). Therefore, although the CAI owes much to the structure and the scoring system of the AAI, it does not rely as heavily on memory for past experiences or retrospective evaluation of parental relationships (which are still very much ongoing for adolescents). The CAI is designed to capture the perception of the *current* availability and responsiveness of attachment figures, as well as the evaluation of the current quality of attachment relationships.

During the CAI, children are asked to describe their current relationship with each of the primary caregivers and are encouraged to support their narratives with details about specific episodes. The questions asked by the interviewer aim to elicit attachment representations, with a focus on times of illness, loss, or separation as these are times

when the attachment system is more likely to be activated. Interviews are coded according to 11 scales (these will be illustrated in the next chapter) that taken together provide an assessment of both verbal and non-verbal behaviours, which allows accessing aspects of attachment that are outside conscious awareness and which therefore cannot be easily accessed through self-report questionnaires.

The CAI can provide different types of attachment measures. Firstly, like the AAI, the CAI is coded for the overall Coherence of the narrative, which is considered a key indicator of security (Shmueli-Goetz et al., 2004). For this reason, a few studies (e.g. Borelli, Crowley, David, Sbarra, Anderson and Mayes, 2010) have used Overall Coherence in the CAI as a primary index of attachment security. Secondly, factor analytically-derived scales that can account for attachment security have also been identified. For instance, Venta, Shmueli-Goetz and Sharp (2014) found that the three factors of Coherence, Anger and Idealization explained together 66.4% of the variance of in the CAI scales. Other studies used dimensional scores from the two factor analytically- derived Dismissing and Preoccupied scales (e.g. Borelli et al., 2016: Zachrisson, Røysamb, Oppedal and Hauser, 2011). Finally, it is possible to obtain a classification of attachment security based on the combinations of scores in the twelve scales, thus identifying four different types of attachment along the categories conceptualized by Ainsworth (1978) and Main and Solomon (1990): Secure, Dismissing (the equivalent of Ainsworth's avoidant), Preoccupied (the equivalent of Ainsworth's ambivalent) and Disorganized (see pp. 50-51).

A growing body of research has reported on the CAI's psychometric properties both in clinical and non-clinical samples and has provided good evidence of its reliability and validity. As a result, the CAI can currently be regarded as the only acceptable interview-based measurement to assess attachment security in youth (Jewell et al.,

2019). Alongside high interrater reliability for both mother and father on the scales (ranging from .7 to .9 in Shmueli-Goetz, Target, Fonagy, Datta, 2008) and the four-way attachment classification (ranging from κ = .52 to κ = .64 in Venta et al., 2014; and from 78% to 85 % in Shmueli-Goetz et al., 2008 –only for mother) the CAI also has good test-retest reliability on both scales and attachment classifications over a 3 months and 1 year period score relatively high (in Shmueli- Goetz et al., 2008, these were α = .7-1.0 and α = .7-.8, respectively). Furthermore, the CAI is not associated with verbal intelligence or expressive language (Shmueli-Goetz et al., 2008). Finally, Borelli, Somers, West et al. (2016) found evidence of incremental validity of the CAI beyond self-report questionnaires with respect to the assessment of internalizing symptoms.

2.1.6. Links and Differences between the IPPA and the CAI

Although the IPPA and the CAI are both widely used instruments to assess attachment in adolescence, it is important to bear in mind that interviews and self-reports assess partially distinct constructs. Research assessing the convergent and concurrent validity of the CAI, for example, found some associations with self-reports across several measures. With respect to the IPPA, Overall Coherence significantly correlated with attachment security as indicated by the total scores in the study by Borelli et al. (2016) and secure attachment in the CAI was significantly associated with higher scores in the Trust and Communication subscales and lower scores in the Alienation subscale (in relation to mothers only) in the study by Venta et al. (2014). However, to date the only few studies that have tested possible associations between IPPA measures and different attachment organizations assessed through the CAI were not conducted on normative samples of adolescents. More precisely, Venta et al (2014) found no associations between IPPA continuous measures and CAI ABCD categories in a sample

of adolescents with psychiatric disorders. Likewise, in their sample of 8 to 12 years old children, Borelli et al (2016) tested the correlations between IPPA total scores (without including single subscales in the analyses) and factor-analytically derived scales of dismissing and preoccupied attachment, finding a significant partial correlation (controlled for age and gender) of r = 0.43 with the preoccupied scale alone.

Notwithstanding the limited findings illustrated above, in their comprehensive review, Jewell and colleagues (2019) identified the CAI and the IPPA as the instruments that are currently best supported by evidence in relation to their psychometric properties and their mutual association, despite their widely differing methodologies. Therefore, the CAI is likely to provide a useful way of addressing the relative value of differing operationalisations of the IPPA subscales for capturing attachment-related phenomena.

2.1.7. The Current Study

The main objective of the current study was to test different operationalisations of the IPPA for measuring attachment security in a large normative sample of adolescents and establish which method provides the best prediction of CAI attachment organization.

The research goals of the current study were:

1) to examine the associations between the different IPPA and CAI attachment measures on a normative sample of young adolescents (13-16 years old);
2) to establish whether a dimensional or a categorical approach to the IPPA affords a better prediction of attachment status as assessed through the CAI.

2.2. Methods

2.2.1. Participants

Participants in this study came from the Twins Early Development Study (TEDS), a large longitudinal cohort of same-sex twins born in England and Wales between 1994 and 1996. This cohort has been followed up for different purposes over the last decades, prime among which to gain a greater understanding of the role of genes and environment in determining different developmental features, such as learning skills, cognitive abilities, and attachment. The recruitment process of the initial cohort is described in Trouton, Spinath and Plomin (2002). Following recruitment, the families have since been invited to take part in studies when the twins were at different ages, from toddlerhood to late adolescence. More recently, a subgroup of TEDS participants was invited to take part in a project investigating the role of genes and environment in parent-child attachment in adolescence (Fearon, Sgmueli- Goetz, Viding, Fonagy and Plomin, 2014). All families participating in the study who lived in London or in the nearby areas met the inclusion criteria (age: 15 years ±14 months) and of these, 592 twin pairs were subsequently assessed.

For the current study, all cases from the above TEDS study were selected. In this circumstance, participants had completed the CAI and the IPPA in relation to their parents (or stepparents, if biological parents were absent). As the research aims of the current study did not involve the exploration of genetic and environmental influences, one twin from each pair was randomly excluded. However, because of the low rates of participants in this sample coded as Preoccupied and Disorganized in the CAI, all such cases were included in this study.

Therefore, for twin pairs where one twin was coded as Disorganized or Preoccupied that twin was chosen (non-randomly) to be included in the current analysis. Further, 11 pairs of twins were included, as in these cases both siblings were classified as Preoccupied or Disorganized. The total sample was composed of 599 participants (341 girls). Of these, 576 (96.2%) completed the CAI in relation to their mothers and 569 (95%) in relation to their fathers, and 543 (90.7%) participants completed the CAI in relation to both parents. The maternal IPPA was completed by 577 (96.5%) participants and the paternal IPPA was completed by 557 (93%) participants. In total, 545 (90.8%) participants completed both the maternal and the paternal forms of the questionnaire.

2.2.2. Socio-demographic factors

Parents of participants provided information on the ethnicity, family income and maternal and paternal educational level. The majority of participants came from British families (82.3%) while the rest of the sample was ethnically heterogeneous. The sample was quite diverse in terms of socioeconomic status, with an annual income < £30.000 reported by 22.6% of the families (median household income: £30,000 -£50,000). With respect to parental education, 66.9% of the mothers and 57.7% of the fathers reported having at least A levels.

2.2.3. Measures

Inventory of Parents and Peer Attachment

The Inventory of Parent and Peer Attachment (IPPA; Armsden and Greenberg, 1987) is a self-report measure of the quality of parent and peer attachments.

Respondents rate a series of 25 items regarding their relationships with their parents and peers (e.g. “My mother/father respects my feelings”, “I wish I had a different mother/father”) on a 5-point Likert scale: (1) almost never or never true; 2) not very often true; 3) sometimes true; 4) often true; 5) almost always or always true). For the purposes of this study, only parental scales (mother and father separately) were considered, each scale consisting of 25 items, following the revised version by Armsden and Greenberg (1989).

Three dimensions relating to attachment quality were assessed: Trust Communication and Alienation. In this sample, Cronbach’s alphas in relation to IPPA total scores were .67 and .69 for mother and father items respectively, showing adequate internal reliability. Cronbach’s alphas in relation to IPPA subscales also showed adequate internal reliability (Mother – Trust: .66, Communication: .70, Alienation: .68; Father – Trust: .68; Communication: .71, Alienation: .69).

Attachment security was measured based on IPPA scores in three different ways.

Firstly, following a dimensional approach, total scores and single subscales (Trust, Communication and Alienation) were considered for each parent. Total scores were obtained by subtracting Alienation scores from the summed scores of Trust and Communication.

Secondly, the method proposed by Armsden and Greenberg was replicated by following the procedure reported in their study (Armsden and Greenberg, 1987 -p 442). Each participant was given a rating of "low," "medium" or "high" for each of the three subscales after evaluating the cut points for three equal groups, depending on where their score fell in the distribution. Subsequently, individuals were assigned to the High Security (HS) group if their Alienation scores were either low or medium and if their Trust

or Communication scores were at least medium. In line with Armsden and Greenber's (1987) study, following the assumption that the element of trust in the attachment relationship is particularly relevant according to classic theories (Bowlby,1980), in cases where Trust scores were medium and Alienation scores were also medium, HS group assignment was not made. Alternatively, participants were assigned to the Low Security (LS) group if their Trust and Communication scores were both low, and if their Alienation scores were medium or high. Cases were assigned to the LS group even if Alienation score was high and the Trust and Communication scores were medium *and* low (i.e. low Trust, medium Communication, or vice versa). The rest of the sample was classified as Midrange (MID). This procedure is summarized in Table 2.1. This type of classification will be referred to as "IPPA Low-Mid-High".

Table 2.1. *IPPA Low-Mid-High Security Classification. Cut-off scores for high, medium and low categories in Trust, Communication and Alienation and related classification, based on Armsden and Greenberg (1987).*

	Trust	**Communication**	**Alienation**
		Mother	
Mean	42,07	32,36	12,61
High	>46	>36	>14
Medium	41- 46	30 - 36	10 - 14
Low	<41	<30	<10
		Father	
Mean	40,13	28,12	13,44
High	>44	>31	>15
Medium	38 -44	25 -31	11 - 15
Low	<38	<25	<11

IPPA Low-Mid-High Classification			
	Trust	**Communication**	**Alienation**
	high	high	low/medium
High Security	high	medium	low/medium
	medium	medium/high	low
	Trust	**Communication**	**Alienation**
	low	low	medium/high
Low Security	low	medium	high
	medium	low	high

Notes: This table illustrates all possible combinations for participants to be assigned to the High Security and Low Security groups. Participants whose combination of scores are not reported in this table were classified as Midrange.

Thirdly, K- means clustering was run using the statistical programme R to group the single subscales of the IPPA in relation to each parent, imposing 5 clusters corresponding to High Security, Low Security, Average Security and the intermediate categories Moderately High Security and Moderately Low Security, replicating the attachment security profiles found by Andretta and colleagues (2017). The descriptive statistics of each resulting profile in relation to the IPPA subscales are reported in Table 2.2. This classification will be referred to as “IPPA 5-way classification”.

Table 2.2. *IPPA 5-way classification, obtained through K- means clustering on 5 groups based on Andretta et.al (2017). Cluster descriptive statistics.*

	Mother									
	High Security (N=153)		Moderately High Security (N=133)		Average Security (N=188)		Moderately Low Security (N=56)		Low Security (N=48)	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Trust	47.61	2.19	44.79	2.98	40.29	3.88	38.75	4.40	28	5.02
Communication	40.41	2.63	33.95	2.43	30.62	2.92	23.7	2.47	18.98	4.19
Alienation	9.41	2.48	10.36	2.42	14.43	3.03	14.36	3.67	19.38	3.80

	Father									
	High Security (N=93))		Moderately High Security (N=61)		Average Security (N=201)		Moderately Low Security (N=159)		Low Security (N=43)	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Trust	48.35	1.69	46.08	1.92	41.90	2.76	34.77	5.21	25.14	6.41
Communication	38.81	3.29	31.20	1.98	29.30	3.34	22.43	3.64	15.65	3.66
Alienation	9.12	3.01	9.13	2.05	13.79	3.19	14.74	3.90	22.84	2.59

Child Attachment Interview

The Child Attachment Interview (CAI; Shmueli-Goetz et al., 2004) consists of 17 questions concerning experiences and perceptions of attachment figures (e.g. “What happens when your mum/dad gets cross with you or tells you off? Provide an example”). Adolescents are evaluated on their ability to describe their experiences and their reflective ability when thinking about the impact of these experiences. The interviewer is trained to give adequate prompts throughout the interview to solicit the child to build detailed narratives with a focus on emotional processing. The interviews are filmed and subsequently transcribed verbatim. Coders rate transcripts and videotapes of the interviews on the following 9-points scales: Emotional Openness, Balance of Positive and Negative references to attachment figures, Use of examples, Preoccupied Anger, Resolution of Conflicts, Idealization, Dismissal, Atypical Disorganized behaviour and Overall Coherence. Preoccupied Anger, Idealization, and Dismissal are rated separately with respect to mother and father, with the remainder of the scales rated across the entire narrative. In the present study, Overall Coherence and the combinations of the scores in all scales were analysed, as illustrated in the CAI coding and classification manual (Target, Fonagy, Shmueli-Goetz, Datta and Schneider, 2007). The Secure classification is indicated by relatively high Emotional Openness, Balance of Positive

and Negative References, Use of Examples, Resolution of Conflicts, and Overall Coherence as well as relatively low scores on the Idealization, Dismissal, and Preoccupied Anger subscales. The Insecure Dismissing classification is indicated by high Idealization or Dismissal scales and relatively low scores on all other subscales. The Insecure Preoccupied classification is indicated by an elevated Preoccupied Anger score and relatively low scores on all other subscales. Finally, Attachment disorganization or atypical behaviour is captured as present or absent. The manual (Target et al., 2007) contains a detailed list of behaviours and discourse violations that are considered as markers of this category. The original sample was interviewed by trained research assistants. Inter-rater agreement was 80% or higher between one of the authors (Y. Shmueli-Goetz) and the research assistants for the four-way attachment classification, while for the secure vs non-secure split it was 85% for mother (Kappa =.69) and 86% for father (kappa=.72).

2.2.4. Procedure

The assessments used in this report were obtained during a single research assessment session, which took place either in a central university facility or in the family home. All twins were interviewed at the same time in separate rooms by two trained research assistants. Socio-demographic information was also included. Further details of recruitment and assessment are escribed in Fearon et al. (2014).

2.2.5. Data analysis

As a preliminary analysis, Spearman's rank-order correlations were computed to determine the relations between CAI measures (CAI Coherence and CAI 2-way

classification) and IPPA measures (IPPA single subscales, IPPA total scores, IPPA Low-Mid-High and IPPA 5-way classification). The associations between IPPA and the CAI ABCD Classifications were analysed in a series of one-way ANOVAs to test the mean differences between CAI ABCD categories in terms of IPPA Trust, Communication, Alienation and total scores, and a series of Chi-Squared tests to examine the association between CAI ABCD classification and IPPA Low-Mid-High and 5-way classifications. Subsequently, the relations between measures of both instruments and socio-demographic factors (gender, socio-economic status and ethnicity) were tested.

Finally, a comparison was carried out between models where IPPA measures were considered as predictors and CAI measures as dependent variables. The goodness-of-fit of the candidate models was tested using different coefficients of determination (candidate models and coefficient of determinations will be illustrated more in-depth in the next section). Through a critical evaluation of such coefficients, these analyses aimed to establish which operationalisations of the IPPA could best capture attachment security as assessed through different CAI measures.

2.3. Results

2.3.1. Preliminary Analysis

The mean of Overall Coherence in the CAI was 5.04 and the standard deviation was 1.76 in relation to mother, while the mean was 5.08 and the standard deviation 1.73 in relation to father (differences were due to missing values). 272 (45.5%) participants were classified as secure in relation to mother and 255 (35.5%) in relation to father. In relation to mother, 212 (35.5%) insecure participants were classified as Dismissing, while 65 (10.9%) were classified as Preoccupied and only 27 (4.5%) as Disorganized.

Similarly, 204 (34.1%) adolescents with insecure attachment in relation to father were classified as Dismissing, 83 (13.9%) as Preoccupied and 24 (4%) as Disorganized. Missing scores in the CAI were 23 (3.85%) and 32 (12.5%) in relation to mother and father respectively. The concordance between the two-way classification (secure vs insecure) of attachment in relation to mother and father was very high (95.8%, kappa=0.91) as well as the concordance between the ABCD classifications in relation to both parents (92.4%, kappa = 0.88).

With respect to the IPPA (see descriptive statistics in Table 2.3.), the strength of the correlation between the total scores of mothers and fathers was high (r=.56, p<.001). Correlations of Trust scores between maternal and paternal scales were also high (r= .53, p<.001), as well as scores in Communication (r= .52, p<.001) and Alienation (r= .59 p<.001).

***Table 2.3**. Descriptive statistics of IPPA Total Scores and Subscales*

IPPA scale			**Mother**		
	Mean	SD	Min	Max	Missing
Total	61.87	15.30	5	89	21
Trust	42.07	6.34	15	50	9
Communication	32.36	7	9	45	11
Alienation	12.61	4.23	6	30	12
			Father		
	Mean	SD	Min	Max	Missing
Total	54.72	17.3	-8	89	42
Trust	40.13	7.49	10	50	33
Communication	28.12	7.28	9	45	30
Alienation	13.44	4.77	6	28	33

Descriptive statistics of IPPA classifications are illustrated in Table 2.4. The concordance of the categories of Low-Mid-High classification in relation to both parents

was low (53.9%, kappa=.30), while the categories of the 5-way classification had a very low concordance between maternal and paternal IPPA (38.5%, kappa=.20).

Table 2.4*. Frequency and Percent of IPPA categories in Low-Mid-High and 5-way classifications.*

Classification type		**Mother**		**Father**	
		N	%	N	%
Low-mid-high	HS	214	35.9	225	37.6
	Midrange	189	29.2	181	25.2
	LS	175	31.4	151	30.2
	Missing	21	3.5	42	7
	Total	599	100	599	100
5-way Classification	HS	153	25.5	93	15.5
	MHS	133	22.2	61	10.1
	Average	188	31.3	201	33.5
	MLS	56	9.3	159	26.5
	LS	48	8	43	7.2
	Misssing	21	3.7	42	7.2
	Total	599	100	599	100

Notes. Low-Mid-High: Low Security, Midrange, High Security; 5-way Classification: Low Security, Moderately Low Security, Average, Moderately High Security, High Security; LS= Low Security;

Table 2.5. illustrates Spearman's rank-order correlations between all key measures, except for CAI ABCD Classifications. As expected, CAI Coherence significantly correlated with CAI 2- way Classification. Similarly, IPPA total scores and subscales showed significant correlations with IPPA Low-Mid-High and 5-way classifications, according to our expectations. Interestingly, all IPPA measures appeared to correlate significantly with the CAI measures in the expected directions, except for IPPA Alienation, which showed significant correlations only with CAI 2-way classification, but not with CAI coherence. With respect to CAI ABCD classification, significant correlations were found with CAI Coherence in relation to both parents, as expected [mother: F (3, 575) = 331.909, p<.001; father: F(3, 562) = 336.315, p<.001]. Additionally, one-way ANOVAs showed that CAI ABCD classification had significant correlations with all IPPA continuous measures both in relation to mother [Trust: F (3,

363) =15.729, *p*=.000; Communication: F (3, 561) = 10.291, *p*<.001; Alienation: F (3, 560) = 12.142, *p*<.001; Total: (3, 551) = 14.842, *p*=.000] and father [Trust: F (3, 541) =23.830, *p*<.001; Communication: F (3, 544) = 15.014, *p*<.001; Alienation: F (3, 541) = 21.058, *p*<.001; Total: (3, 532) = 24.328, *p*<.001].

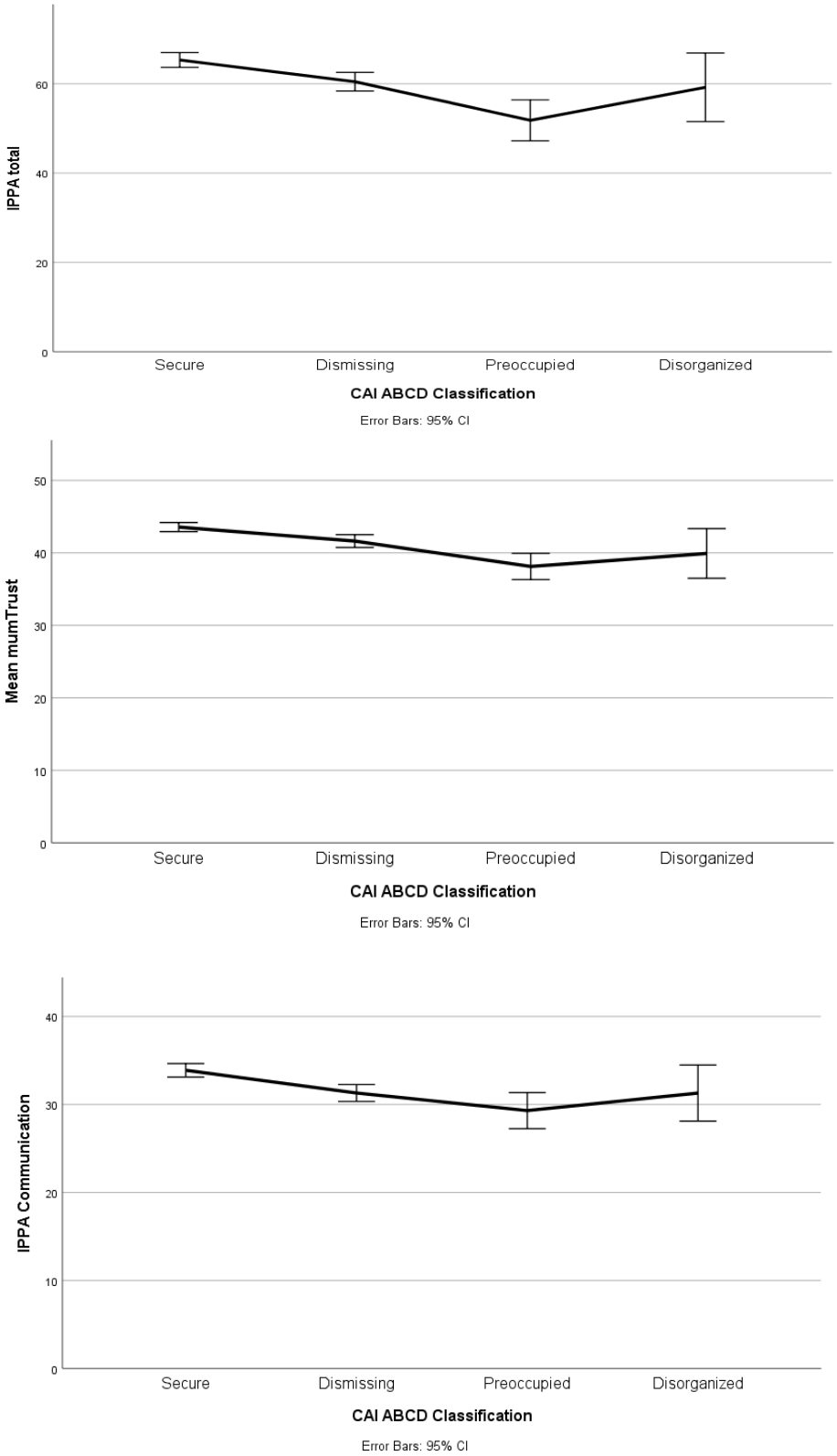
Table 2.5. Spearman's rank- order correlations coefficients between CAI and IPPA measures

	Variable	1	2	3	4	5	6	7	8
				Mother					
1	CAI Coherence	-							
2	CAI Secure vs Insecure	-.80**	-						
3	IPPA Trust	.17**	-.21**	-					
4	IPPA Communication	.19**	-.20**	.75**	-				
5	IPPA Alienation	-.04	.10*	-.59**	-.53**	-			
6	IPPA Total	.17**	-.21**	.89**	.902**	-.76**	-		
7	IPPA Low-Mid-High	.14**	-.17**	.81**	.75**	-.76**	-.89**	-	
8	IPPA 5wayClassification	.16**	-.19**	.80**	.89**	-.68**	.94**	.82**	-
				Father					
1	CAI Coherence	-							
2	CAI Secure vs Insecure	-.80**	-						
3	IPPA Trust	.19**	-.25**	-					
4	IPPA Communication	.18**	-.24**	.77**	-				
5	IPPA Alienation	-.06	.11**	-.59**	-.53**	-			
6	IPPA Total	.17**	-.25**	.92**	.91**	-.75**	-		
7	IPPA Low-Mid-High	.13**	-.24**	.79**	.73**	-.77**	.86**	-	
8	IPPA 5wayClassification	.19**	-.27**	.84**	.88**	-.64**	.93**	.79**	-

*Notes. ** Significant at <0.01 level (2-tailed); * Significant at < 0.05 level (2-tailed); CAI= Child Attachment Interview; IPPA= Inventory of Parent and Peer Attachment; CAI Secure vs Insecure: Secure =1, Insecure =2. CAI ABCD Classification not included as represented by non-ordinal categories*

Figures 2.1 and 2.2. illustrate the variability of each IPPA continuous measure across the CAI ABCD categories in maternal and paternal scales, respectively. Chi squared tests also showed significant correlations between CAI ABCD groups and IPPA Classifications, both in relation to mother [Low-Mid-High: X^2 (1) = 7.627, *p*=.006; 5-way: X^2 (1) = 12.704, *p*<.001] and father [Low-Mid-High: X^2 (1) = 9.182, *p*=.002; 5-way: X^2 (1) = 13,159, *p*<.001].

Figure 2.1. *Simple Error Bar Mean of Mother IPPA single subscales and total scores by CAI ABCD Classification*



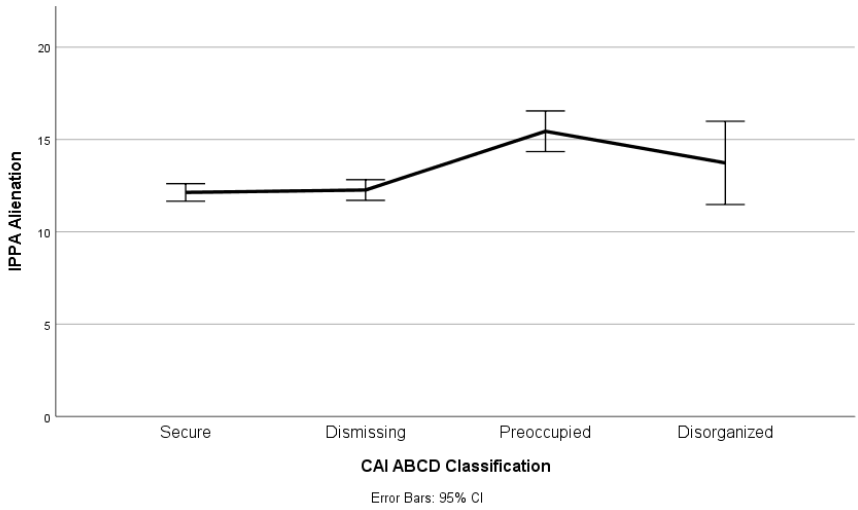
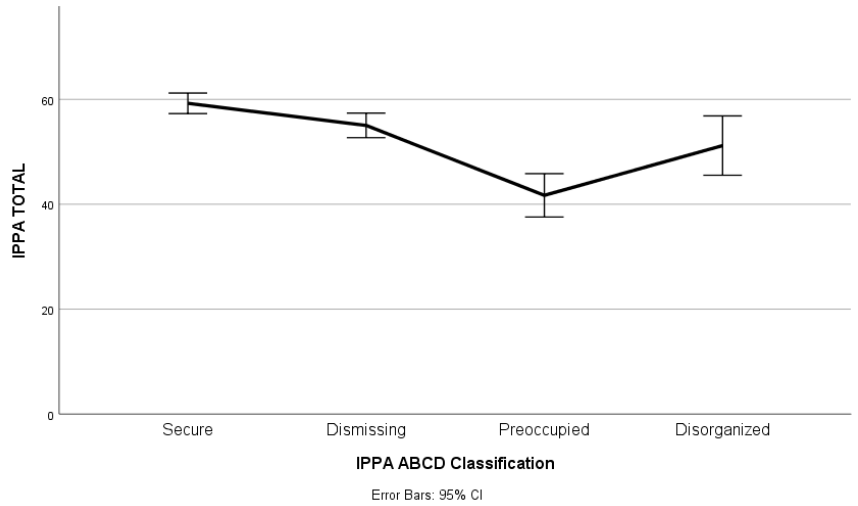
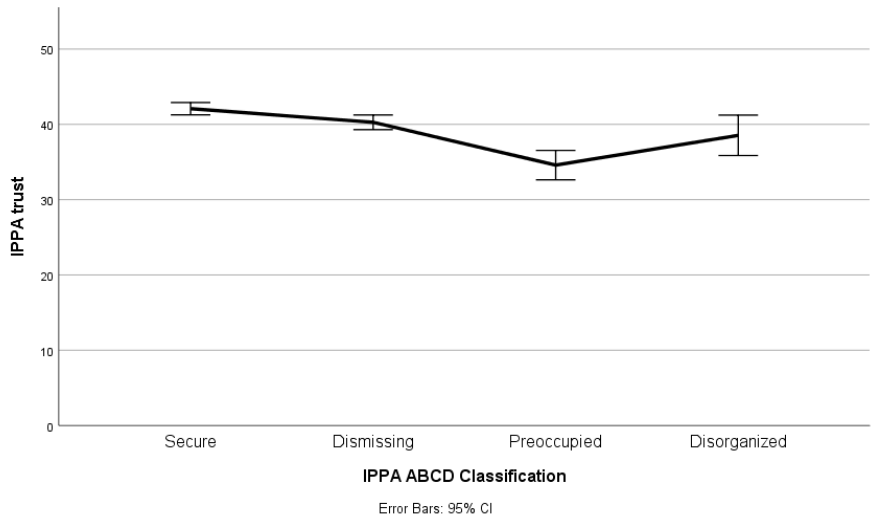
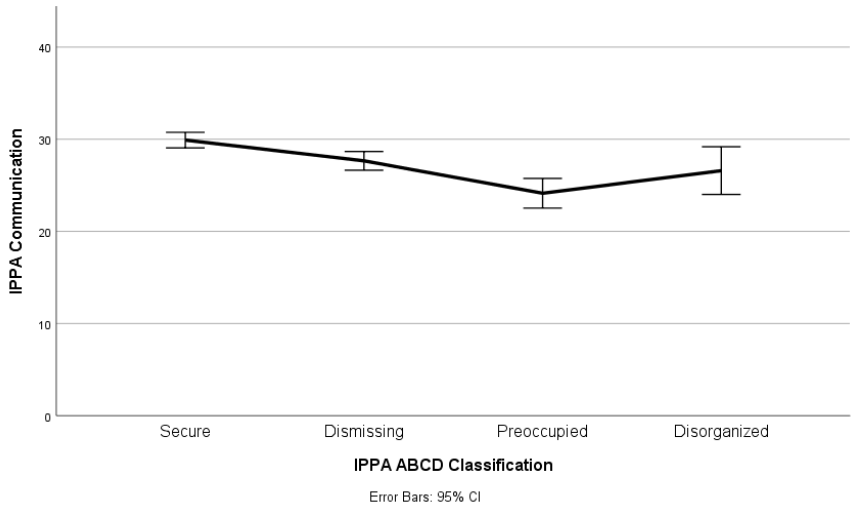
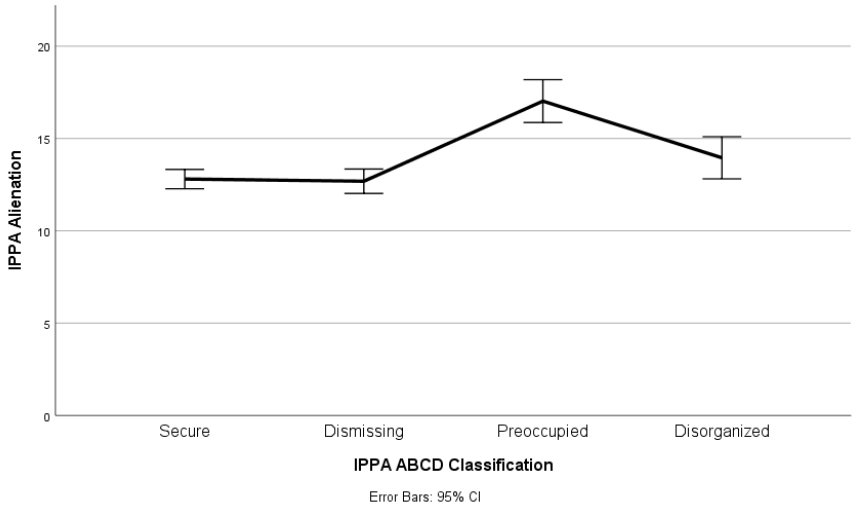


Figure 2.2. *Simple Error Bar Mean of Father IPPA single subscales and total scores by CAI ABCD Classification*









2.3.2. Measures of Attachment and Demographic Variables

The relations between demographic variables and attachment measures with respect to both parents were explored both in CAI and IPPA through a series of T-Tests, ANOVAs and Chi Square tests. The purpose of such an investigation was to evaluate whether any demographic variables were to be controlled for in the next steps of our analysis.

The number and percentages of female and male participants across all measures of the CAI and the IPPA can be found in Table 2.6. for continuous measures

and Table 2.7. for categorical measures. With respect to the CAI, higher rates of Overall Coherence were shown by females compared to males, in relation to both parents. However, this difference was significant only in relation to father (Females: *Mean*=5.24*, SD*=1.78. Males: *Mean*= 4.80*, SD*=1.71). A significant correlation was also found between Gender and CAI two-way classification (mother: $\chi^2(1) = 3.064$, $p = .03$; father: $\chi^2(1) = 4.541$, $p = .04$), whereby females appeared more equally distributed in relation to both parents as compared to males, who appeared more insecure both in maternal and paternal scales (see percentages in Table 2.7). Similarly, genders differed significantly within the CAI ABCD classification (mother: $\chi^2(3) = 19.673$, $p < .001$; father: $\chi^2(3) = 9.893$, $p = .02$). In both scales, male participants classified as dismissing outnumbered females with the same classification, while preoccupied females outnumbered preoccupied males (see percentages in Table 2.7).

With respect to IPPA continuous measures, total scores in relation to both parents did not differ significantly between genders. However, in the maternal scale genders differed significantly in in Alienation, with females (*Mean*= 13.89*, SD*=3.82) scoring higher than males (*Mean*= 12.88*, SD*= 4.23). In the paternal scale of the IPPA, genders also differed significantly in terms of Alienation, with males (*Mean*= 13*, SD*= 4.39) displaying higher scores than females (*Mean*= 12.11*, SD*= 4.73), and Communication, with higher scores displayed by females (*Mean*= 32.99*, SD*= 2.79) compared to males (*Mean*= 31.57*, SD*= 7.28) (see *T* coefficients in Table 2.6). No significant correlation was found between IPPA Low-Mid-High and gender, while 5-way classification was significantly associated to genders only in relation to the maternal scale ($\chi^2(4) = 16.708$, $p = .04$) (see other χ^2 values in Table 2.7).

***Table 2.6**. Comparison of Gender means across continuous measures of attachment (CAI Coherence, IPPA subscales and IPPA total scores)*

mother						
Scale	females		males		T value	*df*
	mean	*SD*	mean	*SD*		
CAI Coherence	5,27	1.75	4,84	1.69	3,001	564
IPPA total	54,01	16.68	55,59	15.39	-1,073	555
IPPA Trust	40,3	6.64	39,91	6.4	0,632	564
IPPA Communication	27,82	6.08	28,49	7.0	-1,094	567
IPPA Alienation	13,89	3.82	12,88	4.23	**2,524**	560

father						
Scale	females		males		*T* value	*df*
	mean	*SD*	mean	*SD*		
CAI Coherence	5,24	1.78	4,80	1.71	**2,981**	574
IPPA total	62,25	18.11	61,4	17.33	0,661	576
IPPA Trust	42,23	7.38	41,88	7.49	0,649	588
IPPA Communication	32,99	6.79	31,57	7.28	**2.514***	586
IPPA Alienation	13	4.39	12,11	4.73	**2,552**	585

*Notes. In bold: Significant at < 0.05 level (2-tailed); * Significant at <0.01 level (2-tailed)*

Table 2.7. Comparison of Gender means across categorical measures of attachment (CAI 2-way classification, CAI 4-way classification, IPPA Low-Mid-High classification and IPPA 5-way classification)

					Mother	
Attachment Category	females		males		χ^2 value	*df*
	N	%	N	%		
CAI Secure	162	59.6%	110	40.4%		
CAI Dismissing	95	44.8%	117	55.2%	**19.673***	3
CAI Preoccupied	47	72.3%	18	27.7%		
CAI Disorganized	17	63.0%	10	37.0%		
CAI total insecure	159	52.3%	145	47.7%	**3.064**	1
IPPA LS	96	54.9%	79	45.1%		
IPPA Mid	97	51.3%	92	48.7%	2.64	2
IPPA HS	127	59.3%	87	40.7%		
IPPA LS	32	65.3%	17	34.7%		
IPPA MLS	32	58.2%	23	41.8%		
IPPA Average	88	47.1%	99	52.9%	**16.708**	4
IPPA MHS	67	49.6%	68	50.4%		
IPPA HS	101	66.4%	51	33.6%		
					Father	
Attachment Category	females		males		χ^2 value	*df*
	N	%	N	%		
CAI Secure	153	60.0%	102	40.0%		
CAI Dismissing	95	46.6%	109	53.4%	**9.893**	3
CAI Preoccupied	50	60.2%	33	39.8%		
CAI Disorganized	15	62.5%	9	37.5%		
CAI total insecure	160	51.30%	152	48.70%	**4.541**	1
IPPA LS	91	60.3%	60	39.7%		
IPPA Mid	97	53.6%	84	46.4%	2.072	2
IPPA HS	120	53.3%	105	46.7%		
IPPA LS	31	72.1%	12	27.9%		
IPPA MLS	88	55.3%	71	44.7%		
IPPA Average	97	48.3%	104	51.7%	10.394	4
IPPA MHS	35	57.4%	26	42.6%		
IPPA HS	57	61.3%	36	38.7%		

*Notes. In bold: Significant at < 0.05level (2-tailed); * Significant at <0.01 level (2-tailed)*

Ethnicity and socio-economic status did not correlate with any of the key variables.

Since gender correlated with many of the attachment variables, gender was controlled for in all subsequent analyses.

2.3.3. Model Comparison

To test for the associations between IPPA scales and categories, series of models of multiple linear regression and multinomial logistic regression were computed, including gender as predictor alongside IPPA measures. Ultimately, the candidate models for the final comparison were the following:

1) IPPA SUBSCALES: $Y = \beta 0 + \beta_0 + \beta_1(Gender) + \beta_2(IPPATrust) + \beta_3(IPPACommunication) + \beta_4(IPPAAlienation) + \varepsilon$

2) IPPA TOTAL: $y = \beta_0 + \beta_1(Gender) + \beta_2(IPPATotal) + \varepsilon$

3) IPPA LOW-MID-HIGH: $y = \beta_0 + \beta_1(Gender) + \beta_2(IPPALow - Mid - High) + \varepsilon$

4) IPPA 5-WAY: $y = \beta_0 + \beta_1(Gender) + \beta_2(IPPA5wayClassification) + \varepsilon$

Y represents the CAI measure that in each model was chosen as dependent variable (i.e. Overall Coherence, 2-way Classification and ABCD Classification); β_o is the intercept; β_1, β_2, β_3, β_i, β_j β_k are the regression coefficients and ε represents the residuals of each model. Based on the results from Spearman's rank- order correlations, IPPA Alienation was excluded from the predictors in IPPA SUBSCALES with CAI Coherence as dependent variable.

CAI Coherence

Table 2.8. illustrates results of linear regression models using CAI Overall Coherence as dependent variable. In all models, Gender and IPPA measures predicted CAI Coherence significantly in relation to both parents. However, the proportion of variance in Coherence accounted for by Gender and IPPA measures was low, as indicated by the R square values. The proportion of variance inevitably increases when

more predictors are included in the model, which largely explains the relatively higher values for IPPA 5-WAY model. Adjusted R square values showed a similar trend, with R-squared being slightly higher for IPPA SUBSCALES model (with IPPA Trust and Communication scores as predictors) as compared to the other models, both in relation to mother and father. The Root Mean Square Error (RMSE) of each model provides the simplest and most robust estimate of the predictive power of a model and as the table shows, all models showed quite similar RMSE values. No model differed from another by more than 3% on the RMSE values, which suggests very small differences in predictive power. Therefore, regression statistics combined together tended to favour the simplest formulation for prediction of CAI coherence, which is the total score of the IPPA as a continuous scale.

Table 2.8. Multiple linear regressions of IPPA measures and Gender on CAI Overall Coherence

	ANOVA				MODEL SUMMARY		
				Mother			
	df1	df2	F	*p*	R^2	Adj R^2	RMSE
IPPA SUBSCALES	3	557	12.053	<.001	0.061	0.056	1.709
IPPA TOTAL	2	552	14.342	<.001	0.049	0.046	1.722
IPPA LOW-MID-HIGH	3	551	6.273	<.001	0.033	0.028	1.738
IPPA 5-WAY	5	549	6.478	<.001	0.056	0.047	1.721
				Father			
IPPA SUBSCALES	3	538	11.336	<.001	0.059	0.054	1.689
IPPA TOTAL	2	533	12.656	<.001	0.045	0.042	1.697
IPPA LOW-MID-HIGH	3	530	6.612	<.001	0.036	0.031	1.723
IPPA 5-WAY	5	528	7.096	<.001	0.063	0.054	1.702

Notes. Df1= Degrees of freedom of regression; Df2= Degrees of freedom of residuals; R2 = Coefficient of determination; Adj R2 = Adjusted coefficient of determination; RMSE = Root Mean Square of Error.

CAI Secure versus Insecure Classification

Table 2.9. illustrates results of multinomial logistic regression models using CAI 2-way (secure vs insecure) attachment classification as dependent variable. Like Overall Coherence, Gender and IPPA measures significantly predicted CAI 2-way classification in all models with respect to both parents.

Logistic regression does not have an equivalent to R-square. Therefore, to evaluate the goodness-of-fit of logistic models, a number of pseudo R-squared have been developed. The current analyses included 1) Cox and Snell, an index of improvement of the full model over the intercept model; 2) Nagelkerke, which provides an adjustment to Cox and Snell's with a wider range of possible values extending from 0 to 1; 3) McFadden, which is the log likelihood of the intercept model which is treated as a total sum of squares, and the log likelihood of the full model treated as the sum of squared errors, thus providing an index of both the explained variability of the response variable and the improvement of the fitted model over the intercept model. For models 3 and 4, which have only categorical variables (Gender, IPPA Low-Mid-High and 5-way classifications) as predictors, the overall correct predicted percent of each model was evaluated alongside Pseudo R-Squared.

Table 2.9. *Multinomial logistic regressions of IPPA measures and Gender on CAI Secure vs Insecure Classification*

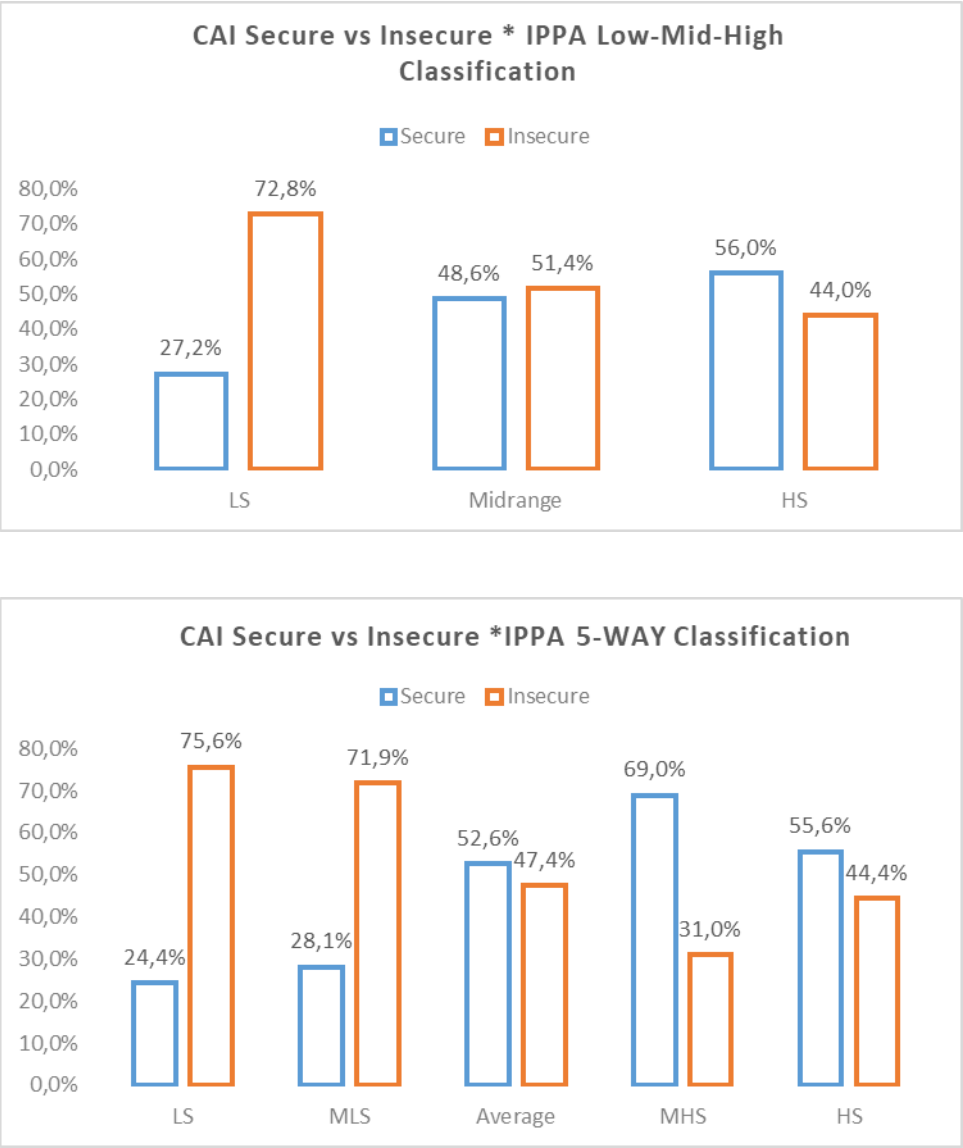
	MODEL FITTING INFORMATION			PSEUDO R^2			PREDICTED PERCENT
				Mother			
	Chi square	df	*p*	Cox & Snell	Nagelkerke	Mc Fadden	overall correct%
IPPA SUBSCALES	37.13	4	<.001	0.065	0.086	0.048	
IPPA TOTAL	30.59	2	<.001	0.054	0.072	0.04	
IPPA LOW-MID-HIGH	18.56	3	<.001	0.033	0.044	0.024	58.4
IPPA 5-WAY	33.35	5	<.001	0.063	0.085	0.047	59.7
				Father			
IPPA SUBSCALES	41.55	4	<.001	0.075	0.1	0.056	
IPPA TOTAL	37.35	2	<.001	0.067	0.09	0.051	
IPPA LOW-MID-HIGH	36.88	3	<.001	0.066	0.089	0.05	59.6
IPPA 5-WAY	53.71	5	<.001	0.095	0.127	0.073	64.6

As illustrated in Table 2.9., all Pseudo R squared values indicated relatively low improvement of fitted models with respect to the intercept model, with IPPA 5-WAY model showing the highest percent accounted for in relation to the paternal scale. For the maternal scales, IPPA SUBSCALES, IPPA TOTAL and IPPA 5-WAY models all performed similarly. The model fit was marginally better for IPPA SUBSCALES and IPPA 5-WAY models than IPPA LOW-MID-HIGH, but IPPA TOTAL performed nearly as well as the former models. Differences between Pseudo R squared values among the models were generally very low, as well as the differences between correct predicted percent of classification in IPPA LOW-MID-HIGH and IPPA 5-WAY classifications (1.3% in the maternal scale and 5% in the paternal scale).

It is important to highlight that the goodness of fit of a set of given models expressed by pseudo R squared values and correct predicted percent values can only be inferred through the comparison between such parameters, rather than in absolute terms. The highest improvement of fit appeared between IPPA LOW-MID-HIGH and IPPA 5-WAY in the paternal scale. Thus, to look further in depth into the associations between IPPA classifications and the CAI Secure vs Insecure classifications, graphs

were develop ed to illustrate the correlations among the classifications of the two instruments (see Figure 2.3).

Figure 2.3. *Bar charts illustrating percentages of CAI secure and insecure participants across IPPA Low-Mid-High classification (above) and IPPA 5-way classification (below)*



As shown in the first graph in relation to IPPA Low-Mid-High classification, midrange and high security groups did not differ substantially in terms of percentage of participants classified as secure and insecure in the CAI. One would expect that an

alternative classification system capable of improving the discrimination between secure and insecure participants in the CAI would show more clear-cut trends in relation to these two groups. As shown in the second graph, when the IPPA 5-way classification scheme was examined, participants belonging to the Moderately High Secure group in the IPPA had a higher probability to be classified as secure and lower probability to be classified as insecure in the CAI (69% and 31% respectively) compared to those in the High Secure group (55.6% and 44.4% respectively). This may explain the marginally better prediction achieved by IPPA 5-WAY model than the other models for the paternal scales (because all other operationalisations could not capture such a non-linear relationship).

CAI ABCD Classification

Table 2.10. illustrates results of multinomial logistic regression models using CAI ABCD (Secure, Dismissing, Preoccupied, Disorganized) attachment classification as dependent variable. Gender and IPPA measures significantly predicted this type of classification in relation to both maternal and paternal scales. All indicators of model fit tended to be similar across the 4 models, although as in the previous analyses IPPA LOW-MID-HIGH model - i.e. the original Armsden & Greenberg's (1987) classification - performed the least well. There was no indication in this case that the cluster-based approach (IPPA 5-WAY model) did any better than models with IPPA continuous measures.

Table 2.10. *Multinomial logistic regressions of IPPA measures and Gender on CAI ABCD Classification (Secure, Dismissing, Preoccupied, Disorganized)*

	MODEL FITTING INFORMATION			PSEUDO R^2			PREDICTED PERCENT
				Mother			
	Chi square	df	*p*	Cox & Snell	Nagelkerke	Mc Fadden	overall correct%
IPPA SUBSCALES	76.91	12	<.001	0.129	0.145	0.063	
IPPA TOTAL	57.84	6	<.001	0.099	0.111	0.047	
IPPA LOW-MID-HIGH	45.78	9	<.001	0.079	0.089	0.037	50.3
IPPA 5-WAY	57.54	15	<.001	0.098	0.111	0.047	51.4
				Father			
IPPA SUBSCALES	95.082	9	<.001	0.164	0.182	0.078	
IPPA TOTAL	73.91	6	<.001	0.129	0.143	0.06	
IPPA LOW-MID-HIGH	75.56	9	<.001	0.135	0.15	0.063	48.1
IPPA 5-WAY	90.8	15	<.001	0.156	0.173	0.074	51.9

In general, data tended to indicate that if maximising prediction of the CAI is a goal, the three scales of the IPPA produce marginally greater overall prediction, whereas the total scale nevertheless does nearly as well in a single summary variable.

2.4. Discussion

The main goal of the current study was to explore which modality of measuring attachment through the IPPA could give the best prediction of attachment security as assessed through the CAI in a normative sample of adolescents. Previous studies comparing different measurements of attachment between these two instruments did not include classification systems of the IPPA. Therefore, the current study extended prior evidence on the correlations between CAI's and IPPA's measures by demonstrating that three distinct ways of assessing attachment via the CAI (narrative coherence, Secure vs Insecure and 4-way attachment classifications) relate not only to scores of Trust, Communication and Alienation and total scores in the IPPA, but also to different

categories of attachment derived from the distribution of such scores. The results obtained from the preliminary analysis and the model comparison in the current study are discussed in greater detail below.

The means of CAI coherence, 2-way and 4-way classifications, as well as IPPA total scores and subscales partially mirror those in previous studies conducted on normative samples of adolescents (e.g. Shmueli-Goetz, 2008; Borelli, 2016; Armsden and Greenberg, 1989). With respect to CAI classifications, our sample showed higher percentages of insecure than secure participants. Indeed, there was a predominance of participants with dismissing attachment in relation to both parents, with similar percentages to those found in pilot studies (Shmueli-Goetz et al., 2008). The large proportion of dismissing adolescents in normative samples is consistent with findings in the literature with respect to the AAI, according to which such a trend might be due to the gradual and somewhat intentional shift in the focus of adolescents' attachment system from parents to peers and romantic partners (Bakermans- Kranenburg and Van Ijzendoorn, 2009).

To address the first research question, a preliminary analysis was conducted to test the correlations between all continuous and categorical measures of attachment derived from the IPPA and the CAI.

Both in maternal and paternal scales, higher scores in IPPA Trust and Communication were associated with secure attachment and higher scores of narrative coherence in the CAI. By contrast, scores of Trust and Communication progressively decreased across secure, dismissing and preoccupied participants in the CAI. This confirms that adolescents' trust in their caregivers' responsiveness is a crucial element not only in determining a secure type of attachment, but also in allowing the shift of the attachment focus to peers and romantic partners, in a process which for some

individuals arguably entails the adoption of dismissing strategies toward parents. Trust toward caregivers fails instead where parents are perceived to hinder the individual's process toward autonomy, such as for participants classified as preoccupied in the CAI, whose narratives are generally hard to follow and convey high vulnerability due to distress and constant state of overwhelm. Similarly, these results are in line with Armsden and Greenberg's (1987) understanding of the quality of communication between parents and adolescents as a powerful indicator of attachment security, insofar as it reflects the shift from the search for physical proximity with parents in childhood to a more symbolic and cognitive type of bond. The perceived quality of communication with parents is poorer at the increase of dismissing strategies by the adolescents, and very poor for preoccupied participants, who tend to report interactions with caregivers as characterised by unpredictable and mixed emotional messages.

IPPA Alienation showed significant relations with CAI classifications. In particular, higher scores of Alienation were associated with preoccupied attachment in relation to both parents, while the same scores were similar for adolescents classified as Secure and Dismissing in the CAI. However, no correlations were found between IPPA Alienation scores and CAI Coherence in relation to either parent. Shmueli-Goetz et al. (2008) suggested that CAI narratives that have high coherence but which describe negative rapport with the parent might reflect an effort to maintain a representation of a good relationship with the caregiver regardless of the quality of interactions taking place in everyday life. This might indicate that a certain degree of emotional disconnection from parents reflected in IPPA Alienation scores does not impact the general attachment- related state of mind expressed through narrative coherence in the CAI.

Total scores in the IPPA faithfully mirrored scores of IPPA subscales, as they positively correlated with CAI coherence and secure attachment, and progressively

decreased across secure, dismissing and preoccupied participants in the CAI, in relation to both parents.

Subsequently, the effect of demographic factors on all key variables was tested. In line with previous studies, socioeconomic status and ethnicity did not significantly correlate with any of the examined measures. However, gender had a significant effect on most of IPPA and CAI measures. The differences between genders found in this study are in line with previous findings (e.g. Fearon et al., 2014; Borelli et al., 2016).

To achieve the second goal of the current study (i.e. to explore which modality of measuring attachment through the IPPA gives the best prediction of attachment as assessed through the CAI), a model comparison was conducted by using different types of attachment measurements. The ultimate candidate models consisted of multiple linear regressions (with CAI coherence as response variable) and multinomial logistic regressions (with CAI 2-way and ABCD classifications as separate response variables), with IPPA measures as predictors.

The most critical result in this part of analysis was the relative weakness of coefficients of determination in all candidate models in relation to all dependent variables. With respect to CAI Coherence, Adjusted R^2 indicated similar trends in relation to both maternal and paternal scales, with very small proportions of the variability of the dependent variable explained by the predictors. Coherently with Adjusted R^2 values, root mean square errors also showed minimal differences among the candidate models. This trend was expected, as normally these two values are inversely related in models with the same dependent variable and the same estimation period (i.e. the lowest RMSE corresponds to the highest Adjusted R^2). However, since root mean square errors are more sensitive than other measures to large error, such values could have potentially shown larger differences among the candidate models. As

this was not the case, the comparison among RMSE confirmed the general weakness of associations across all models.

Notwithstanding the weak coefficients, model comparison showed that models with IPPA classifications as predictors did not improve the strength of associations between variables as compared to models with IPPA continuous measures, while regression coefficients taken together tended to favour IPPA total scores over all other measurements.

Similar results were found in relation to CAI 2-way and ABCD classifications, whereby coefficient of determinations (Pseudo R- square) again showed relatively weak associations across all models. Moreover, the models with IPPA classifications as predictors did not improve the strength of associations as compared to models with dimensional measures. Based on these results, it is possible to assert that IPPA classification systems based on the “quantity” of attachment (low vs high security) drawn from the distribution of trust, communication and alienation scores do not necessarily reflect the distinction between secure and insecure types of attachment as assessed by the CAI, despite a significant degree of correlation.

Moreover, although in the IPPA 5-WAY Classification model (with moderate categories) Pseudo R-square values were the same or slightly higher than those in IPPA SUBSCALES model, the comparison between the correct predicted percent between models with IPPA categorical measurements revealed minimal differences in relation to both parents as compared to both CAI 2-way and ABCD classifications. Despite the theoretical credit of their proposed classification system, Andretta and colleagues (2017) found that the five perceived parental security profiles were strongly associated with self-esteem, but the same strength of correlation was not found for other attachment related constructs, such as academic self-efficacy, social self-efficacy and emotional self-

efficacy. Furthermore, the attachment security profiles in our sample resulted from the adaptation of k-means clustering to the purpose of replicating the 5 profiles found by Andretta et al. (2017) through model- based clustering. However, the latter study was carried out on a larger normative sample of adolescents (N = 1.126), with a wider age range (12-16) and a revised version of the IPPA (Gullone and Robinson, 2005) was administered. It is therefore plausible that model- based clustering analysis would not lead to the two moderate low and high security categories when applied to samples of adolescents with different characteristics. This aspect could be investigated by future research aiming to implement the reproducibility of the findings to date. Results of the current study suggest that the addition of moderate categories to the IPPA three- way classification introduced by Armsden and Greenberg (1987) does not implement the assessment of attachment security in adolescence.

Based on the statistical grounds of the current study evaluating the IPPA in relation to CAI alone, continuous scales in the IPPA generally seem to provide a better prediction of attachment organization as compared to IPPA classifications. Nonetheless, researchers and clinicians could still adopt a hierarchical categorical approach to assess attachment security through the IPPA, rather than interpreting IPPA scores along a continuum, in order to identify individuals that fall into borderline or transient categories for *ad hoc* purposes.

Finally, since IPPA measures showed very weak associations with CAI measures, it is worth questioning if these could potentially be accounted for by the presence of latent variables mediating the correlations between IPPA and CAI measurements. For instance, it is indispensable to point out that, for the purposes of the current study, the peer scales of the IPPA were not considered, and hence participants' perceived quality of their relationships with peers. Indeed, learning to establish supportive bonds outside

the family is a major task in adolescence, whereby peer relationships gradually take on attachment functions, in that they provide sources of intimacy, emotional regulation and feedback about social behaviours (Collins and Laursen, 2004). While IWMs of attachment in relation to caregivers are thought to function as prototypes for relationships with peers (e.g. Fonagy and Target, 1996), peer relationship might nonetheless be supported by distinct behavioural and affective systems as compared to attachment to parents (Zeifman and Hazan, 2008), which reflects some degree of inconsistency of correlations between IPPA parental and peer scales reported in a few studies (e.g. Venta et al., 2014). Therefore, not measuring the perceived quality of peer relationships might imply overlooking an extensive amount of information regarding attachment organization in this developmental phase. This principle is particularly suitable if it is assumed that attachment in adolescence is conceptualized as an overall state of mind (Hesse, 2008; Main, Kaplan and Cassidy, 1985), with a representation of the self as existing apart from relationships with specific attachment figures, as previously discussed.

Furthermore, it is arguable that the weakness of correlations between the two scales found in the current study adds further evidence on the fundamental difference between self-report and interview- based instruments assessing attachment in adolescence. Such a difference is traditionally attributed to the fact that interviews assess automatic and unconscious representations of attachment figures, whereas self-reports require conscious processing on the perception of the quality of the relationships (Crowell et al., 2008). However, in line with Jewell et al. (2019), the current findings also support the idea that attachment in adolescence is more difficult to detect and hence measure than in previous phases, due to the developing socio-cognitive abilities of individuals and the greater fluidity of attachment patterns and relationships, as discussed in the introduction of this chapter. Furthermore, it is also possible that the

inconsistent results in the literature regarding the structural validity of current self-reports is due to the fact that the constructs these tools set out to measure are not entirely reflective of the phenomenology of attachment in adolescence. For these reasons, it is arguable that the notion of a single attachment construct in adolescence tapped by a variety of heterogeneous measures could be more fruitfully replaced by a different approach, which consists of identifying a priori which aspect or *component* of attachment one is aiming to assess (Jewell et al., 2019).

The current study encourages the use of both the CAI and the IPPA in adolescent populations, with the caution that these might produce valuable and potentially complementary insights on different aspects related to attachment security.

2.4.1. Limitations and Directions for Future Research

A few limitations are noteworthy. The first and most important one lies in the choice not to include factor -analytically derived scales of the CAI amongst the key measures of attachment. In recent studies (e.g. Venta et al., 2014; Borelli et al., 2016), the use of these scales has been recommended when seeking dimensional attachment variables, as they capture most of the variance in the eleven CAI subscales, while substantially reducing the number of the variables in question. Additionally, in relation to interview measures based on ABCD paradigm, the use of simpler coding systems yielding dimensional scores for avoidance and preoccupation has been recommended (Zachrisson et al., 2011) to improve inter-rater reliability, statistical power and theoretical congruence with research supporting the notion of attachment being distributed across two dimensions in developmental phases after childhood (e.g. Fraley and Roisman, 2014). Nonetheless, the ABCD classification structure in the CAI was maintained while

opting to utilise Overall Coherence as the only CAI dimensional measure with the purpose of simplifying the model comparison and to align the current study with previous studies (see Fearon et al., 2014) and the third study reported in this thesis conducted on the current sample.

Secondly, participants in the current study presented a range from 13.5 to 15.5 years of age. The temporal stability of the CAI can be viewed as problematic, as test-retest reliability has been evaluated only in younger populations, while attachment organization in adolescence might represent a less stable construct. For these reasons, a potential area for future research might consist of testing the associations between all measures of the CAI and the IPPA on younger and older samples of adolescents.

Finally, the subgroups of adolescents classified as preoccupied and disorganized in the CAI were underrepresented. These low rates probably affected the effect size of the correlations between IPPA measures and CAI ABCD Classifications as, for instance, IPPA continuous measures showed a great variability in the Disorganized subgroup (see Figure 2.1.). Since the current study was conducted on a normative sample, a low rate of participants classified as preoccupied and disorganized in the CAI was expected. However, research on higher-risk and clinical samples with larger proportions of participants falling into these two categories might expand the limited findings to date.

2.5. Conclusions

Although the current study has the merit of expanding evidence on the correlations between different dimensional and categorical measures of the CAI and IPPA, these findings confirm the widely discussed substantial differences between these two instruments in terms of the construct they set out to assess. In so doing, this study

ultimately casts further epistemological doubts with respect to the clarity of the underlying structure of attachment in adolescence. Despite the enunciated theoretical gap, the reported findings provide important sources of information that can guide the adoption of different operationalisations of the CAI and the IPPA on adolescent populations, both in clinical and research contexts.

Chapter 3 - Study 2

A behavioural genetic study on parent and peer attachment security in adolescence

3.1. Introduction

According to classic attachment theory, attachment represents an innate motivational system aimed at promoting survival through maintenance of proximity with caregivers. Bowlby was strongly influenced by scientific studies focusing on caregiving behaviours of different animal species, providing evidence of the profound evolutionary and biological roots of the attachment system in humans (Bowlby, 1969; 1980; 1988).

Nonetheless, developmental researchers have looked for decades into the causal antecedents of attachment organization by focusing heavily on the role of the environment. Several studies have shown that the quality of parenting is a crucial factor in the development of individual differences in attachment organization. Based on findings from longitudinal studies, secure early attachment relationships with parents during infancy are thought to represent an ongoing protective factor against emotional and behavioural disorders across childhood, adolescence and adulthood (Fearon, Bakermans-Kranenburg, van Ijzendoorn, Lapsley, & Roisman, 2010; Lyons-Ruth, Alpern, & Repacholi, 1993).

Nonetheless, throughout development children tend to progressively extend their sources of attachment beyond their relationship with caregivers. By adolescence, this process also occurs under the influence of the individuals' developing ability to reflect upon their internal experience, thanks to cognitive development and the shift into formal operations (Kobak & Cole, 1994). Paralleling these changes in cognitive abilities are typically a series of

environmental and biological challenges, including transitions to new schools, self-image and puberty concerns, possible family conflict, and the development of sexuality (Nieder & Seiffge-Krenke, 2001; Shaw & Dallos, 2005). This juxtaposition of biological factors and environmental demands appears to create the optimal circumstances for the adolescent to extend their range of intimate relations. The negotiation between habitual patterns of attachment with parents and the increasing affiliation with peer groups merge into a proper process of individuation and self-determination with important repercussions on the individual's self-esteem and successful passage into adulthood (Laible, Carlo & Roesch, 2004). Therefore, adolescents' representations of attachment relationships may be continuously modified, thus appearing far more complex and intricate than what is experienced in infancy and early childhood (Carlson, Sroufe, & Egeland, 2004; Simpson, Collins, Tran, & Haydon, 2007).

Furthermore, as previously illustrated, Fearon Shmueli- Goetz, Viding, Fonagy and Plomin (2014) have shown that individual differences in attachment security toward parents beyond childhood are increasingly influenced by genes, while the role of shared environment tends to decrease over time (see introduction p. 20). These findings were obtained through the administration of the Child Attachment Interview. Results from this study were in sharp contrast to those from twin studies of infant and toddler attachment and called for a re-consideration of the construct at later stages: genes accounted for 38% of the variation in attachment security, while shared environment did not contribute to the variation at all.

However, despite a growing appreciation for the differences between child and adolescent attachment formation, research on attachment in adolescence is relatively modest as compared to attachment studies in infancy and childhood and the mechanisms underlying the genetic shift in the conceptualisation of attachment remain

unknown. For example, differences in the findings by Fearon et al. (2014) on adolescents compared to earlier findings on infants (e.g. Bokhorst et al., 2003; O'Connor & Croft, 2001) could be attributed to the different conceptualizations and measures used to assess attachment security at different life stages. As shown in the previous chapter, the assessment of attachment security via the Child Attachment Interview focuses on the way in which individuals meta-cognitively think about their attachment relationships: an ability that in part relies on individual inherited attributes (Main, 1996). However, given that in the sample assessed in the study by Fearon et al. (2014) preoccupied and disorganised attachment classifications were infrequent (5% and 3% respectively), the generalizability of attachment dimensions other than secure and dismissing is limited.

In addition, as illustrated in the previous chapter, an alternative approach to measuring parent-child attachment in adolescence has its origins in social psychology and uses self-report measures that encourage adolescents to appraise the quality of their relationships with parents and peers. It has been reported that one of the most widely used instrument of this kind in adolescence is the Inventory of Parent and Peer Attachment (Armsden & Goldberg, 1987; 1989). Like most attachment self-report questionnaires administered in late childhood and adolescence, the IPPA assesses the individual's direct perception of their current relationships, as well as their feelings and behaviours within them (Crowell, Fraley and Shaver, 2008). The IPPA aims to measure attachment security by investigating how parents and peers are consciously perceived by adolescents as sources of psychological well-being and safety in terms of trust, quality of communication and feelings of alienation.

In the current study, the findings of Fearon et al. (2014) were extended by examining the genetic and environmental determinants of adolescent attachment using the IPPA. This self-report instrument allows the examination of continuous

measures of these distinct components of attachment organisation in adolescence in relation to mother and father separately, in addition to peer affiliations. These aspects of attachment phenomena have not been explored yet from a behavioural genetic perspective during adolescence.

The following sections will illustrate some of the main behavioural genetic studies investigating the quality of relationships with parents as well as peer group affiliation in adolescence.

3.1.1. Behavioural genetics of the relationship with mother and father in adolescence

The increasing role of genetic influences and the diminishing role for shared environment is a common finding in the behavioural genetic literature. This is likely to occur because during the course of later development individuals exert increasingly greater influence on their environment and therefore have greater opportunities to express their genetic inclinations compared with earlier stages (e.g. Del Giudice, 2009; Picardi, Giuliani & Gigantesco, 2020). The hypothesis of an increasing evocative gene-environment correlation in attachment organisation throughout development (Fearon et al., 2014) would be consistent with past findings indicating that children's and adolescents' genes significantly influence a number of parental behaviours including positivity, negativity, monitoring, involvement, physical discipline, physical affection and control (Plomin, 1986; Plomin & Bergmann, 1991; Plomin, Reiss, Hetherington & Howe, 1994; Wade & Kendler, 2000; Klahr, Thomas, Hopwood, Klump & Burt, 2013). These aspects will be illustrated in further detail in the next chapter.

Furthermore, a significant body of research has shown that mothers and fathers exhibit different patterns of rGE in relation to their parenting with their adolescent children.

For instance, Neiderhiser et al. (2007; 2004) found that maternal positivity was largely due to passive rGE (i.e. genic variation in maternal positivity affects environmental influences on the offspring's behaviour), but paternal positivity was influenced strongly by evocative rGE. This indicated that a father's positive behaviour toward his child is a response, at least in part, to that child's genetically influenced characteristics, whereas a mother's positivity reflects a more general personality trait or behavioural pattern. Moreover, while paternal negativity was attributed to both passive and evocative rGE, maternal negativity was primarily attributed to evocative rGE, indicating that a mother's monitoring and controlling behaviour tends to be triggered by the child's genetically influenced features.

A number of other studies investigating genetic and environmental contributions to the link between parenting and child adjustment found significant differences between mothers and fathers (Marceau et al., 2013; Narusyte et al., 2011; Formoso, Gonzales & Aiken, 2000; Videon, 2005). In particular, the evidence appears to indicate that the association between parenting and externalizing problems is explained primarily by evocative rGE in mothers (implying that negative parenting may be evoked by their children's externalizing behaviour), while paternal negative parenting affects adolescent behaviour exclusively through environmental mechanisms. These findings support the general position arising from research on parenting indicating that processes operating within families are supported by different genetic and environmental factors, likely reflecting different parenting practices and their distinct effects in mothers and fathers (Bornstein, 2015).

Currently, there is a lack ofq evidence regarding the differential aetiology of attachment-related constructs in adolescent-mother relationships compared to adolescent-father relationships. In fact, in their behavioural genetic investigation on adolescent attachment assessed via the CAI, Fearon et al. (2014) did not address this question, as the scores of Narrative Coherence provide a unique measure of attachment security.

3.1.2. Behavioural genetics of peer relationships in adolescence

A critical hypothesis arising from attachment theory is that relationships with parents form a blueprint for functioning in other key relationships (Tambelli et al., 2012; Fonagy & Target, 1996; Armsden, et al., 1990). Indeed, consistent with that, there is solid evidence that early security of attachment is associated with better social functioning within peer relationships during childhood (Groh et al., 2014). Research has further revealed that adolescents who have secure attachments to their parents have better social competences and tend to form better quality friendships with their peers compared to those with insecure attachment to parents (Castro-Schilo, et al., 2013; Dykas, Ziv & Cassidy, 2008).

The quality of peer relationships is in turn thought to be particularly crucial for socio-emotional development during the adolescent period (Bukowski, Adams & Santo, 2006). Peer and friend relationships in adolescence have been shown to promote development of self-concept, social competences and emotional regulation (e.g. Grunebaum & Solomon, 2015), alongside empathy and perspective taking (e.g. Laible, 2007; Selman, 1980). Perception of supportive peers is also associated with decreased misbehaviour and better conduct in school (Williams & Anthony, 2015).

Research to date has been quite inconclusive about whether adolescents' friends can serve as attachment figures. In contrast to romantic relationships, which are traditionally conceived as attachment bonds (Ainsworth, 1989), friendships are non-exclusive and not motivated by the sexual system (Hazan & Zeifman, 1999).

The distinction between emergency and non-emergency situations (Waters & Cummings, 2000) provides a useful way of differentiating between attachment bonds and other supportive relationships. Some research suggests that friendships are characterized by proximity seeking and safe haven functions, but not by separation distress or enduring commitment, and thus cannot be considered as proper attachment bonds (Hazan & Zeifman, 1999). Nevertheless, friendships do provide valuable opportunities to develop skills in cooperation and reciprocal altruism, which play an important role in the formation of romantic relationships (Furman, 2001). Furthermore, peers can offer emotional and instrumental support in gaining developmentally appropriate autonomy from caregivers, which is a fundamental task of adolescence (Furman & Buhrmester, 1992).

Understanding the factors that influence the quality of peer relationships as they emerge at this age is an important goal for developmental research.

Although attachment theory emphasises the importance of environmental causes, several behavioural genetic studies have shown that various aspects of adolescent's relationships with their peers are quite strongly influenced by genes. For instance, substantial genetic influences have been observed in relation to adolescent's tendency to seek out deviant peers (Tarantino et al., 2014). Mirroring similar trends to other behavioural phenotypes, peer pressure encouraging of

delinquent behaviour showed limited genetic influence in preadolescence, but increasing genetic influence across adolescence (Connolly et al., 2015). Similarly, the co-occurrence of substance use and both antisocial behaviours (e.g. McAdams, et al., 2012) and delinquency (Boisvert et al., 2018; Boisvert et al., 2014) also appear to be significantly driven by common genes, especially in adolescent males. Recent studies have also found that genes play a large role in determining risk of becoming bullies, victims, or both (Veldkamp et al, 2019; Silberg et al., 2016; Shakoor et al., 2015) in adolescence, suggesting that some children are more inclined to be exposed to bullying than others, partly due to genetically influenced traits.

Twin studies provide the opportunity to test the notion derived from attachment theory that environmental processes drive the association between parental attachment and peer relationship quality, and contrast it with the alternative hypothesis that common genetic processes underlie the two (Plomin, 1994). The current investigation makes use of the fact that the IPPA asks adolescents to also report on their relationships with peers to examine this question.

3.1.3. The current study

In summary, behaviour genetic literature shows that genes play a crucial role in shaping various aspects of adolescent development, including essential characteristics of parent and peer relationships. However, very little research has examined the behavioural genetics of attachment at this developmental stage, especially in relation to different attachment figures.

This study is the first one to examine the role of genes and environment underlying attachment security assessed via a well-validated self-report measure, namely the IPPA. Findings from this study could implement the current knowledge about

behavioural genetics of attachment in adolescence, to date examined only through interview-based measures assessing general representations of attachment (Fearon et al., 2014). As illustrated in the previous chapter, given the widely discussed differences between attachment self-reports and interview-based measures, the nature of the current study was exploratory.

The primary goals were:

1. To estimate the genetic and environmental influences on maternal, paternal and peer attachment in adolescence.
2. To examine the genetic and environmental contributions to the association between paternal and maternal attachment.
3. To examine the genetic and environmental contributions to the association between parental attachment (maternal and paternal) and peer relationship quality.

3.2. Method

3.2.1. Participants

The participants in this study came from the Twins Early Development Study (TEDS), a large longitudinal cohort of same-sex twins born in England and Wales between 1994 and 1996, and whose detailed description is reported in chapter 2.

For the current study, all families from the TEDS cohort who met the children age inclusion criteria (age: 15 years ±14 months) were initially approached. Out of these 1292 families, 694 (54%) agreed to participate. Of these, only same-sex twin pairs were included in the analyses in order to avoid potential inflation of genetic estimates. Moreover, 28 cases had missing information regarding twin zygosity and in

one family one of the siblings did not complete any of the IPPA scales. The final sample was therefore composed of 592 twin pairs (321 females -55.2%). Of these, only 565 pairs completed the IPPA in relation to mothers and 545 in relation to fathers. This was due to the absence of one of the parents or due to missing items in a few cases. Subsequently, only twin pairs whose scores were available for both twins (i.e. both twin 1 and twin 2) were kept, thus bringing the final sample to 541 pairs in relation to maternal IPPA and 519 pairs in relation to paternal IPPA. Following the same procedure, it was possible to collect peer IPPA scores of 550 twin pairs.

Parents of participants provided information on ethnicity, family income and maternal and paternal educational level. The majority of the twins came from British white families (82%) while the rest of the sample was ethnically heterogeneous. The sample was quite diverse in terms of socioeconomic status, with an annual income < £30.000 reported by 20.1% of the families (median household income: £30,000 - £50,000). With respect to parental education, 44% of the mothers and 45% of the fathers reported having at least A levels. 28% of the mothers and 26% of the fathers were educated at the degree level or higher.

3.2.2. Measures

The *Inventory of Parent and Peer Attachment* was used in its revised version by Armsden & Greenberg (1989). This tool is designed to assess the perception of affective and cognitive dimensions of relationships with parents and close friends in adolescents aged between 12 and 19 years of age. It contains 25 questions about relationship with mother and father (e.g. “My mother accepts me as I am”, “My father

accepts me as I am") and 25 questions about peer attachment (e.g. "My friends can tell when I'm upset about something").

As compared to the original version of the questionnaire (Armsden & Greenberg, 1987) comprising one scale for parental attachment, this version of the IPPA (Armsden & Greenberg, 1989) is recommended as it assesses the quality of relationship with each parent separately (Pace, Martini, Zavattini, 2011) thus allowing dissimilarities to emerge (see previous chapter).

For each item, a 5-point Likert- type scale is used with the following possible responses: 1) almost never or never true; 2) not very often true; 3) sometimes true; 4) often true; 5) almost always or always true. Each item provides scores for one of the subscales of Trust, Communication and Alienation. The three-factor model of attachment assessed by the IPPA has been reported to provide a more complete outline of attachment than a one-factor model (attachment) or a two-factor model (trust–communication and alienation) (Pace, San Martini, & Zavattini, 2011).

Due to a copy error, two items in the peer scale ("I like to get my friends' point of view on things I'm concerned about" and "Talking over my problems with my friends makes me feel ashamed or foolish") were omitted. These items were part of the subscales of Trust and Alienation respectively. The current version of the peer scale was therefore composed of a total of 23 items, of which 9 items were scored as Trust (score range: 0 – 45), 7 as Communication (0- 35) and 7 as Alienation (0- 35).

The scores for mother, father and peer scales were summed to calculate the scores for each subscale, while the total scores were obtained by subtracting Alienation scores from the summed scores of Trust and Communication. Test-retest reliability was .93 for parent attachment and .86 for peer attachment (Armsden &

Greenberg, 1989). In the current study, the Cronbach alphas were calculated for each subscale: Trust (mother: .78, father: .77, peer:.78), Communication (mother: .76, father: .77, peer:.79), Alienation (mother: .81, father: .81, peer:.80) and total scores (mother: .77, father: .77, peer: .79).

3.2.3. Procedure

Contact details were obtained from the TEDS database and initial contact was made by phone. Research assistants met the families who agreed to participate either in a central university facility or in the family home. A battery of questionnaires was administered to parents and adolescents assessing psychopathology, parental discipline, callous and unemotional traits and relationships with friends. For the purpose of the current study, these measures were not considered. The IPPA were scored by trained research assistants.

3.2.4. Data analysis

As a preliminary analysis, phenotypic correlations among IPPA components of adolescent attachment (trust, communication and alienation) were calculated in relation to mother, father and peer scales.

Furthermore, descriptive statistics on the means, variance and proportions of the key variables (IPPA subscales and total scores in relation to mother, father and peer scales) were computed. These parameters provide an approximate indication of genetic and environmental contributions. Genetic influences are broadly indicated by greater covariance between monozygotic twin pairs (MZ, sharing 100% of the genes) than dizygotic twin pairs (DZ, sharing on average 50% of the genes). Shared-

environment effects (i.e. family resemblance not explained by genes) are inferred from similar covariance between MZ twins and DZ twins. Non-shared environment effects are indicated by the variation within MZ twin pairs. Residual effects (e.g. measurement errors) are included in the non-shared environment estimate (Neale & Cardon, 1992).

Univariate standard biometrical genetic analysis for twin data (Neale & Cardon, 1992) was subsequently conducted to compare monozygotic and dizygotic twin correlations and obtain the estimates of genetic and environmental effects on IPPA scores in relation to mother, father, and peers. The programme Mplus 8 was used to calculate the estimates of additive genetic (A), shared environmental (C) and non-shared environmental (E) factors determining the variance in IPPA scores. The contribution of A, C and E components are estimated in a saturated ACE model alongside reduced models which remove the effect of the genetic variance (CE model), shared environment variance (AE model) and both genetic and shared environment variance (E model). Chi-square test is used as a measure of goodness of model fit, with small, non-significant chi square values indicating a good fit. When saturated ACE model and reduced model are compared, significant increase of the chi-square value – i.e. increase greater than 3.84 for a single degree of freedom - indicates significant deterioration of model fit when a specific component is removed. The AIC (Akaike's Information Criterion) statistic can also serve as a guide to determine the best fitting model. The best fitting model is typically taken to be the one with the fewest number of parameters that can be obtained without significantly reducing the model fit, as well as the model that minimises AIC values. Significances of the parameters A, C and E represent direct tests of the

first research question outlined in the introduction. The model is illustrated in Figure 3.1.

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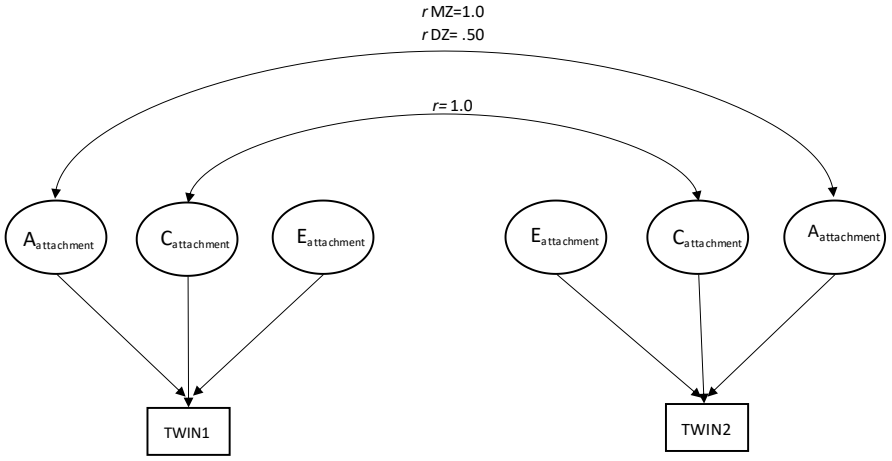
Figure 3.1. *Path diagram of the univariate genetic model of attachment.*



Notes. A, C and E refer to genetic, shared environmental and non-shared environmental latent variables, respectively.

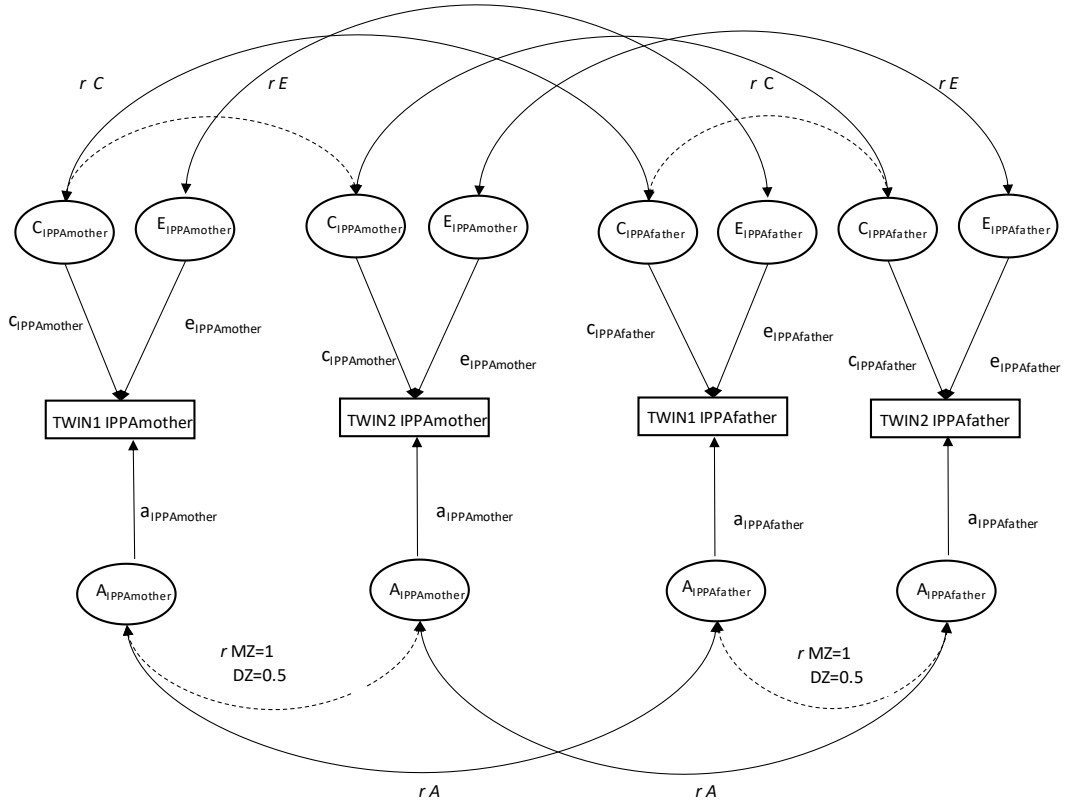
How much of the *association* between the measured variables is due to common genetic or environmental factors is estimated from the pattern of within-twin and cross-twin correlations between one measure and the other. Therefore, cross-twin correlations and within-twin correlations between IPPA subscales and total scores in relation to mother, father and peers were calculated. Cross-twin correlations refer to the correlations between one twin's first measure and the second twin's second measure (e.g. twin1 IPPA attachment to mother and twin2 attachment to father). Within-twin correlations refer to the same measures in relation to the same twin.

Influence of common genetic factors in the association between, for example, maternal and paternal IPPA is inferred if the cross-twin correlation between maternal and paternal IPPA scales is higher in MZ than in DZ twins. In this case, the bivariate genetic model would estimate a significant genetic correlation (r_a – see figure 3.2.). By

contrast, if the cross-twin correlation does not vary between MZ and DZ twins, this indicates that environmental factors are responsible for the association between the two measures. If the within-twin correlation and the between-twin correlation (in both MZ and DZ twins) are of similar magnitude, this suggests that environmental processes responsible for the association are shared across twins, therefore a shared environmental correlation will be detected by the bivariate genetic model (r_C). In other words, this indicates that the quality of attachment relationship with mother for one twin could be estimated from both their own and the other twin's perceived quality of attachment relationship with father, regardless of twin zygosity. Finally, if the within-twin correlation is high but the cross-twin correlation is low, this indicates that the association between maternal and paternal IPPA scores derives from a process that is twin specific (non-shared), and bivariate models would detect a non-shared environmental contribution (r_E). This implies that, while there is a relationship between the perceived quality of attachment relationship with mother and father in one twin, the perceived quality of attachment relationship with mother shown by one twin has no bearing on the other twin's perception of the attachment relationship with father.

Lastly, bivariate genetic models were utilised to test the estimates of genetic and environmental contributions to the associations between maternal, paternal and peer attachment as assessed by the IPPA. Multivariate genetic analysis is normally adopted to analyse genetic and environmental effects to relationship between two or more variables by decomposing the correlations between the measures into that due to genetic components, shared environment and non-shared environment (Neale & Cardon, 1992). The model is illustrated in Figure 3.2. The estimates of A, C and E components in relation to maternal, paternal and peer scales represent direct tests of the second and third research question outlined in the introduction.

***Figure 3.2**. Path diagram of the bivariate genetic model of attachment to parents and peers.*



Notes. A, C and E refer to genetic, shared environmental and non-shared environmental latent variables, respectively.

3.3. Results

Pearson's correlation coefficients among IPPA subscales and total scores in relation to mother, father and peers are shown in Table 3.1. All scores were significantly correlated across the three IPPA scales. The strongest relationship appeared to be the association between alienation from mother and alienation from father (.63). Overall, coefficients of the correlations between parents and peers were relatively lower than those between parents.

***Table 3.1**. Phenotypic correlations between attachment components in relation to mother, father and peer*

IPPA Variable		Mother	Father	Peer
Trust	Mother	-		
	Father	.53**	-	
	Peer	.12*	.15*	-
Communication	Mother	-		
	Father	.54**	-	
	Peer	.12*	.11*	-
Alienation	Mother	-		
	Father	.63**	-	
	Peer	.23**	.27**	-
Total	Mother	-		
	Father	.56**	-	
	Peer	.13*	.13*	-

*Notes. *p<0.005, **p<0.001.*

Descriptive data, covariance matrices and twin intra-class correlations with respect to the scores of IPPA maternal, paternal and peer scales are illustrated in Tables 3.2., 3.3 and 3.4. respectively. With respect to maternal IPPA total scores and subscales, twin intra-class correlations were generally higher for MZ twins than DZ (and all significant with p <.05). Indeed, the correlations for MZ twins were approximately double that for DZ twins, indicating an important genetic contribution and little shared-environmental influence.

By contrast, with respect to the paternal IPPA scores the differences between the correlations for MZ and DZ twins were quite modest, potentially indicating some genetic influence, but also an important shared-environment contribution (all correlations were significant at the p<.05 level).

Finally, with respect to peer scale the MZ intraclass correlations were nearly twice the size of the DZ correlations with respect to the Communication and Trust subscales. However, covariance of similar magnitude was observed for Alienation between MZ and DZ twins, pointing to important shared-

environment contributions. With respect to peer measures, all correlations were statistically significant ($p < .05$).

Table 3.2. *Descriptive statistics and covariance matrices for Mother IPPA Total, Trust, Communication and Alienation scores for MZ and DZ twins.*

	MOTHER							
	Total				**Trust**			
	MZ		DZ		MZ		DZ	
	Twin 1	Twin2	Twin1	Twin2	Twin 1	Twin2	Twin1	Twin2
Descriptive statistics								
Mean	62.67	62.44	61.53	61.57	42.27	42.38	41.88	42.24
SD	14.87	15.5	15.73	14.87	6.41	6.43	6.43	5.72
N	278	278	262	262	278	278	262	262
Covariance Matrix								
Twin1	221.02	.61[b]	247.46	.33[b]	41.14	.56[b]	41.39	.31[b]
Twin2	140.19[a]	240.34	76.61[a]	220.22	24.51[a]	41.34	11.56[a]	33.08

	Communication				**Alienation**			
	MZ		DZ		MZ		DZ	
	Twin 1	Twin2	Twin1	Twin2	Twin 1	Twin2	Twin1	Twin2
Descriptive statistics								
Mean	32.54	32.4	32.24	31.93	12.41	12.57	12.47	12.43
SD	6.81	6.93	7.18	6.75	4.05	4.27	4.21	4.08
N	278	278	262	262	278	278	262	262
Covariance Matrix								
Twin1	46.4	.61[b]	51.67	.30[b]	16.4	.52[b]	17.73	.29[b]
Twin2	29.01[a]	48.1	14.71[a]	45.56	9.07[a]	18.26	5.06[a]	16.66

Notes. a=Covariance; b=Correlation

Table3.3-. *Descriptive statistics and covariance matrices for Father IPPA Total, Trust, Communication and Alienation scores for MZ and DZ twins*

FATHER								
	Total				**Trust**			
	MZ		DZ		MZ		DZ	
	Twin 1	Twin2	Twin1	Twin2	Twin 1	Twin2	Twin1	Twin2
Descriptive statistics								
Mean	55.94	55.97	53.91	55.54	40.73	40.58	39.78	40.29
SD	17.13	17.47	17.79	16.29	7.15	7.47	7.28	6.98
N	270	270	249	249	270	270	249	249
Covariance Matrix								
Twin1	293.44	.58[b]	316.63	.45[b]	51.1	.58[b]	59.72	.46[b]
Twin2	173.29[a]	305.23	131.04[a]	265.38	31.14[a]	55.15	24.81[a]	48.72

	Communication				**Alienation**			
	MZ		DZ		MZ		DZ	
	Twin 1	Twin2	Twin1	Twin2	Twin 1	Twin2	Twin1	Twin2
Descriptive statistics								
Mean	28.67	28.65	27.81	28.47	12.93	13.15	13.52	13.14
SD	7.23	7.45	7.24	6.78	4.51	4.7	4.73	4.57
N	270	270	249	249	270	270	249	249
Covariance Matrix								
Twin1	52.2	.54[b]	52.36	.41[b]	20.38	.52[b]	22.44	.34[b]
Twin2	28.97[a]	55.58	20.21[a]	45.99	10.98[a]	22.06	7.29[a]	20.92

Notes a= Covariance; b=Correlation

Table 3.4*. Descriptive statistics and covariance matrices for Peer IPPA Total, Trust, Communication and Alienation scores for MZ and DZ twins*

PEER								
	Total				**Trust**			
	MZ		DZ		MZ		DZ	
	Twin 1	Twin2	Twin1	Twin2	Twin 1	Twin2	Twin1	Twin2
Descriptive statistics								
Mean	52.25	54.99	54.06	55.21	38.92	39.25	39.51	39.27
SD	12.75	11.99	10.56	11.75	5.61	5.45	4.93	5.48
N	286	286	264	264	286	286	264	264
Covariance Matrix								
Twin1	162.62	.41[b]	111.67	.26[b]	31.48	.41[b]	24.36	.22[b]
Twin2	63.91[a]	143.76	32.67[a]	138.19	12.48[a]	29.8	6.09[a]	30.1

	Communication				**Alienation**			
	MZ		DZ		MZ		DZ	
	Twin 1	Twin2	Twin1	Twin2	Twin 1	Twin2	Twin1	Twin2
Descriptive statistics								
Mean	26.47	26.83	27.06	27.04	13.14	11.09	12.72	11.16
SD	5.66	5.51	5.28	5.68	3.98	3.49	3.79	3.27
N	286	286	264	264	286	286	264	264
Covariance Matrix								
Twin1	32.1	.47[b]	27.9	.31[b]	15.84	.29[b]	14.38	.27[b]
Twin2	14.72[a]	30.47	9.39[a]	32.36	4.67[a]	12.17	3.65[a]	10.67

Notes a=Covariance; b=Correlation

3.3.1. Univariate twin modelling

In order to obtain estimates of the genetic and environmental effects on the perceived quality of attachment relationships to mother, father and peers, the standard ACE models were tested using structural equation modelling. The results of the saturated ACE models for each scale are shown in table 3.5.

With respect to the maternal scales, the model yielded relatively large estimates of the genetic component, ranging from 42% to 58% in the saturated ACE models across the IPPA total scores and subscales, while shared environment effects were modest. Furthermore, deletion of the genetic parameter A from the ACE model led to a significant reduction in model fit (Total: $\Delta\chi^2$ (1) =25.77, p<.001; Trust: $\Delta\chi^2$ (1) = 20.98, p<.001; Communication: $\Delta\chi^2$(1) = 28.24, p<.001; Alienation: $\Delta\chi^2$(1) =11.90, p<.001) while deletion of the shared environment parameter C did not alter the model fit significantly for any of the maternal IPPA scales (Total: $\Delta\chi^2$ (1) =0.28, p=.59; Trust: $\Delta\chi^2$ (1) = 0.33, p=.561; Communication: $\Delta\chi^2$(1) <.01, p=1; Alienation: $\Delta\chi^2$(1) = 0.36, p= .55).

By contrast, ACE modelling of the paternal scale showed relatively large contributions of shared environment across total, trust and communication scores, with percentages averaging 33%, with the exception of the scores of alienation, in relation to which the estimates of the shared environment were relatively lower (17%). By contrast, the estimate of the genetic effects on alienation was higher (39%) compared to those in relation to trust (29%), communication (21%) and total (25%) scores. Moreover, deletion of single latent variables (A or C) in Total and Trust scores reduced the model fit significantly, indicating significance of both genetic and shared environment components, whereas deletion of the latent variable A in the subscale of Communication led to a non-significant reduction of the model fit ($\Delta\chi^2$ (1) = 2.763,

p=.96), indicating a non-significant genetic contribution in relation to this specific attachment component. Conversely, the best fitting model for Alienation was the AE model, as deletion of the C parameter led to a non-significant decrease in the model fit ($\Delta\chi^2(1) = 1.608$, $p = .20$). The estimate of the genetic component in the AE model of Alienation was very high (56%).

With respect to the Peer scale, results showed fairly heterogeneous patterns of estimates across the subscales. However, chi-square values of the ACE models in relation to all subscales were relatively high, with significant or almost significant *p* values, indicating non-optimal fit of the models. Non-shared environment appeared to be the most predominant factor across all scores, ranging from 51% to 78%. Results showed consistent influence of the shared environment across all scores (trust: 11%, communication: 17%, alienation: 23%, total: 23%), whereas an important genetic contribution was found in relation to the scores of trust (31%) and communication (32%), as opposed to a 3% of genetic contribution in relation to alienation scores. With respect to Trust scores, deletion of the A component led to a significant decrease in the model fit ($\Delta\chi^2(1) = 4.119$, $p = .04$), unlike deletion of the C component, which led to a non-significant decrease of the fit ($\Delta\chi^2(1) = 0.52$, $p = .47$). In the AE model for Trust, the estimates of the genetic component were fairly high (42%). With respect to alienation scores, deletion of the C component led to a significant decrease in the model fit ($\Delta\chi^2(1) = 3.88$, $p = .04$), while deletion of the A component did not alter the fit significantly ($\Delta\chi^2(1) < .01$, $p = 1$). Deletion of the A and C components in the Total and Communication scores led to non-significant decrease of the model fit.

Table 3.5. *ACE Univariate Model-Fitting Statistics for Mother, Father and Peer IPPA variables. Estimates of saturated ACE models*

		Model Statistics				Model parameter estimates		
	Variable	Chi square	*df*	*p*	AIC	A	C	E
Mother	Trust	6.57	7	.51	6989.13	**.53** (.27 - .72)	**.07** (.00 - .47)	**.40** (.18- .63)
	Communication	3.277	7	.85	7210.08	**.62** (.57 - .68)	**.00** (.00-.05)	**.38** (.33 - .42.)
	Alienation	1.426	7	.98	6121.10	**.42** (.22 - .62)	**.09** (.00 -.29)	**.47** (.27 -.67)
	Total	3.533	7	.83	8774	**.58** (.52-.64)	**.04** (.00-.10)	**.38** (.31-.44)
Father	Trust	5.575	7	.56	7079.89	**.29** (.11-.47)	**.33** (.15-.51)	**.38** (.20-.56)
	Communication	5.769	7	.57	7104.08	**.21** (.03-.40)	**.33** (.15-.51)	**.46** (.28-.64)
	Alienation	4.178	7	.75	6156.66	**.39** (.16-.64)	**.17** (.00-.44)	**.44** (.20-.68)
	Total	6.463	7	.49	8751.82	**.25** (.00-.52)	**.33** (.08-.60)	**.42** (.17-.69)
Peer	Trust	10.201	7	.18	6778.51	**.31** (.07-.65)	**.11** (.00-45)	**.58** (.24-.92)
	Communication	4.914	7	.07	6806.19	**.32** (.02-.62)	**.17** (.00-.47)	**.51** (.21-.81)
	Alienation	105.13	7	.00	6019.29	**.03** (.00-.11)	**.23** (.16-.32)	**.74** (.66-.82)
	Total	24.846	7	.00	8506.97	**.15** (.00-.48)	**.23** (.00-.56)	**.62** (.29-.95)

Notes. AIC= Akaike Information Criterion; A= additive genetic; C= shared environment; E=non-shared environment

3.3.2. Cross-twin and within-twin correlations between Mother, Father and Peer IPPA subscales and total scores

Within-twin and cross-twin correlations for Mother IPPA and Father IPPA are presented in Table 3.6. Cross-twin correlations across all IPPA subscales and total scores were greater in MZ twins than DZ twins, indicating some common genetic influence in the association between these measures. Wider gaps in the cross-twin correlations between MZ and DZ twins were found in relation to Trust (MZ twins *r*= .43; DZ twins *r*= .28) and Alienation (MZ twins *r*= .37; DZ twins *r*= .28). The within-twin correlations were of a greater magnitude compared to the cross-twin correlations both

for MZ and DZ twins across all IPPA subscales and total scores (see estimates in Table 3.6), suggesting that the non-shared environment also plays a role in the association between the measures. Since the within-twin correlations were almost twice the size of the cross-twin correlations, it was assumed that the shared environment played a negligible role in the association between the subscales and total scores of Mother and Father IPPA.

Table 3.6.- *Mean within-twin and cross-twin correlations for Mother IPPA and Father IPPA subscales and total scores*

	Mother and father IPPA							
Correlations	Trust		Communication		Alienation		Total	
	MZ	**DZ**	**MZ**	**DZ**	**MZ**	**DZ**	**MZ**	**DZ**
Within-twin correlation	.69**	.60**	.55**	.50**	.57**	.56**	.66**	.52**
Cross-twin correlation	.43**	.28**	.35**	.30**	.26**	.25**	.37**	.28**

*Notes **p<.001.*

Within-twin and cross-twin correlations for Mother IPPA and Peer IPPA are presented in Table 3.7. It is noted that the cross-twin correlations reached statistical significance only in relation to Alienation scores, for both MZ (*r*= .19) and DZ twins (*r*= .15). Despite the relatively small coefficients, genetic contribution was indicated by the stronger cross-twin correlation for MZ twins compared to DZ twins. Within-twin correlations for the scores of Trust, Communication and Total scores were slightly higher than cross-twin correlations for both MZ and DZ twins (see estimates in Table 3.7), indicating some influence of the non-shared environment on the associations between these measures in relation to mother and peers.

***Table 3.7**.- Mean within-twin and cross-twin correlations for Mother IPPA and Peer IPPA subscales and total scores*

Mother and Peer IPPA								
Correlations	Trust		Communication		Alienation		Total	
	MZ	**DZ**	**MZ**	**DZ**	**MZ**	**DZ**	**MZ**	**DZ**
Within-twin correlation	.10*	.14*	.13*	.11*	.19**	.30**	.13*	.15*
Cross-twin correlation	.08	.01	.07	.06	.19**	.15*	.05	.03

*Notes **p<.001, * p<.05*

Within-twin and cross-twin correlations for Father IPPA and Peer IPPA are presented in Table 3.8. Similar to the above, the cross-twin correlations reached statistical significance only in relation to Alienation scores, for both MZ (*r*= .25) and DZ twins (*r*= .10). Despite the relatively small coefficients, within-twin correlations for the scores of Trust and Total scores were slightly higher and significant compared to cross-twin correlations for both MZ and DZ twins (see estimates in Table 3.8), indicating that the non-shared environment also plays a role in the associations between these measures in relation to father and peers.

***Table 3.8.-** Mean within-twin and cross-twin correlations for Father IPPA and Peer IPPA subscales and total scores*

Father and Peer IPPA								
Correlations	Trust		Communication		Alienation		Total	
	MZ	**DZ**	**MZ**	**DZ**	**MZ**	**DZ**	**MZ**	**DZ**
Within-twin correlation	.17*	.13*	.07	.03	.31**	.26**	.15*	.12*
Cross-twin correlation	.08	.01	.03	.01	.25**	.10*	.03	.03

*Notes **p<.001, * p<.05*

3.3.3. Bivariate twin modelling

Table 3.9. illustrates the estimates of the genetic and environmental contributions to the covariance between scores of maternal, paternal and peer IPPA.

With respect to the association between mother IPPA and father IPPA, the ACE saturated model provided a good fit for the data across all subscales and total scores. However, the effect of the shared environment was found to be consistently modest in the association between all IPPA measures in relation to mother and father, with general estimates averaging 5%. By contrast, the genetic effect was found to be predominant in all these associations, ranging from 48% (in relation to the covariance between mother and father Alienation) to as high as 58% (in relation to the covariance between mother and father Communication).

Estimates of the genetic and environmental effects on the association between mother IPPA and peer IPPA scores were found to be similar to those in relation to the association between mother IPPA and father IPPA scores. Indeed, the shared environment effect appeared to be very modest across all IPPA scores, with the highest effect amounting to 7% in relation to mother and peer alienation. By contrast, the genetic contribution appeared to prevail in all associations between mother and peer IPPA scores, ranging from 46% (in relation to the covariance between mother and peer Alienation) to as high as 63% (in relation to the covariance between mother and peer Communication).

Finally, associations between father IPPA and peer IPPA scores were also largely determined by genetic factors, ranging from 20% (in relation to father and peer Communication) to 39% (in relation to father and peer alienation). Nevertheless, contrary to previous bivariate analyses, the shared environment contribution appeared to be relevant in determining the association between father IPPA and peer IPPA scores.

More specifically, while the shared environment effect accounted for an average of 32% in relation to the covariance between father and peer trust, communication and total IPPA scores, only 13% of the covariance between father and peer alienation was accounted for by a shared environment effect.

A consistently significant non-shared environment effect was found to account for the association between all maternal, paternal and peer IPPA subscales and total scores (see estimates in Table 3.9).

***Table 3.9**. Percentage of covariance between perceived quality of relationship with mother, father and peer due to Common Additive Genetic (A), Shared Environment (C) and Non-shared Environment (E)*

		Model statistics				**A**	**C**	**E**
		Chi square	*df*	*p*	AIC			
	Trust	21.08	17	.22	13710.99	**.51** (.29 -.79)	**.06** (0 - .50)	**.43** (.34 -.49)
Mother IPPA and Father IPPA	Communication	25.92	17	.08	13953.59	**.58** (.27- -79)	**.03** (0 - .15)	**.39** (.31 - .44)
	Alienation	14.17	17	.65	11757.90	**.48** (.25 - .76)	**.05** (0 - .50)	**.47** (.38 -.54)
	Total	16.43	17	.49	17039.22	**.56** (.34-.62)	**.04** (0- -23)	**.40** (.30- .44)
	Trust	17.22	17	.43	13756.39	**.50** (.33 -.74)	**.06** (0 -.36)	**.44** (.35 -.49)
Mother IPPA and Peer IPPA	Communication	9.18	17	.09	14009.19	**.63** (.53 -.69)	**.01** (0- .16)	**.36** (.31 - .45)
	Alienation	10.91	17	.09	14088.12	**.46** (.28 -.54)	**.07** (0 -.27)	**.47** (.39 -.56)
	Total	30.88	17	.21	17244.19	**.58** (.34 -.82)	**.04** (0 -.56)	**.38** (.32 -.46)
	Trust	15.95	17	.53	13837.11	**.28** (.09 -.54)	**.32** (.15 - .54)	**.40** (.33 - .47)
Father IPPA and Peer IPPA	Communication	10.77	17	.86	17138.78	**.20** (.02 -.51)	**.32** (.15 - .58)	**.48** (.39 - .56)
	Alienation	11.98	17	.21	13105.05	**.39** (.17 - .69)	**.13** (0 - .46)	**.48** (.39 -.56)
	Total	33.11	17	.20	17183.78	**.24** (.06 -.53)	**.32** (.16 - .56)	**.44** (.35 -.50)

3.4. Discussion

This study set out to implement the current knowledge on behavioural genetics of attachment in adolescence by assessing the conscious, direct perception of the quality of relationships with significant figures in adolescents' lives through administration of the Inventory of Parent and Peer Attachment. In so doing, this study explored the genetic and environmental factors underlying the complex relationship between parent attachment and peer attachment, addressing the importance of affiliation outside the family environment in a developmental phase characterised by fundamental intrapsychic and social transformations.

The first goal of the current investigation was to estimate the genetic and environmental influences on maternal, paternal and peer attachment measured separately. Taken together, the findings of the current study are in keeping with existing evidence of genetic influence on adolescent attachment organisation, as reported in previous studies, albeit using interview-based measures (Fearon et al. 2014). Indeed, it was found that every component of the perceived quality of relationships with both parents and peer (except for peer alienation) was significantly influenced by genes. This is compatible with the idea that in adolescence, genes come to the fore during recollection of attachment experiences, independently of the assessed attachment figure and the modality through which recollection is elicited (i.e. internal attachment representations activated through interview-based measures or conscious processing activated through the IPPA).

Furthermore, additive genes were found to explain significant portions of the covariance between attachment scores across parents and peers. Taken together,

results from genetic analyses showed that a significant part of adolescent attachment organisation can be attributable to individual characteristics, in line with findings from research investigating adolescents' deviant behaviours and bullying experiences (e.g. Boisvert, et al., 2019; Veldkamp et al., 2019). More generally, this is compatible with the assumption that genetic heritage is a more systematic source of individual differences in complex traits than environmental effects are and that intra-psychic transformations and the interpersonal challenges characterising adolescence seem to be influenced by a large magnitude of genetic influences (Plomin, 2018).

Interestingly, the distinct assessment of attachment security with mother and father brought to light different degrees of influence of the shared environment. While this component was very modest or absent across IPPA maternal subscales, an important shared environment effect was found in relation to father trust, communication and total scores. Therefore, components of the perceived quality of the relationship with fathers, but not with mothers, were significantly determined by environmental factors shared between siblings. It is important to highlight that the two components of environmental influence (shared and non-shared) do not reflect specific types of environments in any straightforward sense; they simply describe whether unspecified environmental features make children in the same family similar to or different from each other. Future research should investigate specific environmental factors (e.g. the quality of parenting) that might influence conscious representations of attachment relationships.

However, the finding of a significant contribution of the shared environment in relation to the perceived quality of relationship with fathers in part contrasts findings from Fearon et al (2014), based on which the shared environment did not have any effect on attachment organisation. In part, this may be due to substantial differences in the

constructs that the CAI and the IPPA set out to assess (see previous chapter). In addition, it is possible that stable characteristics of the father determine the overall perception of the quality of the father-child relationship, which is in part shared between siblings.

The second goal of the current study was to look into the genetic and environmental contributions to the association between paternal and maternal attachment. Bivariate analysis showed a very modest contribution of the shared environment in the association between all scores of maternal and paternal IPPA subscales. In part, this confirms the proclivity of adolescents to notice differences in parental treatment, for which aspects of parenting tend to be perceived as different, rather than similar, between siblings (Avinun & Knafo, 2014). Additionally, differential parenting is likely to increase as siblings grow older, as a result of an increase in the siblings' independence and individual experiences (Kiang & Furman, 2007; Allen & Land, 1999).

Combining both findings from the univariate and bivariate analyses, it is possible to argue that perceived trust, quality of communication and feelings of alienation in relation to fathers tend to be more similar between siblings with respect to the same attachment components in relation to mothers. This would be consistent with evidence suggesting that fathers' behaviour toward their children is more reactive to stable external factors than in mothers' behaviour (Pike, Atzaba-Poria & Kretschmer, 2016). These factors include cultural values and family related aspects such as socio-economic status or the quality of marital relationships. Greater similarity of both siblings' attachment security toward their father compared to mother might also be due to fathers' genetic inheritance and personality traits affecting their parenting style (Burt, 2009).

By contrast, because results in the current study showed that genetic effects were even larger than non-shared environmental effects in determining adolescent attachment to mothers, it is likely that daily mother-child interactions are primarily driven by adolescent's individual traits, as reported in prior studies assessing different aspects of parent-adolescent relationships through retrospective reports (e.g. Neiderhiser et al., 2007; 2004; Jang et al., 2005). These findings might reflect the possibility of an evocative rGE underpinning attachment security toward mothers, but less so toward fathers.

A noteworthy result from analyses in relation to parental attachment was that the shared-environment effect was modest in relation to adolescents' feeling of alienation from both parents (9% in mothers and 17% in fathers - this estimate was significantly lower compared to other Father IPPA subscales), as well as in relation to the association between the two (3%). In general, feelings of alienation were mainly accounted for by genes and the non-shared environment. This outcome is possibly consistent with a biologically determined need for the adolescent to affiliate with peer groups and establish meaningful and autonomously chosen relationships outside the family context. This process is likely to involve a certain degree of emotional and behavioural individuation from parents and siblings, resulting in a sense of alienation from parents that is partly independent from parents' individual characteristics or family aspects. Alternatively, the perception of different parental treatment toward both twins may significantly contribute to the degree of alienation from parents, which would explain the large effect of the non-shared environment.

The third goal of the study was to explore the genetic and environmental contributions to the association between parental attachment (maternal and paternal) and peer relationship quality. It is noted that phenotypic correlations between parental

and peer measures were consistently low across all parents and peers IPPA subscales and total scores, in keeping with previous studies showing that the associations between parent and peer attachment in adolescence tends to be low to moderate (Gorrese & Ruggeri, 2012). This possibly indicates that, while during childhood attachment relationships with parents may serve as prototypes for meaningful relationships with peers through the mediation of internal working models (e.g. Fonagy and Target, 1996), in adolescence the rapid changes in social relationships may promote the reorganization of an existing attachment system, functioning as an independent attachment source (Allen & Miga, 2010).

Notwithstanding the aforementioned results, bivariate genetic analysis on the covariance between parental and peer attachment showed that common genetic factors play an important role in the association between the IPPA measures in relation to these attachment figures. In particular, 46% to 62% of the covariance between mother and peer IPPA scores was found to be determined by genes. This might indicate that attachment toward mother (and to a relatively lesser extent toward father) and peers significantly relies on certain individual characteristics of the adolescent, which may elicit behaviours in others that are likely to promote or discourage the formation of meaningful bonds. Alternatively, personality traits and characteristics that are relevant to attachment toward parents may bring adolescents to seek out peers with similar traits, thus impacting the development of attachment relationships outside the family context.

Furthermore, univariate genetic analysis on peer attachment showed that genetic contribution was significantly lower in relation to scores of Peer Alienation compared with scores of Peer Trust and Peer Communication. These findings might suggest that some components of adolescents' attachment relationships with peers (i.e. trust and quality of communication) may be determined by individual characteristics, while others

(i.e. feelings of alienation) may depend more on the environmental contexts in which these bonds are formed and, in part, by characteristics of the environment in which siblings are raised. IPPA Alienation scores are defined by low levels of sociability and integration, perception of exclusion, judgement and rejection (Armsden & Greenberg, 1989). Effects of the shared environment on these features might suggest that stable family contextual factors, possibly including the quality of parenting, might be relevant in the development of adolescents' dysfunctionalities in seeking affiliation, stemming from family relationships and extending to peer groups. Nevertheless, levels of trust, quality of communication and feeling of alienation from peer groups were primarily determined by characteristics of life contexts which are uniquely experienced by each adolescent (i.e. the non-shared environment). These might include characteristics of each sibling's peer group.

In addition, bivariate genetic analysis showed that associations between parent and peer attachment were also largely influenced by the non-shared environment. This finding might corroborate the idea that the quality of peer relationships can be relevant in determining the overall attachment organisation in adolescence and even in determining attachment security specifically with parents. It is well documented that adolescents increasingly rely on peers for intimacy and support, while the amount of time spent with parents during adolescence is expected to drop considerably compared to childhood (Benson, McWey, & Ross, 2006; Larson et al., 1996). Based on the current results, and because the correlations between IPPA parental and peer scales were relatively weak, it is possible to argue that attachment toward parents and peers in adolescence may be partially supported by distinct behavioural and affective systems and that unique social experiences may become progressively more relevant organisers of adolescent attachment organisation compared to family factors.

However, an important finding from the current bivariate genetic analysis was the significant contribution of the shared environment to the association between father and peer attachment in relation to IPPA Trust, Communication and Total scores. On one hand, the important genetic effect found on both parent and peer attachment arguably reflects the progressive tendency of adolescents to actively create and modify their environments, in virtue of the increasingly gained behavioural independence from their family. On the other hand, the finding that the environment shared between siblings influences adolescent attachment to father as well as peers challenges this idea. Indeed, this result implies that, to some extent, stable family aspects affecting the adolescents' perceived quality of relationships with their father – possibly including the quality of fathering - are *passively* experienced by adolescents and exert a significant impact on the quality of social relationships outside the family context.

Taken together, the current findings brought to light fundamental aspects of the behavioural genetics of attachment in adolescence to date remained unexplored. On one hand, the current findings in part validate the idea that adolescent attachment security reflects a metacognitive, generalised state of mind that is progressively determined by genes and unique individual experiences (Fearon et al., 2014). On the other hand, the finding that the shared environment significantly influences important aspects of attachment to fathers, as well as the correlation between father and peer attachment contrasts the hypothesis that attachment representations in adolescence are entirely independent from environmental factors directly coming to play within the family context.

Limitations

A few limitations need to be taken into account when interpreting the estimates of genetic and environmental effects found in the current analyses.

Firstly, the obtained estimates apply only to the population under consideration, which was mainly composed of white and middle-class families, while other ethnicities and disadvantaged communities were under-represented. These elements may limit the generalization of the current findings.

Secondly, the age range of the current sample was restricted. Having a sample with a broader age range could have determined, for instance, a lower effect of the non-shared environment and larger effect of the shared environment on the associations between parent and peer attachment, as it is possible that younger adolescents are less behaviourally autonomous than older adolescents. Furthermore, for younger adolescents, relationships with parents might still represent the main sources of safety and comfort, as opposed to peer affiliations (e.g. Rosenthal & Kobak, 2010; Seibert & Kerns, 2009; Zaifman & Hazan, 2008). Due to the limited age range of the sample tested in the current study, it was not possible to distinguish between different phases of adolescence and thus evaluate age as a possible moderator of the genetic effect throughout this developmental period (Avinun & Knafo, 2014).

Thirdly, the non-optimal model fits of the ACE models in relation to the peer scales made it difficult to interpret the results in relation to this scale. This might be due to a low statistical power of the current structural modelling. Similarly, the relatively weak correlations between parent and peer IPPA scores made it difficult to infer the real estimates of the genetic and environmental contributions to the associations between these attachment measures.

Finally, it is crucial to reiterate that IPPA scores do not provide a whole picture of the complex phenomenon of adolescent attachment. Rather, they provide a dimensional measure of the *perceived* attachment security toward significant attachment figures, which is a component of attachment theory (Crowell et al., 2008).

Beyond childhood, the quality of attachment bonds is commonly tested in relation to emergency situations such as danger to self or threats to an attachment figure's availability (Waters & Cummings, 2000), which are aspects that are not directly assessed via the IPPA. Furthermore, IPPA measurement system based on "quantity" of attachment (low vs high security) drawn from the distribution of trust, communication and alienation scores is only partially associated with the more widely recognised Ainsworth's (1978) secure vs insecure classification system (Roisman et al., 2007; Borelli et al., 2016; Venta et al., 2014; Bartholomew & Shaver, 1998) which can be obtained through interview-based measures. For these reasons, IPPA scores should not be interpreted as exhaustive indexes of adolescent attachment organisation. Rather, the IPPA provides relevant, yet partial information on a wide and complex phenomenon that to date remains exceptionally challenging to detect (see previous chapter), and would therefore benefit from being integrated with different assessment methods.

Conclusions

In this study, behavioural genetic methodology was applied for the first time on scores of a widely used self-report instrument in the attachment field, in contrast with previous behavioural genetic studies assessing attachment organisation in adolescent populations through the administration of interview-based instruments, such as the Adult Attachment Interview (in non-twin populations) or the Child Adolescent Interview. Furthermore, the current study adds to a growing behavioural genetic literature on attachment by taking into examination both adolescent parental and peer relationships. The finding that

genes contribute to the recollection of attachment experiences in adolescence independently of the assessed attachment figures and the measure being utilised (self-report vs interview-based measures) stands in stark contrast to findings on infancy. These results provide further evidence that, throughout development, attachment becomes progressively less reliant on the characteristics of the environment in which children are raised. The shared environment, however, still appears to be relevant in determining adolescent attachment to father as well as the association between the latter and attachment to peers.

The current findings support the idea that adolescent internal working models activated in the relationships with parents and in the relationships with peers are supported by partially independent behavioural and affective systems, consistent with the hypothesis that unique individual experiences and search for autonomy, along with genetic factors, are central organisers of attachment in adolescence.

Chapter 4 – Study 3

A behavioural genetic study on parenting and attachment security in adolescence

4.1. Introduction

Bowlby (1969) described the origins, antecedents and implications of the attachment system within the context of parent-child relationships. He argued that the drive to seek proximity and form an attachment bond with caregivers was biological, and further postulated that the nature of this bond was shaped by the quality of the care given through repeated daily interactions from birth. Based on this assumption, the nature of parent-child attachment relationships was first widely researched with reference to infancy.

The quality of parenting has been widely identified as a key determinant of attachment security in early life phases (e.g. Madigan et al., 2006; van Ijzebdoorn, Schuengel & Bakermans-Kranenburg, 1999). In particular, as reported in the introduction of the thesis, parental sensitivity has been traditionally regarded as the most relevant determinant on infant attachment security (Ainsworth, Blehar, Waters, & Wall, 1978; Bowlby, 1969; Pederson & Moran, 1995). The first findings from observational and experimental studies of attachment corroborated the idea that the degree to which caregivers respond sensitively towards their child's attachment cues shapes attachment patterns in the first life phases (De Wolff & van Ijzendoorn, 1997).

Furthermore, in a behavioural genetic study, Fearon et al. (2006) found that the variation of maternal sensitivity ratings between 12 months old twins was accounted for only by shared and non-shared environmental factors, while genes appeared not to be influential (see introduction). Additionally, shared variance in maternal sensitivity was found to account for some degree of the similarity between twins in attachment security

which, in other words, indicated that attachment security of one twin may be linked to the parenting (i.e. maternal sensitivity) coming into play in the parent-infant relationship with the other twin. These findings supported the idea that maternal sensitivity is substantially influenced by a parent's state of mind with respect to attachment (Van IJzendoorn, 1995) and that this may exert a fairly constant effect on caregiving behaviour, independently of child characteristics (Steele & Steele, 1994). This added weight to attachment theorists' hypothesis about the role of parenting as an environmental factor shaping secure and insecure attachment from birth.

Nevertheless, parenting may have a less determinant role on attachment organisation at later stages. For instance, large-scale longitudinal studies and meta-analyses have indicated that the magnitude of associations between early experiences with attachment figures and representations of attachment in adolescence and adulthood are fairly modest (e.g. Groh et al., 2014; Sroufe et al., 2005; Fraley & Shaver, 2000; de Wolff & van IJzendoorn, 1997).

Indeed, in the previous chapters, it has been widely illustrated how attachment and its antecedents change substantially throughout development. These changes are consistent with the different developmental tasks of infancy, childhood and adolescence, with individuals seeking greater independence and less physical proximity to parents as they grow (e.g. Allen et al., 2018). Moreover, the development of meaningful bonds outside the family context such as peer and romantic relationships, as well as other adult relationships such as those with teachers (Bergin & Bergin, 2009), have important implications for attachment organisation. Furthermore, the wide variety of methods and tools assessing attachment security across different developmental stages, from observed behaviours to assessments of internal working models in the form of pattern of speech related to attachment history and expectations (Main, Kaplan & Cassidy, 1985), may also play an important role.

In considering the above, it is possible to expect that parenting may impact infant and adolescence attachment in substantially different ways. Nonetheless, the role of parenting factors in determining adolescent attachment security remains unclear. Although research suggests that a range of parenting variables do contribute to attachment security in adolescence (as it is reported in the next section), these findings are inconsistent and vary dramatically based on the population being studied, making it difficult to identify which aspects of parenting have a significant impact.

Similarly, it has been previously illustrated that a child's inherited characteristics seem to exert a greater influence on representations of attachment in adolescence compared to earlier phases, independently of whether these representations are assessed through interview-based (Fearon, Shmueli-Goetz, Viding, Fonagy and Plomin, 2014) or self-report (see chapter 3) measures. The reasons for this shift are unknown. However, Fearon et al (2014) hypothesised a possible bidirectional mechanism, whereby the child's genetically determined characteristics become more prominent in later childhood and evoke a certain type of responses in the parents, which in turn may impact on attachment representations in adolescence (see introduction).

To date, little has been examined in terms of the relative contribution of genetic factors in the association between quality of parenting and adolescent attachment security. The current study used data from the same twin study design (TEDS) described in the previous chapters with the aim of exploring the relative contribution of genetic factors on the quality of parenting and its association with adolescent attachment security. The next sections will discuss what is currently known about the role of parenting – considering the multiple aspects of parenting – in relation to attachment security in adolescence. In the last part of this introduction, the latest findings in relation to the influence of child's genetic characteristics on parenting will also be explored.

4.1.1. Parenting and attachment across development

It has been previously described how parenting (in particular sensitivity) plays a significant role in determining the nature of attachment security in infancy. Moreover, according to classic attachment theory (Ainsworth et al., 1978), parental sensitivity in infancy represents a key factor influencing attachment security throughout the lifespan. Using an observational measure of parenting, Vaughn et al. (2016) examined the predictive effect of parental sensitivity in infancy, as well as infant attachment classifications, on attachment security at later stages. The authors found that these variables accounted for only 11% of the variance in attachment classification at age 18. Measures of parental support, monitoring and involvement at different points across childhood and adolescence accounted for another 8% of the variance.

Research shows that the construct of attachment in adolescence, unlike infancy, is the result of multiple antecedents that extend far beyond the quality of parenting (Fraley & Shaver, 2000). Moreover, stability of attachment from infancy to adolescence strictly varies depending on the population being studied, with high-risk populations being more insecure and less stable than low-risk populations. Indeed, in a longitudinal study investigating the continuity of attachment from infancy to adolescence, Hamilton (2000) found that the presence of negative life events (e.g. single parenting, alcohol or drug abuse and parental divorce in the early years) significantly contributed to the maintenance of insecure attachment. Another study by Waters et al. (2000) found that these events can even shift attachment security to attachment insecurity throughout development. The presence of these and other negative factors across childhood, such as conflict between parents (e.g. Martin et al., 2017), parental divorce (e.g. Lewis, Feirling & Rosenthal, 2000) and low socio-economic status (e.g. Allen et al., 2004) appear to be associated with insecure attachment in adolescence.

With respect to these factors, it is plausible that the quality of parenting plays a mediating effect. More specifically, it has been hypothesised that parents who cope with difficult life events, or experience conflict and negativity in the couple relationship, may become less available and responsive towards their children. In other words, it is possible that these factors have a direct impact on parental sensitivity, which contributes to the development of insecure attachment in adolescence (Feinberg, Kan & Hetherington, 2007). Alternatively, these events could have a direct effect on adolescents' internal working models of relationships, self and other, independently of the quality of parenting.

4.1.2. Assessing the quality of parenting in adolescence

Research investigating the relationship between *current* parenting and adolescent attachment has provided mixed findings. Before reporting these findings, it is important to point out that such inconsistencies are partly due to the administration of self-report measures of parenting in large part of the studies. Although cost-effective and efficient, the use of questionnaires to measure the quality of parenting can be problematic, as both parent and child reports are strongly susceptible to biases. For instance, a parent rating on their own practices might be influenced by the wish to present the relationship with their children in a socially and culturally desirable way. Parents might also not be fully aware of their parenting practices, or how their parenting behaviour compares to the ones of other parents in similar cultural environments. Adolescents may also be biased in completing self-report questionnaires about parenting, as it is possible that their attachment security affects their perception of parenting, and not vice versa. For example, insecurely attached adolescents might rate their parents' behaviours more negatively than securely attached adolescents, making it difficult to evaluate the

direction of the relationship between the two constructs (Taber, 2010; Morsbach & Prinz, 2006).

By contrast, observational measures of parenting quality based on parent-child interactions constitute a “gold standard”, as they offer a much lower susceptibility to bias than self-reports (Sessa, Avenevoli, Steinberg & Morris, 2001). Furthermore, reports are only weakly correlated to observational measures of parenting (Allen et al., 2004; Sessa, Avenevoli, Steinberg & Morris, 2001). The observed interactions between parent and child are commonly assessed while the dyad accomplish structured or non-structured conflict-resolution tasks. These tasks have been adopted to assess the quality of parenting in several studies with adolescents (e.g. Bakermans-Kranenburg & van Ijzendoorn, 2007; Scott, Briskman, Woolgar, Humayun & O’Connor, 2011; Kobak, Cole, Ferenz-Gilles, Fleming & Gamble, 1993), and will be described in further detail in the next section.

4.1.3. Parenting variables and attachment security

Parental sensitivity, parental positivity and mutuality

Research studies adopting different observational measures of parenting show that the effect of the quality of parenting on attachment security in adolescence strictly depends on the aspect of parenting being assessed, as well as the type of population being tested (Glazebrook, 2015).

For instance, a study investigating parental sensitivity as an independent construct in adolescence showed that maternal sensitivity was strongly associated with attachment security for adolescents in care, but not with attachment insecurity (Joseph at al., 2014 – F (1, 46)= 8.23, p<.01, d=.78). Another study by Beijersbergen et al. (2012) examined continuity of attachment from infancy to adolescence and the role of maternal sensitivity in determining continuity or discontinuity of attachment on a large sample of adopted

children. The authors found that maternal sensitive support in adolescence predicted continuity of secure attachment from 1 to 14 years, and that increase in maternal sensitivity measured at different points of development predicted shifts from insecurity in infancy to security in adolescence. The authors concluded that both early and later parental sensitive support are important for attachment security. Other studies confirmed the role of parental sensitivity in association with adolescent attachment security using sensitivity scores as part of different composite ratings of parenting behaviour (e.g. Scott et al., 2011).

In addition to parental sensitivity, further aspects of the parenting quality have been examined in association with attachment security in adolescence. For example, in a study by Scott, Briskman, Woolgar, Humayun & O'Connor (2011) maternal positivity – consisting of warmth, assertiveness, communication and involvement – was found to be strongly associated with attachment security in adolescence across a combined high, medium and low-risk sample ($F(1, 209) = 5.74$, $p < .05$, $d = .38$). The same factors observed in mothers have been found to be related to attachment security of adolescents in care (Joseph et al., 2014) ($F(1, 47) = 7.09$, $p < .05$, $d = .72$). Interestingly, however, a more recent study by O'Connor, Woolgar, Humayun, Briskman & Scott (2018) found that similar parenting factors – warmth and involvement – were no longer significant predictors of attachment security in adolescence once parental sensitivity in early years was controlled for. Because this study was conducted only on medium and high-risk samples, it is plausible that earlier parental sensitivity could be more deterministic in high-risk contexts than low- risk contexts.

In another study investigating the stability of attachment security across adolescence, Allen, McElhaney, Kupermine & Jodl (2004) combined adolescents' reports with observed measures of parenting during parent-child interactions. Despite a

consistent degree of stability in attachment classification, results showed that adolescents' reports of maternal supportiveness and self-reported over-personalising and enmeshed behaviour with mothers predicted change in attachment. By contrast, the *observed* measures of maternal attunement and dyadic engagement/empathy were found not to be associated with changes in attachment across adolescence. After controlling for other confounding variables, (i.e. income and depressive symptoms), the authors found that only adolescent over-personalising behaviour appeared to be a significant predictor of attachment change – explaining an additional 6% of the total variance. These findings underscore the importance of parenting in favour of personal characteristics of the adolescent in determining attachment security, possibly suggesting that, by adolescence, relevant changes in the parent-child relationship affecting attachment organisation may have already occurred – and been missed by the aforementioned study.

In addition, research on the relationship between parental warmth and attachment security in adolescence has shown that parental warmth alone is not related to attachment in adolescent girls (Hershenberg et al., 2011) and with organised (secure and insecure) attachment in a mixed sample of young adolescents (Kerns et al., 2000). These findings are consistent with Aisworth & Marvin's (1995) idea that warmth represents an inherent characteristic of the parent and as such it is not fundamental for the development of secure attachment. By contrast, parental sensitivity is grounded in the behaviour, rather than personality traits, of the caregiver in that it reflects the caregiver's ability to respond to the child's cues promptly and accurately. As such, sensitivity is pivotal for the development of parent-infant attachment bonds. According to the authors, equally warm caregivers can have a completely different impact on their children depending on their degree of sensitivity.

A different study by Allen et al. (2003) on a normative sample of adolescents found a modest correlation between adolescent attachment security and dyadic relatedness/mutuality, measured as the degree of engagement and empathy displayed by both parents and adolescents during a revealed differences task (Allen et al., 2002) (r=.20, p<.05). Similar findings were obtained in a study by Obsuth et al. (2014) investigating the relationship between the quality of parenting, including dyadic collaborative communication – intended as the degree to which the interaction is cooperative, reciprocal and balanced – and disorganised attachment, using a sample of families and adolescents with low socioeconomic status. Results showed that more collaborative interactions were associated with lower rates of disorganised attachment in adolescence, with respect to both the Unresolved classification (χ^2= 6.20, p=.01, OR=1.59) and the Hostile-Hopeless (χ^2= 8.82, p=.003, OR=1.64) classification in the Adult Attachment Interview (George, Kaplan & Main, 1985)[3]. In the same study, results also showed that greater parental disorientation considerably increased the risk for the adolescents to be classified as Unresolved (χ^2= 4.72, p=.003, OR=1.64). Similarly, parental punitive control significantly increased the risk for the adolescents to be

[3] In the Adult Attachment Interview, lack of resolution with respect to loss or a traumatic event is inferred when the interviewee provides evidence of poor monitoring of reasoning during the discussion of the event. For instance, this is conveyed through extreme attention to details of the loss or trauma or in indications that the person feels unrealistically responsible for the event. These and other aspects define the *Unresolved* classification. By contrast, *Hostile-Helpless* classification is characterised by pervasive indicators of hostile and/or fearful states of mind and continued identifications with hostile or helpless caregivers. These identification processes result in explicit contradictory and unintegrated emotional evaluations of caregivers across the interview. For instance, there may be concurrent indicators of affective numbing, as manifested by laughter at painful anecdotes, and evidence of affectively unstable relationships, as manifested by ruptures in the contact with family members (Lyons-Ruth, et al. 2005).

classified as Hostile-Hopeless (χ^2= 4.17, *p*=.041, OR=1.38). These findings are in line with evidence from research conducted on infant populations, where anomalous parental behaviour (e.g frightened/frightening, maltreatment, neglect – see introduction) has been found to be significantly associated with disorganised attachment (e.g. van Ijzendoorn, et al., 1999).

Parental negativity

Research investigating on other negative aspects of current parenting in association with adolescent attachment has provided mixed findings. For instance, Roisman, et al. (2001) explored the relationship between dyadic negative affect (obtained from the combination of scores of conflict, hostility and anger) and attachment security, measured at 13 and 19 years old. In both moments of assessment, the authors found no significant correlations between negative affect and adolescents' scores of coherence in the AAI. Additionally, ratings of negative affect at 13 were not found to be predictive of differences in attachment security or insecurity at 19. Other studies using non-dyadic measures of negativity found non-significant correlations between adolescent attachment security and negative aspects of parenting – e.g. anger and coerciveness in Scott et al. (2011) or parental embarrassment, hostility and emotional dysregulation in Herschenberg et al. (2011). Nevertheless, a cross-sectional study by Kobak, Ferenz-Gilles, Fleming & Gamble (1993) demonstrated that secure attachment in adolescence was negatively associated with some measures of negativity in parent-adolescent interactions during a conflict-resolution task. These measures were dyadic dysfunctional anger (i.e. raised voices, criticism, sighing) (females: *r*=-.36, *p*<.05; males: *r*=-.45, *p*<.05) and avoidance of problem solving (i.e. lack of interest in the problem, poor focus on the task) (males: *r*=-.53, *p*<.01). Parental dominance (i.e. the difference

between parent's and adolescent's scores of assertiveness) was also found to be associated with avoidant attachment in females (r=.39, p<.05).

In summary, amongst studies that used observational measures, or a combination of self-reports and observational measures of parenting in adolescence, there are inconsistent findings with respect to the relationship between parenting quality and attachment security. While some studies suggest that parenting is mostly relevant in shaping attachment patterns at earlier stages, reporting modest effects of current parenting in adolescence (e.g. O'Connor et al., 2018; Allen et al., 2004), other studies suggest that a range of parenting behaviours are still important determinants of attachment security at this stage (e.g. Scott et al., 2011; Vaughn et al., 2016).

Among the relevant aspects of current parenting, research indicates that sensitivity and mutuality are most strongly related to adolescent attachment security. Negative aspects assessed within the parent-adolescent dyad, as well as negative aspects of parenting, appear in general to exert less influence on adolescent attachment security compared to positive aspects.

4.1.4. Behavioural genetics of parenting in adolescence

Parenting can be conceptualised as a socialization process, in which parents take an active role in shaping their children. According to this conceptualisation, parenting is considered as a feature of the child's social environment, namely an inherent characteristic of the parents independently of the characteristics of their offspring (Darling & Steinberg, 1993). However, it has been previously illustrated that parenting behaviours are in fact shaped by some characteristics of the child -which constitute child

effects on parenting (Sameroff & McKenzie, 2003). A transactional model of parenting involves a bidirectional interactive process between children and caregivers, in which the quality of parenting develops in response to the child's individual characteristics and behaviours as well as those of their caregivers.

As previously illustrated, behavioural genetic designs examining data from twins raised within the same families can provide a thorough investigation on the extent to which correlations among parenting features are influenced by environmental factors – including parents' individual characteristics – as well as child / genetic sources. In order to examine genetic influences on parenting, researchers have used *parent- based designs* (including parents-as-twin studies) and *child-based designs* (including adoption studies and children-as-twin studies). In a parent-based design, the focus is placed on influences that stem from the parents, whereby the genetic component is referred to the genetic influences of the parent's genotype on their own parenting behaviours. In contrast, in a children-as-twin model of parenting, the key question is whether monozygotic twins (who share 100% of their genetic heritage) experience more similar parenting than dizygotic twins (who share on average 50% of their segregating genes). In this case, part of the variability in the quality of parenting that is experienced by the child is associated with the child's genes. The concept of "heritable" environment implies that the environment is not always passively experienced. Rather, individuals shape their environment by selecting and evoking responses from the significant others around them. When these processes are directed by genetically influenced traits, the environment becomes matched to one's genotype in a gene-environment correlation (rGE -see introduction) (Plomin & Bergeman, 1991).

In a children-as-twin model of parenting, the shared environment represents the variance of similar parenting experienced by the children. This variance in parenting reflects the characteristics of the parents – including parents' genes, that may be shared

with the children – as well as broader contexts that may influence parenting, such as socio-economic status, culture, parental relationship, etc. By contrast, non-shared environment in parenting quantifies the extent to which children perceive being treated differently by their parents, possibly due to factors that depend on their genotypes (e.g. past illnesses, feeding difficulties in infancy, etc.) as well as situational factors individual to each child, specific parent-child relationships, and any other differences between twins not attributable to genes.

Research has reported small to large estimates of child-genetic influences on parenting, both in childhood and adolescence. In a meta-analysis of 56 twin and adoption studies examining the aetiology of parenting behaviour, Klahr & Burt (2014) found that at least moderate genetic effects accounted for parental warmth, control (both psychological and behavioural) and negativity. This study demonstrated that patterns of genetic and environmental influence might differ across parenting dimensions. In particular, parental warmth was found to be influenced by the largest estimate of shared environmental variation (39%), whereas parental control was subject to the largest non-shared environment effect (44%). Warmth and control were found to be influenced by child-genetic factors by 26% and 23% of the total variance respectively.

Another meta-analysis including 32 children-as-twin studies (Avinun & Knafo, 2014) evaluated the extent to which children's genes are associated with parenting negativity and positivity. The study revealed a heritability estimate of 23%, indicating that genetically determined behaviour of the child appears to affect parental behaviour to a significant degree. Large shared- and non-shared-environmental estimates (43% and 34% respectively) indicated not only substantial consistency in parental behaviour, but also possible differential treatment between twins. Age and assessment method were found to be significant moderators of these influences. In particular, results showed a decrease in the shared environment effect and an increase in heritability and non-shared

environment effects with age, suggesting that differential parenting increases as the twins grow older, most likely as a result of an increase in the twins' independence and a greater impact of individual experiences. Furthermore, observational measures of parenting yielded lower estimates of heritability as well as lower estimates of non-shared environment as compared to parent- and children-reports, suggesting that children are more likely to report differential parenting and that evocative rGE is more likely to emerge through child reports than in observations. Considering that self-report measures of parenting are highly susceptible to biases, the generalisability of results reported in these meta-analyses is limited.

To date, a very limited number of studies have examined genetic and environmental influences on parenting adopting observational measures in adolescent populations. For instance, O'Connor, Hetherington, Reiss & Plomin, (1995) used The Family Interaction Coding System (Hetherington, Hagan & Eisenberg, 1992) on videotaped parent-adolescent interactions during a conflict resolution task to explore the role of genetically-based child effects on parenting. This sample was part of the Non-shared Environment in Adolescent Development (NEAD) project, a longitudinal study of twins/siblings and parents assessed in middle adolescence, late adolescence, and young adulthood. Siblings in the sample varied in the degree of genetic relatedness, including identical twins, fraternal twins, full siblings, half siblings and genetically unrelated siblings in stepfamilies. O'Connor et al (1995) collected data from 675 families comprising children between 9 and 18 years of age. Univariate genetic analysis was used to compare sibling correlations to estimate the genetic and environmental contributions to the quality of parenting. The findings suggested that a large variance of parents' negativity was accounted for by adolescents' genes (38% for maternal negativity and 24% for paternal negativity) and shared environment effect (34% for maternal negativity and 42% for paternal negativity). Parental positivity was also found

to be accounted for by 18% of heritability and 19% of shared environment for both paternal and maternal parenting.

Pike, McGuire, Hetherington, Reiss & Plomin (1996) used data from the NEAD project to explore the gene-environment correlations between parental negativity and depressive symptoms, as well as antisocial behaviour in adolescence. The authors evaluated total composite rating of maternal and paternal negativity based on parental report, adolescent report and multiple observational measures in 719 same-sex sibling pairs ranging from 10 to 18 years of age. Multivariate genetic analysis showed that genetic contribution accounted for most of the phenotypic correlation between measures of parental negativity and adolescent depressive symptoms and antisocial behaviour. Pike at al (1996) argued that these findings indicate that heritable traits in the adolescent may evoke negativity in the parents which in turn exert an important influence on adolescents' depression and antisocial tendencies.

4.1.5. The current study

The aims of the current study were threefold.

Firstly, the study aimed to examine the extent of genetic and environmental contribution to the variation in the quality of parenting in parent-adolescent interactions. The quality of parenting was assessed through observational measures of a range of parenting behaviours and characteristics deemed to be important for attachment security, such as sensitivity, mutuality and positivity. Thus, the study aimed to test the hypotheses of a genetic effect account, a shared environmental effect account and a non-shared environmental effect account on the quality of parenting in adolescence.

Secondly, using multivariate behavioural genetic methods, the current study aimed to analyse the extent to which genetic and environmental factors underlie associations between the quality of parenting and adolescent attachment security. Bivariate behavioural genetic models use differences in within-twin and cross-twin correlations to estimate genetic, shared environmental, and non-shared environmental correlations between the two explored measures (Purcell, 2002) (see Chapter 3). The hypothesis of a genetic correlation account would imply that common genetic factors underlie the association between the quality of parenting and attachment security, indicating that parenting and attachment security in adolescence might be associated because they are both influenced by the same genes. This genetic correlation would be evident if the quality of parenting measured in relation to one twin was a better predictor of the other twin's attachment security in DZ twins than in MZ twins. In contrast, the hypothesis of a shared environmental model would be found if attachment security of each twin could be equally well predicted from the parenting shown toward either twin, regardless of genetic similarity. Thus, the correlation between parenting and attachment for one twin would be of a similar magnitude to the cross-correlation between one twin's parenting rating and the other twin's attachment security. Finally, a non-shared account would imply that, despite a positive association between parenting and attachment security in one twin, the parenting rating would not significantly predict the other twin's attachment security. This would indicate that the association between parenting and adolescent attachment represents a dyad-specific process. A non-shared account would be inferred by a strong within-twin correlation between parenting and attachment but a low cross-twin correlation.

Finally, the current study also aimed to test if the association between parenting and adolescent attachment security could be supported by different degrees of genetic and environmental influences, depending on the measure adopted to assess attachment representations. Given the incongruences between self-report and interview-based

measurement of adolescent attachment security that have been illustrated throughout the previous chapters, it is expectable that results from bivariate analysis yield to different genetic and environmental accounts with respect to the association between parenting and attachment as measured via the CAI or the IPPA.

4.2. Method

4.2.1. Participants

The participants in this study were part of the Twins Early Development Study (TEDS), a large longitudinal cohort of same-sex twins born in England and Wales between 1994 and 1996. Characteristics of this cohort and the inclusion criteria leading to the final sample are described in the first chapter.

592 twin pairs were recorded separately in interaction with their parent (mother or father) during the Hot Topic Resolution Task (HTRT -see next sections). Of these 1184 recordings, 61 (6%) were randomly chosen to calculate interrater reliability. 27 videos for T1 and 33 videos for T2 had technical audio-visual issues or were interrupted too shortly, 33 were not assessable for other reasons –e.g. the parent-child dyad did not accomplish the task. Thus, the final sample was composed of 1063 twins (593 females – 56.1%, 540 monozygotic -51.1%) divided between 535 T1 and 528 T2.

Like the samples described in previous chapters, the majority of the families were white British (82.1%). In terms of socioeconomic status, an annual income <£30.000 was reported by 27% of the families (median household income: £30.000-50.000). 53% of the mothers and 55% of the fathers reported having at least A levels education, and 34% of mothers and 31% of the fathers were educated at the degree level or higher.

4.2.2. Measures

To assess attachment security in adolescents, two assessments were administered: The Child Attachment Interview (Target, Fonagy, Shmueli-Goetz, Datta & Schneider, 2007) and the Inventory of Parent and Peer Attachment (Armsden & Greenberg, 1989).

Child Attachment Interview (CAI)

The CAI is a semi-structured interview designed to assess attachment organisation by accessing adolescents' mental representations of attachment relationships. The interview consists of 17 questions concerning the relationship between the adolescent and their caregivers (e.g. "Can you tell me three words that describe the relationship you have with your mum/dad?" "What happens when you're ill?").

Detailed description of the CAI is reported in the second chapter.

For the purpose of the current study, scores of Overall Coherence were used as continuous measures of attachment security in order to grant consistent and accessible interpretability of results. Scores of Overall Coherence have been shown to reflect the degree to which the adolescent is able to describe relationship episodes with their caregivers in a spontaneous and consistent way. High scores in Overall Coherence indicate the adolescent's proclivity to speak fluently, without many prompts from the interviewer, and reflect on attachment relationships while holding in mind perspectives and mental states of people involved in the narratives. By contrast, low scores in Overall Coherence are marked by idealisation of the attachment figures, with incoherent or very brief examples, contradictory narratives and lack of spontaneous speech or reflection (Shmueli-Goetz et al., 2008).

Interviews were administered to the entire original sample by trained research assistants. Coding was conducted by one of the authors of the scale (Y. Shmueli-Goetz) and the research assistants. Intra-class correlation for Overall Coherence was .72.

In the current study, Overall Coherence scores were available for 534 (99.8%) T1 and 526 (99.4%) T2.

Inventory of Parent and Peer Attachment

The IPPA is a self-report measure of the quality of adolescents' attachment relationships with parents and peers. Respondents rate a series of 25 items regarding their relationships with their attachment figures on a 5-point scale (e.g. "My mother/father respects my feeling", "I wish I had a different mother/father").

Detailed description of the IPPA is reported in the previous chapters.

For the purpose of the current study, only parental scales were considered, while peer scale was excluded. Only the total scores in relation to the parent who took part in the HTRT recordings were utilised. Total scores provide a measurement of attachment security on a dimensional continuum, with higher total scores being indicative of secure attachment (Armsden & Greenberg, 1989). In the current study, total IPPA scores were available for 487 (91%) T1 and 487 (93%) T2.

Assessment of parental behaviour: Hot Topic Conflict Resolution Task

To assess the quality of parenting, participants and their parents performed the "Hot Topic Resolution Task" (HTRT). Their interactions were filmed and subsequently scored by the author and four trained research assistants.

During the HTRT, adolescents and parents were asked to resolve a disagreement pertaining to specific areas chosen by the adolescent from a pre-given list. These listed areas are typically associated with conflicts between parents and adolescents (i.e. money, friends, dating, use of phone/computer, videogames, grades and schoolwork, alcohol and drugs, brothers and sisters, personal appearance, chores, rules in the house, activities outside of school, religion). The participants were asked to select the two areas on which they believe they disagree most with their parent. Once reunited with their parent for discussion, adolescents were asked to start the discussion by describing the disagreement taking into account their own and their parent's side. Then, adolescent and parent were instructed to debate about the disagreement with the aim of understanding each other's points of view and finding a possible resolution, or compromise. If time permitted, this process was repeated for both chosen topics.

An examiner would instruct the dyad, start recording, leave the room for the entire duration of the task, and come back after 8 minutes to interrupt the recording.

All videos in which the dyad started discussing at least one of the disagreements were considered assessable. Each twin was assessed independently with the same parent.

Rating of Quality of Parenting

For the coding of parent-adolescent interactions, two validated and widely used coding systems were integrated and adapted: The Family Interaction Coding System (FICS- Hetherington, Hagan & Eisenberg, 1992) and the Coding of Attachment Related Parenting (CARP- Matias, Scott & O'Connor, 2006).

The Family Interaction Coding System

The original scale of the FICS consists of 12 general scales: Anger/Rejection, Warmth/Support, Coercion, Assertiveness, Involvement, Transactional Conflict, Self-disclosure, Communication Skills, Authority/Control, Depressed Mood, Positive Mood and Problem Solving. Additionally, the FICS consists of two more ratings for children only: Prosocial Behaviour and Antisocial Behaviour. For each scale, adolescent and/or parent are rated on a 5-point Likert scale, with higher scores indicating greater intensity or frequency of the assessed behaviour (1= No sign of behaviour; 5= systematic display of behaviour). Members of the dyad are rated separately or together, depending on the scale.

The original version of the FICS as described above was substantially adapted for the purposes of the current study.

Firstly, although scores were given to both child and parent as indicated in the coding guidelines, only parent or dyadic ratings were utilised in this investigation, and therefore Prosocial and Antisocial Behaviour scales were excluded, as these are normally rated in relation to child only. Secondly, Self-Disclosure and Authority/Control scales were also excluded, as these proved difficult to define in relation to the child and led to low reliability in previous studies (Scott et al., 2011). Thirdly, the original scale Warmth/Support was modified into two separate scales for Warmth and Support. Warmth refers to the parent's proclivity to show enthusiasm, affection and kindness toward each other, while Support measures the degree to which the target shows interest and concern toward the other's difficulties and needs, investing on the other and acting on the other's best interest (see Appendices A and B). These two constructs related to parenting were kept separate in the current study as they have been found to relate to adolescent attachment in different ways. In particular, parental warmth has been found not to relate to attachment when measured as a separate construct (Hersenberg et al., 2011), while it has been found to be associated with higher level of secure attachment and lower levels of disorganised attachment when combined with support and validation (Kerns et al., 2000). Finally, the

Problem Solving scale was adapted in a previous investigation (Glazebrook, 2015) in order to place greater focus on the process of negotiation within the dyad. For example, a parent who subjugated their own needs, appeared superior to their child or led the process of generating a solution in a one-sided way would not receive a high score, independently of whether a solution was explicitly reached at the end of the task or not. By contrast, high scores were indicated when a parent actively sought solutions throughout the task, understanding the problem and the other's side of it and finally agreeing on a resolution or a compromise (see Appendix C).

All other scales were used without adaptation from their original versions.

The Coding of Attachment Related Parenting

The CARP is a measure of the quality of parent-child interactions originally designed for school-age children and consists of four subscales: Sensitive Responding, Positive Affect, Negative Affect and Mutuality.

Positive and Negative Affect scales are indicative of the degree to which the parent generally displays positive or negative moods and were not considered for the study, as these aspects were already assessed through the Depressed and Positive Mood ratings in the FICS.

The CARP Sensitive Responding scale refers to the degree to which the parent appears aware of the child's needs, adopts their point of view and responds according to their verbal and nonverbal signals by showing warmth and positive emotion. The CARP Mutuality scale refers to the degree to which parent and child foster each other's engagement in the task, reciprocate each other's affectionate behaviour, maintain physical proximity/ closeness in a fluent conversation, and coordinate their efforts in the process of

finding a resolution to the task. Because sensitivity and mutuality aspects of parent-child interactions are important indicators of attachment security in adolescence (de Wolff & van Ijzendoorn, 1997) the CARP scales of Sensitive Responding and Mutuality were utilised as supplements to the FICS. Both represent 7-point Likert scales and provide parental and dyadic ratings respectively, with higher scores indicating higher intensity and frequency of the assessed behaviour (1 = No evidence of behaviour; 7 = Pervasive/extreme evidence of behaviour).

The CARP has been shown to have good psychometric properties. In particular, Sensitive Response and Mutuality scales appear to significantly correlate with other aspects related to parenting reported by parents during interviews, such as sensitivity, communication and aggression, showing good concurrent validity (Matias, Scott & O'Connor, 2006). Furthermore, convergent validity of the CARP was demonstrated in relation to child attachment security ($r=.20$, $p<.05$ for Sensitive Responding and $r=.32$, $p<.001$ for Mutuality), peer-rated popularity ($r=.28$, $p<.001$ for Sensitive Responding, $r=.25$, $p<.05$ for Mutuality) and peer rejection ($r=-.23$, $p<.05$ for Mutuality) (Matias, O'Connor, Futh & Scott, 2014).

Because the CARP was originally designed to code parent-child interactions during play, scoring guidelines were adjusted prior to this study to address parent-adolescent interactions during the HTRT. With respect to the original Sensitive Responding scale, reference to play or play behaviour were replaced with references to conversation, discussion or task. For example, the original guideline "Responsive Engagement - Responsive parents will make enthusiastic comments on child's achievements during play whether or not the child is responsive to the parent. Responsive parents will keep an attentive attitude towards child's activities (note: this attentiveness is more than just looking in child's direction). This attitude on the part of

the parent is a child-focused one ("following" the child in his/her activity because the parent's major motivation is to be immersed in his/her child's activity, thus, keeping a high level of engagement with what his/her child is doing)" (Matias et al., 2006 –p.2) was amended as follows: "Responsive engagement - Responsive parents will make enthusiastic comments and praise the child's ideas. Responsive parents will keep an attentive attitude towards child's conversation. This attitude on the part of the parent is basically a child-focused one: letting child take lead/direction of the conversation, "following" the child" (See Appendix D).

Similarly, references of the original Mutuality scale to play or play behaviour were replaced by references to the task, general mutual and mirroring behaviours of the dyad during discussion. For example, the original guideline "Shared attention -through appropriate eye contact and/or attentiveness to each other's comments and actions regarding the play (this is not simply the equivalent to looking at what the other one is doing, instead, it has to seem obvious to the observer that both parent and child are thinking about the same thing while looking at one another and being attentive to what each other is saying or doing regarding the play)" (Matias et al., 2006 - p.15) was amended as follows: "Shared attention –through appropriate eye-contact and/or attentiveness to each other's comments and actions regarding the task. They are able to respond accordingly and maintain a joint attention on the topic" (see Appendix E).

Table 4.1. illustrates the definitions and characteristics of the total 13 rating scales for parenting quality extracted and adapted from the original FICS and CARP.

Table 4.1. *Use and adaptation of the Family Interaction Coding System (FICS_ Hetherington et al., 1992) and Coding of Attachment Related Parenting (Matias, Scott & O'Connor, 20016)*

Scale	Description	Rating	Adaptation from original scale
Anger/Rejection	Target's most extreme negative, angry, rejecting, or hostile verbal and non-verbal behaviour (e.g. frown, irritable, sarcastic, curt tone of voice, shouting, actively ignoring or turning away from the other, failing to listen to each other, denying the others needs)	Both members of the dyad	Scale used from FICS without adaptation (parent rating only)
Warmth	Target's warmth, enthusiasm, affection and kindness, friendliness and general positive affect towards the other (e.g. touching, kissing, hugging, holding hands, smiling, laughing, happy or good humoured)	Both members of the dyad	Adapted from FICS (parent rating only)
Support	Target's active interest and concern for the other's difficulties and needs, attention paid to what is communicated by the other, investment in the other's wellbeing (e.g. responsiveness, showing concerns for the other's welfare, offering encouragement and help, offering to change behaviour for the other)	Both members of the dyad	Adapted from FICS (parent rating only)
Coercion	Target's expression of needs, wants and opinions and attempts to control or change the behaviour/opinion of the other through negative and manipulative avenues (e.g. whining, power plays, making the other feel guilty, stubbornness, obstinance, physical or verbal threats, forcing one's opinions on the other)	Both members of the dyad	Scale used from FICS without adaptation (parent rating only)
Assertiveness	Target's expression of needs, wants, and opinions through clear, appropriate and positive avenues, while exhibiting self-confidence, persistence, neutral or positive affect and patience with the responses of the other. Focus on how target responses when their assertions are opposed by the other	Both members of the dyad	Scale used from FICS without adaptation (parent rating only)
Involvement	Target's genuine involvement in conversation and interaction with the other; proclivity to initiate ideas within the topic areas or new topics if necessary. No positive or negative judgements implied.	Both members of the dyad	Scale used from FICS without adaptation (parent rating only)
Transactional Conflict	The two family members' proclivity to defuse conflict between them; interaction becoming progressively more negative; level of conflict achieved by parent and child together	Dyadic	Scale used from FICS without adaptation
Communication Skills	Target's ability to clearly state opinions, wants, and needs; ability to listen to the other so that responses are appropriate and reasonable; use of explanations and clarifications; solicitation of the other's views encouraging the other to explain and clarify their point of view	Both members of the dyad	Scale used from FICS without adaptation (parent rating only)
Depressed Mood	Target's verbal and non verbal communication of emotional distress conveyed as dysphoria (sadness, unhappiness, despondency, depression) and/or anxiety (irritability, fear, worry, concern); withdrawal from family activity; apathy (speaking in a low, slow tone, making negative statements about self, crying, appearing tense, fearful)	Both members of the dyad	Scale used from FICS without adaptation (parent rating only)
Positive Mood	Target's expression of happiness, optimism and demonstration of positive affect. Focus on facial expression, body posture, emotional expression, smiling, laughing, positive involvement in the interaction, positive content of statements.	Both members of the dyad	Scale used from FICS without adaptation (parent rating only)

Problem Solving	Ability of the members of the dyad to progress toward the accomplishment of the task, i.e. the resolution of disagreements or problems under discussion. Focus on clear definition of important aspects of the problems; quality of suggested solutions; offer to compromise; agreements on solutions	Both members of the dyad	Adapted from FICS (parent rating only)
Sensitive Responding	Degree to which the parent shows awareness of, and responds sensitively to, the child's needs and requests, expressed through verbal or non-verbal behaviour	Parent only	Adapted from CARP
Mutuality	Degree to which parent and adolescent encourage each other's engagement in the task, maintain joint attention, reciprocate affection and keep physical closeness throughout the discussion; general quality of the interaction seeing both parent and child as an unique feature of the relationship	Dyadic	Adapted from CARP

Notes - Where "both members of the dyad" is indicated, scales were rated for both parent and adolescent. However, only parental scores and dyadic scores were considered in this study

4.2.3. Procedure

Preliminary approach to the families and administration of interviews and questionnaires are described in chapters 1 and 2.

For the current study, only data on socio-demographic information, twin zygosity, adolescent attachment and quality of parenting were utilised for analyses, while other variables (i.e. psychopathology, parental discipline, callous traits and peer relationships) were not considered.

Videos of participants (twins and their parents) completing the HTRTs were coded by the author and other 4 coders, namely research assistants and doctorate students who used subsamples from the current study for different investigations. Each coded one member of every twin pair (T1 or T2). Coders were blind to the scores of the other twin, the adolescent's attachment style and other socio-demographic information (these variables were subsequently utilised). Videos were allocated to each coder depending on

their availability and involvement in the study. Table 4.2. illustrates each coder's allocation of tapes belonging to T1 and T2.

Table 4.2. *-Number and percentage of allocated tapes to each coder for T1 and T2*

	HTRT tapes	
	T1 N(%)	T2 N(%)
Coder 0 (author)	64 (11.9%)	438 (82.9%)
Coder 1	60 (11.2%)	43 (8.2%)
Coder 2	108 (20.2%)	47 (8.9%)
Coder 3	102 (19.2%)	0
Coder 4	201 (37.5%)	0
Total coded	535 (100%)	528 (100%)

Notes. Missing videos are excluded. HTRT = Hot Topic Resolution Task

HTRTs were completed by twins and the parent who was available for assessment. The majority of interactions took place between twins and their mothers (N fathers= 36 – 6.8%).

4.2.4. Inter-rater reliability for parenting variables

To establish inter-rater reliability between coders across all parenting variables, the author and the coders rated a total of 61 randomly selected videos (6%). To control for possible drifts in reliability, all coders initially coded 30 videos and then on a regular basis extracted a video from the final sample to utilise for inter-rater reliability computation.

Intraclass Correlation Coefficients (ICCs) are reported in Table 4.3. These appeared to be ranging from moderate to good across all scores, except for Communication and Depression. Since ICCs for these scales were too low, these were excluded from analysis. Other scores whose ICCs were below .70 (i.e. Anger, Support, Coercion, Assertiveness, Involvement, Transactional Conflict and Problem Solving) were kept as in line with range of ICCs reported in previous studies adopting the Family Interaction Coding System (e.g. Hetherington et al., 1999; Kim, Hetherington & Reiss, 1999).

Table 4.3.- *Interrater reliability for parenting scales indicated by Intra-Class Correlations*

Scale	***r* (N=61)**
Anger/Rejection	0.58
Warmth	.81
Support	.47
Coercion	.53
Assertiveness	.61
Involvement	.60
Conflict	.63
Communication	.22
Depression	.34
Positive Affect	.76
Problem Solving	.68
Sensitive Responsivene	.78
Mutuality	.81

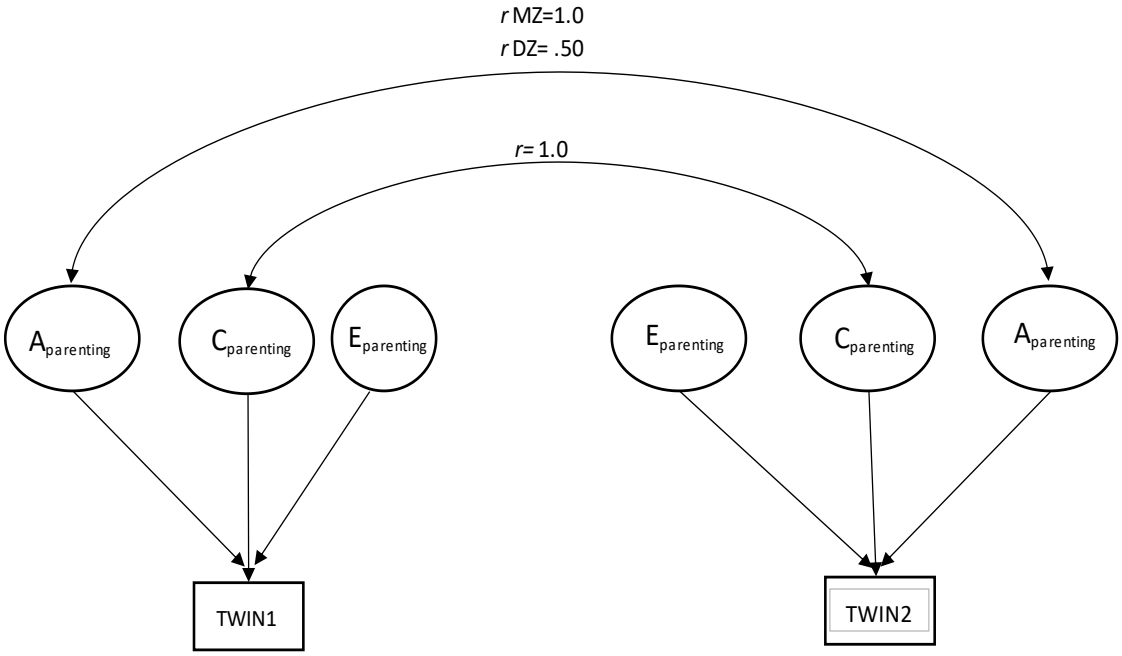
4.2.5. Data analysis

Exploratory factor analysis was first used to reduce the large number of observed parenting variables (11 in total, considering the excluded variables of Communication and Depression due to low ICCs).

Furthermore, descriptive statistics on the means, variance and proportions of the parenting variables were computed. These parameters provide an approximate indication of genetic and environmental contributions (for further detail, see method section of chapter 2).

Then, univariate standard biometrical genetic analysis for twin data (Neale & Cardon, 1992) was conducted to compare monozygotic and dizygotic twin correlations and obtain the estimates of genetic and environmental effects on the quality of parenting. The programme Mplus was utilised 8 to estimate the degree to which additive genetic (A), shared environmental (C) and non-shared environmental (E) factors determined the variance in parenting variables. Residual effects, such as measurement errors, are included in the non-shared environment component and are not explicitly detected in the model (Neale & Cardon, 1992). The procedure to evaluate the fit of the saturated ACE models and the reduced AE, CE and E models was illustrated in depth in the previous chapter (p. 88). The significances of the parameters A, C and E in each model represent direct tests of the first question outlined in the introduction. ACE model of parenting is illustrated in Figure 4.1.

Figure 4.1.- *Path diagram of the univariate genetic model of parenting*



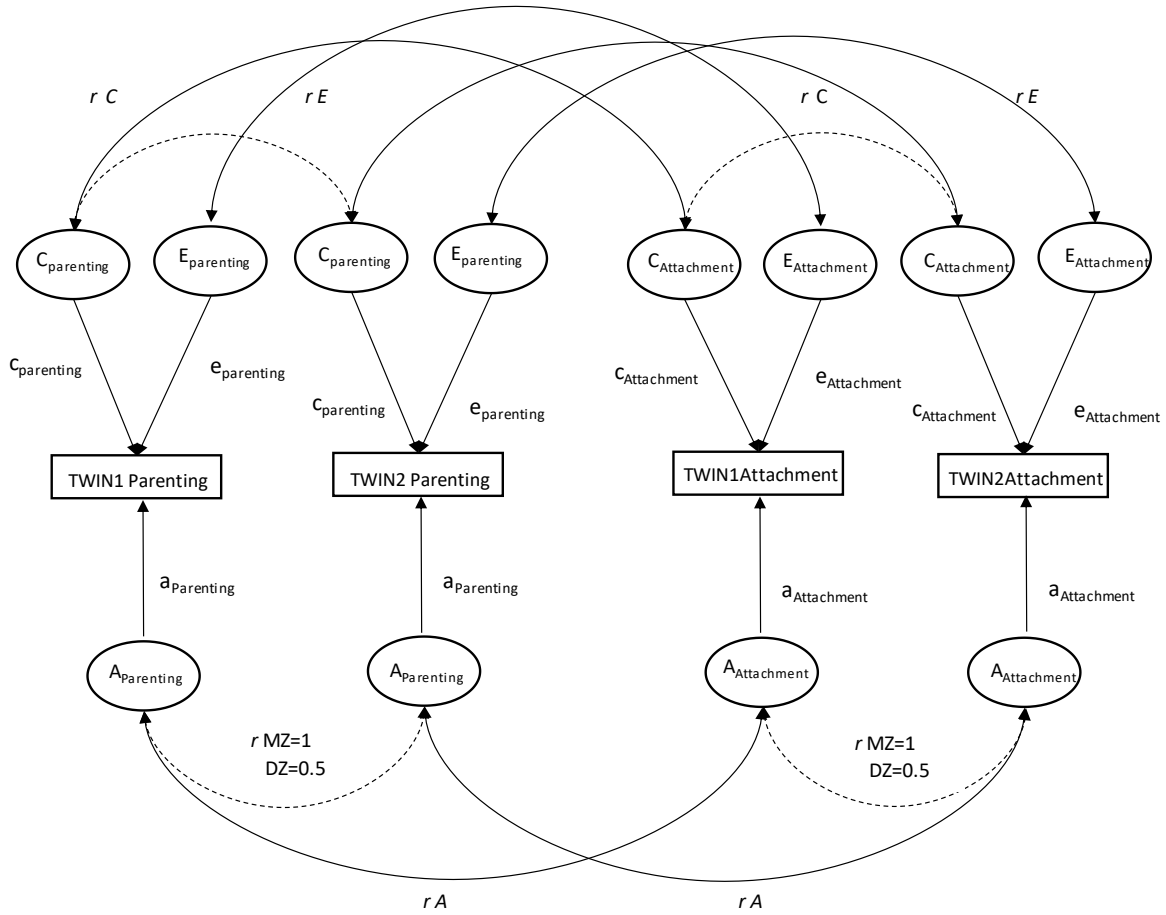
Notes. A, C and E refer to genetic, shared environmental and non-shared environmental latent variables, respectively.

Cross-twin correlations and within-twin correlations analyses were subsequently conducted to explore whether genetic factors contribute to the association between parenting and adolescent attachment security, using both the Overall Coherence scale of the Child Attachment Interview and the total IPPA scores. As illustrated in the previous chapter, the cross-twin correlation is the correlation between one twin's environmental measure and the second twin's outcome measure. In this case, greater cross-twin correlation in MZ twins than in DZ twins indicates a common genetic influence in the association between quality of parenting and attachment. Whereas similar cross-twin correlations between MZ and DZ twins suggests that environmental factors are responsible for the association between the two measures. A shared environmental influence is indicated if the within-twin correlation (the correlation between parenting and attachment for one twin) is of a similar strength to the cross-twin correlation (the

correlation between one twin's parenting and the other twin's attachment security), in both MZ and DZ twins. This implies that the attachment security for one twin could be estimated from the quality of parenting shown towards the other twin as well as from their own parenting, regardless of twin zygosity. Meanwhile, a non-shared environmental influence is assumed when the within-twin correlation is high but the cross-twin correlation is low. This indicates that, while there is a relationship between quality of parenting and attachment security in relation to the same twin, the quality of parenting shown to one twin has no bearing on the other twin's attachment security. In other words, the association between parenting and attachment originates from a process that is specific to each twin.

Then, bivariate genetic models were used to precisely estimate the genetic and environmental effects underlying the association between quality of parenting attachment, as assessed by both the CAI and the IPPA. Multivariate genetic analysis is used to analyse genetic and environmental contributions to relationship between two or more variables by decomposing the correlations between the measures into that due to genetic components, shared environment and non-shared environment (Neale & Cardon, 1992 – see previous chapter). The significances of the parameters A, C and E in each model in relation to CAI Coherence and IPPA total scores represent direct tests of the second and third question outlined in the introduction. ACE bivariate model of parenting and attachment is illustrated in Figure 4.2.

Figure 4.2.- *Path diagram of the bivariate model of parenting and attachment*



Notes. A, C and E refer to genetic, shared environmental and non-shared environmental latent variables, respectively

4.3. Results

4.3.1. Preliminary analysis

Means and standard deviations for parenting and attachment scales according to twin zygosity and gender (as Coherence scores differed across genders – see chapter 1, p. 57) are presented in Table 4.4. Across all twin pairs, no mean scores differed significantly between twin 1 and twin 2.

Table 4.4.- *Means and Standard Deviations by twin zygosity and gender*

Scale	All twins (N=1063)		Monozygotic twins (N=540)		Dizygotic twins (N=523)		Female twins (N=593)		Male twins (N=470)	
	Twin 1 (M, SD)	Twin 2 (M, SD)	Twin 1 (M, *SD*)	Twin 2 (M, *SD*)	Twin 1 (M, *SD*)	Twin 2 (M, *SD*)	Twin 1 (M, *SD*)	Twin 2 (M, *SD*)	Twin 1 (M, *SD*)	Twin 2 (M, *SD*)
Parenting scale										
Family Coding Interaction System										
Anger	1.95 (.89)	2.00 (.98)	1.94 (.92)	1.92 (.98)	1.96 (.86)	2.07 (.99)	1.97 (.89)	2.00 (.98)	21.93 (.89)	2.00 (1.00)
Warmth	3.23 (1.09)	3.22 (.99)	3.22 (1.04)	3.24 (1.02)	3.24 (1.00)	3.21 (.95)	3.29 (1.02)	3.23 (1.03)	3.14 (.97)	3.20 (.98)
Support	3.60 (1.03)	3.59 (1.00)	3.63 (1.02)	3.61 (.99)	3.56 (1.08)	3.57 (1.06)	3.62 (1.027)	3.63 (.98)	3.56 (1.52)	3.52 (1.01)
Coercion	1.74 (1.01)	1.68 (.99)	1.75 (.95)	1.62 (.86)	1.73 (1.06)	1.75 (.98)	1.79 (1.04)	1.67 (,88)	1.69 (1.06)	1.70 (.97)
Assertiveness	4.13 (.85)	4.18 (.79)	4.12 (.83)	4.22 (.67)	4.13 (.86)	4.13 (.82)	4.14 (.89)	4.19 (.79)	4.1 (.79)	4.16 (.62)
Transactional Conflict	2.05 (1.00)	2.03 (1.04)	2.05 (1.01)	2.00 (1.03)	2.05 (1.06)	2.05 (.98)	2.09 (1.00)	2.04 (1.05)	2.00 (1.02)	2.01 (1.04)
Involvement	4.62 (.65)	4.62 (.65)	4.62 (.63)	4.62 (.63)	4.62 (.64)	4.60 (.66)	4.63 (.67)	4.62 (.65)	4.61 (.65)	4.66 (1.00)
Positive mood	3.33 (.98)	3.32 (.97)	3.32 (.98)	3.32 (.94)	3.34 (.98)	3.32 (.96)	3.38 (.98)	3.35 (.93)	3.29 (1.04)	3.27 (1.05)
Problem-solving	3.97 (.96)	4.01 (.95)	3.94 (.97)	4.02 (.95)	4.01 (.96)	3.99 (.96)	3.95 (.97)	3.99 (.95)	4.01 (.95)	4.02 (.97)
Coding of Attachment of Related Parenting										
Sensitivity	4.72 (1.34)	4.77 (1.31)	4.73 (1.34)	4.83 (1.29)	4.71 (1.28)	4.69 (1.33)	4.79 (1.31)	4.83 (1.31)	4.63 (1.32)	4.68 (1.32)
Mutuality	4.86 (1.26)	4.82 (1.27)	4.85 (1.29)	4.93 (1.22)	4.87 (1.8)	4.71 (1.31)	5.06 (1.15)	4.91 (1.72)	4.60 (1.33)	4.71 (1.31)
Attachment Scales										
Child Attachment Interview										
Coherence	5.15 (1.73)	5.14 (1.71)	5.08 (1.76)	5.17 (1.72)	5.23 (1.70)	5.12 (1.71)	5.45 (1.75)	5.37 (1.73)	4.77 (1.73)	4.84 (1.64)
Inventory of Parent and Peer Attachment										
IPPA Total	62.45 (14.85)	61.76(15.72)	63.54 (14.66)	61.30 (14.90)	62.09 (15.88)	61.42 (15.58)	63.48 (15.88)	61.58 (16.95)	61.14 (13.27)	61.98 (14.01)

4.3.2. Data reduction

In order to extract the underlying factor structure of the observed parenting variables, all parenting items for both twins were subject to exploratory factor analysis. Initially, the factorability of the 11 parenting variables was examined. It was observed that all variables had correlation coefficients ranging from *r*=.06 to *r*=.76 in both twins, suggesting good factorability.

Eigenvalues of factor analysis indicated that a three factor solution was preferable as best compromise of overall fit and complexity. Despite the adaptation of the observational scales and the substantial changes from their original versions, this solution was in line with previous studies finding that FICS scales loaded on a two or three factor structure of quality of parenting (Joseph et al., 2014; Ganiban et al., 2007; Hetherington et al., 1999)[4].

The three factors and the respective rotated loadings are reported in Table 4.5. The strongest loadings in the first factor – i.e. which covered the highest variance (46.5%) – were Support and Sensitive Responding (.87 and .84 respectively- See Table 19). The second factor explained 13% of the variance and Anger/Rejection and Conflict represented the scales with the strongest loadings (.83 and .81 respectively). The third latent variable, covering 12% of the total variance, was almost entirely explained by Positive Mood (.91) and Warmth (.63). From a theoretical perspective, the fact that

[4] In the referenced study by Ganiban et al., 2007, it was found that the FICS loaded on a three factor structure, divided into positivity, negativity and *control*. As illustrated in the text, the three factor solution in the current study led to three different variables (i.e. sensitivity, negativity and warmth/positivity), possibly due to the adaptation of the FICS –i.e. the authority/control scale was removed, and the FICS subscales were integrated with other parenting measures from the CARP.

parental warmth and positive mood did not load on parental sensitivity is coherent with classical attachment theory assuming that it is the caregiver's ability to attune with the child's states of mind that grants the foundation of secure attachment (Ainsworth et al., 1978), rather than necessarily the display of positive feelings and affectionate behaviours. This distinction also mirrors different effects of parental sensitivity and parental warmth on attachment security in adolescence (e.g. Joseph et al., 2014; Hershenberg et al., 2011). Moreover, the fact that Warmth and Support loaded on distinct parenting latent variables substantiates the importance of adapting the original FICS by separating Warmth and Support scales, as it was done in the current study.

Table 4.5. - *Rotated loadings of FICS and CARP scales -three factor structure*

Variable	**1**	**2**	**3**
Anger	-.31	.83*	-.15
Warmth	.31*	-.02	.63*
Support	.87*	.00	.02
Coercion	-.42*	.48*	.08
Assertiveness	.79*	.06	.02
Involvement	.78*	.49*	-.05
Transational Conflict	.02	.81*	-0.2
Positive Affect	.00	.09	.91*
Problem Solving	.51*	-.02	.04
Sensitivity	.84*	-.03	.02
Mutuality	.47*	.02	.32*

*Notes- * p<.05*

The three resulting parenting latent variables were therefore named *Parental sensitivity*, *Parental negativity* and *Parental warmth/positivity*.

Loadings with lower values than .4 were excluded, independently of their *p* values. Cross-loading scores on more than one factor were only included in the factor on which they loaded the highest. For instance, Involvement was only included in Parental sensitivity (*r*= .79), but not in Parental negativity (*r*= .49). Similarly, Mutuality scores were taken into account for Parental sensitivity (*r*= .47), but not for Parental warmth/positivity (*r*=

.37). Scores of Parental sensitivity were created by computing the sums of the rating for Sensitive Responding, Support, Assertiveness, Involvement, Problem Solving and Mutuality (range of scores was 9-34, Mean=25.9, SD= 4.55 for T1 and range= 11-34, M=25.98, SD= 4.5 for T2). Scores of Parental negativity were obtained by summing the scores of Anger/Rejection, Conflict and Coercion (range= 4-20, M= 10.36, SD= 2.52 for T1 and range=5-19, M=10.32, SD=2.55 for T2). Finally, Parental warmth/positivity was calculated by summing the scores of Warmth and Positive Mood (range= 2-10, M=6.56, SD=1.80 for T1 and range= 2-10, M=6.55, SD= 1.76 for T2).

These variables were found to have good internal consistency (Cronbach's α: Parental sensitivity T1=.83, T2=.84; Parental negativity T1=.80, T2=.78; Parental warmth/positivity T1=.77, T2=.75).

4.3.3. Socio-demographic variables

The three parenting variables were not found to correlate with Zygosity (MZ vs DZ twins) (Sensitivity: $t(1056) = 0.829$ $p = .31$; Negativity: $t(1056) = .948$, $p = .45$; Warmth/Positivity: $t(19056) = .932$, $p = .22$); Ethnicity (White British vs Other) (Sensitivity: $t(1031) = 1.52$, $p = .21$; Negativity: $t(1031) = -1.55$, $p = .12$; Warmth/Positivity: $t(1031) = 0.19$, $p = .08$) and Gender –although an almost significant difference between males and females was observed in relation to Parental sensitivity- (Sensitivity: $t(1054) = .117$ $p = .05$; Negativity: $t(1054) = .593$, $p = .43$; Warmth/Positivity: $t(1054) = .645$, $p = .09$).

By contrast, family income (<30K vs ≥ 30K p.a.) appeared to correlate with both Parental sensitivity and Parental warmth/positivity (Sensitivity: $t(1037) = .117$ $p < .001$; Negativity: $t(1037) = .329$, $p = .63$; Warmth/Positivity: $t(1037) = .896$, $p < .001$). In particular, parents with higher income displayed greater sensitivity ($M = 26.28$, $SD = 4.35$) and

warmth/positivity (*M*= 6.99, *SD*= 1.73) than parents with lower income (*M*= 25.14, *SD*=4.84 and *M*= 6.22, *SD*=1.82, respectively).

4.3.4. Descriptive statistics and intra-class correlations

Descriptive data, covariance matrices and twin intra-class correlations with respect to the parenting variables of Sensitivity, Negativity and Warmth/ Positivity are illustrated in Tables 4.6, 4.7 and 4.8, respectively.

***Table 4.6**. - Descriptive statistics and covariance matrix for Parental sensitivity for MZ and DZ twins*

PARENT SENSITIVITY				
	MZ		DZ	
	Twin 1	Twin 2	Twin 1	Twin 2
Descriptive statistics				
Mean	26.14	26	25.82	25.66
SD	4.28	4.55	4.776	4.501
N	273	267	263	260
Covariance Matrix				
Twin 1	20.65	.58[b]	20.25	.46[b]
Twin 2	11.39[a]	18.36	10.19[a]	22.82

Notes- a=Covariance; b=Correlation

Table 4.7.- Descriptive statistics and covariance matrix for Parental negativity for MZ and DZ twins.

PARENT NEGATIVITY				
	MZ		DZ	
	Twin 1	Twin 2	Twin 1	Twin 2
Descriptive statistics				
Mean	10.36	10.18	10.36	10.55
SD	2.48	22.57	2.60	2.50
N	273	267	263	260
Covariance Matrix				
Twin 1	6.63	.49[b]	6.39	.36[b]
Twin 2	3.14[a]	6.15	2.36[a]	6..81

Notes - a=Covariance; b=Correlation

***Table 4.8**- Descriptive statistics and covariance matrix for Parental warmth/positivity for MZ and DZ twins*

PARENT WARMTH-POSITIVITY				
	MZ		DZ	
	Twin 1	Twin 2	Twin 1	Twin 2
Descriptive statistics				
Mean	6.51	6.56	6.62	6.52
SD	1.76	1.82	1.75	1.78
N	273	267	263	260
Covariance Matrix				
Twin 1	3.28	.44[b]	3.07	.45[b]
Twin 2	1.42[a]	3.09	1.47[a]	3.19

Notes -a=Covariance; b=Correlation

All three parenting variables did not differ between T1 and T2 (both MZ and DZ twins) in terms of mean scores. In Parental sensitivity, the twin correlations were stronger for MZ twins (r= .58, p<.001) than DZ twins (r= .46, p<.001). However, the difference between the correlations was not statistically significant (Z=1.027, p=.15). A similar pattern was found in relation to Parental negativity: the intra-class correlations were also greater for MZ twins (r= .49, p<.001) than DZ twins (r= .36, p<.001) and the difference between the two was not statistically significant (Z=1.103, p=.13). Finally, with respect to Parental warmth/positivity, intra-class correlations coefficients for MZ and DZ appeared to be of similar magnitude (r= .44, p<.001 and r= .45, p<.001 respectively), indicating relevant shared environment effect and no genetic effect.

4.3.5. Univariate genetic analysis

In order to obtain estimates of the genetic and environmental effects on the parenting variables, the standard ACE models were tested using structural equation modelling via the statistical program Mplus 8. Nevertheless, structural equation

modelling could not provide a good fit for the Parent Warmth/ Positivity data, due to the slightly greater magnitude of the intra-class correlation coefficient for DZ than MZ twins. This was an unexpected result, and reflections on this finding are reported in the Discussion section. Therefore, in the univariate genetic analysis on Warmth/Positivity, the latent variable A was fixed at 0, assuming a null effect of genes on the variable. Results of the saturated ACE models and reduced AE, CE and E models for the parenting variables of Parental sensitivity and Parental negativity, as well as the partial CE and E models for Parental warmth/positivity are shown in Table 4.9.

With respect to Parental sensitivity, the saturated ACE model was found to be an adequate fit to the data ($\chi^2(6) = 3.79$, $p = .71$, AIC = 6038.4). This model yielded a relatively large estimate of the genetic component (33%) and the shared environment component (30%). Deletion of parameters C and A from the saturated ACE model led to significant alterations in the model fit - $\Delta\chi^2(1) = 7.46$, $p = .01$ and $\Delta\chi^2(1) = 7.35$, $p = .01$ respectively -, indicating that both genes and the shared environment significantly contributed to Parental sensitivity. Therefore, the full ACE model was selected as the best fitting model.

A similar pattern of genetic and environmental contributions was found in relation to Parental negativity. The saturated ACE model was found to be an adequate fit to the data ($\chi^2(6) = 5.51$, $p = .48$, AIC = 4887.22). According to the ACE model, genetic factors contributed to 29% of the total variance and the shared environment contributed to 31% of the total variance. Deletion of the shared environment component in the AE model caused a significant reduction of the model fit ($\Delta\chi^2(1) = 4.40$, $p=.04$). Similarly, deletion of the genetic component in the CE model caused a significant reduction in the model fit

($\Delta\chi^2(1) = 3.94$, p =.04). Even in relation to Parental negativity, the full ACE model was selected as the best fitting model.

Finally, with respect to Parent Warmth/ Negativity, the partial CE model was found to be an adequate fit to the data ($\chi^2(7) = 10.43$, p = .53, AIC = 4660.41), with the shared environment effect accounting for 44% of the total variance.

Table 4.9- *ACE Univariate Model-Fitting Statistics for Parental sensitivity, Negativity and Warmth/Positivity*

	Model	Model Statistics				Model Parameter Estimates		
		Chi square	*df*	*p*	AIC	A	C	E
Sensitivity	**ACE**	**3.79**	**6**	**.71**	**6038.4**	**.33** (.12-.58)	**.30** (.13- .51)	**.37** (.28 -.42)
	AE	11.25	7	.13	6043.86	.65 (.56 - .69)	-	.35 (.27 -.39)
	CE	11.14	7	.13	6043.75	-	.53 (.44 -.58)	.47 (.37 -.49)
	E	168.59	8	<.01	6119.15	-	-	1
Negativity	**ACE**	**5.51**	**6**	**.48**	**4887.22**	**.29** (.04- .48)	**.31** (.07 - .53)	**.40** (.28 -.46)
	AE	9.91	7	.19	4889.63	.60 (.44 - .69)	-	.40 (.26 -.50)
	CE	8.45	7	.29	4888.17	-	.51 (.36 -.60)	.49 (.34 -.57)
	E	107.28	8	<.01	4985.01	-	-	1
Warmth/Positivity	**CE**	**10.43**	**7**	**.53**	**4660.41**	**-**	**.44** (.36 - .50)	**.56** (.50 - .64)
	E	111.23	8	<.01	5321.12		-	1

Notes- AIC= Akaike Information Criterion; A= additive genetic; C= shared environment; E=non-shared environment. Best fitting models in bold

Furthermore, based on the results of our preliminary analysis, it was hypothesised that twin sex and family income could be confounding factors in the structure equation modelling. Therefore, possible interactions of these socio-demographic factors with genetic and environmental influences on parenting were also tested. Results of SEM analyses controlling for gender and family income in relation to Parental sensitivity and Parental negativity are presented in Table 4.10.

Even when potentially confounding socio-demographic variables were controlled for, ACE saturated models appeared to be the best fitting models for our data, with significant genetic and shared environmental effects on both Parental sensitivity and Parental negativity (See estimates in table 4.10). No significant difference was found between the Chi squares of the ACE models with and without controls (Sensitivity: $\Delta\chi^2(6) = 5.83$, $p = .43$; Negativity: $\Delta\chi^2(6) = 8.34$, $p = .21$) as well as between the Chi squares of the CE models for Warmth/Positivity ($\Delta\chi^2(5) = 7.80$, $p = .17$). Finally, the effects of both income and gender were null to very modest (<1%) across all models.

Table 4.10*- ACE Univariate Model-Fitting Statistics for Parental sensitivity, Negativity and Warmth/Positivity controlling for gender and family income*

	Model	Model Statistics				Model Parameter Estimates		
Parenting variable		Chi square	*df*	*p*	AIC	A	C	E
Sensitivity	**ACE**	**13.408**	**12**	**.34**	**5736.12**	**.35** (.13-.59)	**.30** (.11- .50)	**.35** (.28 -.42)
	AE	19.44	13	.11	5740.16	.66 (.53 - .67)	-	.34 (.27 -.38)
	CE	20.96	13	.01	5741.68	-	.53 (.42 -.56)	.47 (.37 -.50)
	E	166.24	14	<.01	5884.93	-	-	1
Negativity	**ACE**	**13.85**	**12**	**.31**	**4642.63**	**.34** (.08- .62)	**.27** (.05 - .50)	**.39** (.25 -.42)
	AE	28.46	13	.59	6378.73	.48 (.36 - .59)	- -	.52 (.36 -.64)
	CE	24.42	13	.79	6374.69	-	.44 (.32 -.53)	.56 (.46 -.67)
	E	121.34	14	<.01	4746.13			1
Warmth/Positivity	**CE**	**18.23**	**13**	**.81**	**4687.87**	**-**	**.43** (.35 - .50)	**.57** (.49 - .64)
	E	116.23	14	<.01	4827.12		-	1

Notes- AIC= Akaike Information Criterion; A= additive genetic; C= shared environment; E=non-shared environment. Best fitting models in bold

4.3.7. Cross-twin and within-twin correlations between Quality of Parenting and Attachment Security

Within-twin and cross-twin correlations for parenting and adolescent CAI coherence are presented in Table 4.11. Cross-twin correlations between Sensitivity and attachment were greater in MZ twins (*r*= .21) than DZ twins (*r*= .14), indicating some common genetic influence in the association between parental sensitivity and attachment coherence. The within-twin correlations were of similar magnitude to the cross-twin correlations for MZ twins (*r*= .18) and DZ twins (*r*= .16), which suggests that shared environment also plays a role in the association between sensitivity and adolescent attachment security. Nevertheless, despite the significance of the correlations between parental sensitivity and CAI coherence, Pearson's correlation coefficients were relatively small (see estimates in Table 4.11).

No other significant correlation (both within-twin and cross-twin) was found between parenting (i.e. parental negativity and warmth/positivity) and CAI Coherence. However, it is noted that, in relation to the association between Parental warmth/positivity and CAI coherence, both within-twin correlations and cross-twin correlations were greater for DZ twins than MZ, indicating no genetic effect.

Table 4.11- *Mean within-twin and cross-twin correlations for parenting and CAI Coherence*

	Sensitivity		Negativity		Warmth/Positivity	
	MZ	**DZ**	**MZ**	**DZ**	**MZ**	**DZ**
Within-twin correlation	.18**	.16**	-.04	.01	.04	.08
Cross-twin correlation	.21**	.14**	-.03	-.07	.10	.12

*Notes **p<.001*

Table 4.12 presents within-twin and cross-twin correlations for parenting and IPPA Total scores. It is noted that all correlation coefficients in relation to the association

between parenting and attachment were relatively small. Cross-twin correlations between Sensitivity and IPPA total scores were slightly greater in MZ twins (*r*= .08) than DZ twins (*r*= .06), indicating that genetic factors possibly play a role in the association between parental sensitivity and attachment coherence. However, these correlations were not significant. The within-twin correlations were of somewhat greater magnitude compared to the cross-twin correlations both for MZ twins (*r*= .25) and DZ twins (*r*= .21), which suggests that non-shared environment also plays a significant role in the association between parental sensitivity and adolescent attachment security.

Cross-twin correlations between Negativity and IPPA total scores were greater in MZ twins (*r*= -.14) than DZ twins (*r*= -.09), indicating some genetic influence in the association between the two measures. Similar to Parental sensitivity, the relatively greater magnitude of within-twin correlations (MZ: *r*= -.21, DZ: *r*= -.21) compared to cross-twin correlations indicated a significant contribution of the non-shared environment in the association between parental negativity and adolescent attachment security.

Finally, cross-twin correlations between Warmth/Positivity and IPPA total scores were greater in DZ twins (*r*= -.18) than MZ twins (*r*= .11), indicating no genetic influence in the association between the two variables. Furthermore, cross-twin correlations were of similar magnitudes of within-twin correlations (MZ: *r*= .12, DZ: *r*= .25), which indicates that the shared environment may play an important role in the association between parental warmth/positivity and attachment.

***Table 4.12**- Mean within-twin and cross-twin correlations for parenting and IPPA Total scores*

	Sensitivity		Negativity		Warmth/Positivity	
	MZ	**DZ**	**MZ**	**DZ**	**MZ**	**DZ**
Within-twin correlation	.25*	.21**	-.21**	-.21**	.12*	.25**
Cross-twin correlation	.08	.06	-.14*	-.09	.11*	.18**

*Notes **p<.001. *p<.05*

4.3.8. Bivariate genetic analysis

Estimates of the genetic and environmental effects on the covariance between parenting and attachment security were tested by using structural equation modelling via the statistical program Mplus 8. Similar to univariate genetic analyses on parenting, structural equation modelling could not provide a good fit for the Parent Warmth/ Positivity data, due to the greater magnitude of the correlation coefficients for DZ than MZ twins. Therefore, bivariate genetic analyses on the associations between Parental warmth/positivity and attachment security were carried out by fixing the latent variable A at 0, thus examining only the reduced CE and E models. Structural Equation Modelling was carried out including the saturated ACE models and the reduced AE models of the association between attachment and Parental sensitivity, as well as attachment and Parental negativity.

Table 4.13 presents the genetic and environmental contributions to the covariance between parenting variables and CAI Coherence. With respect to the association between Parental sensitivity and CAI coherence, the ACE saturated model provided a good fit for the data ($\chi^2(17) = 8.89$, $p = .94$, AIC = 10459.32). According to this model, both the genetic (31%) and the shared environment (29%) component fairly contributed to the association between attachment security and parental sensitivity. Furthermore, deletion of both the C component ($\Delta\chi^2(2) = 7.47$, $p = .02$) and the A component ($\Delta\chi^2(2) = 8.06$, $p = .02$) caused a significant decrease in the model fit, thus validating the significant contribution of both genes and the shared environment.

The ACE saturated model was also selected as the best fitting model in relation to the association Parental negativity and CAI coherence ($\chi^2(17) = 9.83$, $p = .91$, AIC = 9332.61), whereby genes and the shared environment contributed to 23% and 25% of

the total covariance respectively. However, deletion of the genetic ($\Delta\chi^2(2)$ = 4.41, p =.11) and shared environment components ($\Delta\chi^2(2)$ = 4.48, p =.10) did not lead to significant reduction of the model fit.

Finally, with respect to the association between Parental warmth/positivity and CAI Coherence, the CE model provided a good fit for the data ($\chi^2(19)$ = 8.64, p = .97, AIC = 8554.67), whereby the shared environment effect accounted for 44% of the covariance between the two variables.

Table 4.13- *Proportions of covariance between attachment security (CAI Coherence) and parenting (Parental sensitivity, Parental negativity and Parental warmth/positivity) due to Common Additive Genetic (A), Shared Environment (C) and Non-shared Environment (E)*

Variables	Model	Model Statistics				Model Parameter Estimates		
		Chi square	*df*	*p*	AIC	A	C	E
Sensitivity and Coherence	**ACE**	**8.89**	**17**	**.94**	**10459.32**	**.31** (.12-.58)	**.29** (.13- .50)	**.40** (.32 -.48)
	AE	16.36	19	.61	10463.06	.62 (.55 - .69)	-	.38 (.32 -.45)
	CE	16.95	19	.84	10331.06	-	.43 (.36 -.50)	.57 (.50-.67
	E	176.1	21	<.01	10619.12	-	-	1
Negativity and Coherence	**ACE**	**9.83**	**17**	**.91**	**9332.61**	**.23** (.04- .58)	**.25** (.07 - .54)	**.52** (.42 -.61)
	AE	14.24	19	.76	9331.64	.51 (.43 - .59)	- -	.49 (.41-.53)
	CE	14.31	19	.76	9060.95	-	.50 (.44-.61)	.50 (.41-.58)
	E	111.71	21	<.01	9426.48	-	-	1
Warmth/Positivity and Coherence	**CE**	**8.64**	**19**	**.97**	**8554.37**	**-**	**.44** (.36 - .50)	**.56** (.49 - .63)
	E	117.78	21	<.01	18659.51	-	-	1

Notes- AIC= Akaike Information Criterion; A= additive genetic; C= shared environment; E=non-shared environment. Best fitting models in bold

Table 4.14 illustrates the genetic and environmental contributions to the covariance between parenting and attachment security assessed via the IPPA total scores. With respect to the association between Parental sensitivity and IPPA Total scores, the ACE saturated model was selected as the best fitting model ($\chi^2(17)$ = 17.91,

p = .39, AIC = 14768.79). According to this model, genes and the shared environment contributed to 34% and 31% of the covariance between parenting and attachment security, respectively. Furthermore, deletion of both the C component ($\Delta\chi^2(2) = 7.49$, p =.02) and the A component ($\Delta\chi^2(2) = 7.64$, p =.02) led to significant reductions of the model fit.

Similarly, based on inspection of goodness of fit criteria, the ACE saturated model appeared to be the best fitting model for the association between Parental negativity and IPPA total scores ($\chi^2(17) = 19.20$, p = .31, AIC = 13627.21). According to this model, genes and the shared environment contributed to 24% and 25% of the covariance between negative parenting and attachment security, respectively. However, deletion of the C component ($\Delta\chi^2(2) = 4.75$, p =.09) and the A component ($\Delta\chi^2(2) = 3.25$, p =.19) from the ACE model led to non-significant reductions of the fit.

Finally, with respect to the association between Parental warmth/positivity and IPPA total scores, the CE model provided a good fit for the data ($\chi^2(19) = 18.61$, p = .19, AIC = 12852.79), and the shared environment effect accounted for 44% of the covariance between the two variables.

Table 4.14*- Proportions of covariance between attachment security (IPPA total scores) and parenting (Parental sensitivity, Parental negativity and Parental warmth/positivity) due to Common Additive Genetic (A), Shared Environment (C) and Non-shared Environment (E)*

Variables	Model	Model Statistics				Model Parameter Estimates		
		Chi square	*df*	*p*	AIC	A	C	E
Sensitivity and IPPA Total	**ACE**	**17.91**	**17**	**.39**	**14768.79**	**.34** (.12-.58)	**.31** (.12 .52)	**.45** (.33-.48)
	AE	25.40	19	.14	14771.90	.63 (.56- .69)	-	.37 (.31 -.43)
	CE	25.55	19	.14	14772.01	-	.52 (.46-.58)	.48 (.43-.55)
	E	14927.84	21	<.00	14921.84	-	-	1
Negativity and IPPA Total	**ACE**	**19.20**	**17**	**.31**	**13627.21**	**.24** (.04-.58)	**.25** (.07 - .52)	**.51** (.42 -.60)
	AE	23.95	19	.19	13627.98	.50 (.43 - .59)	- -	.50 (.41-.56)
	CE	22.45	19	.26	13626.37	-	.42 (.36 -.50)	.58 (.49-.64)
	E	148.65	22	<.00	13746.67	-	-	1
Warmth/Positivity and IPPA Total	**CE**	**18.16**	**19**	**.91**	**12852.79**	**-**	**.44** (.36- .50)	**.56** (.49 - .63)
	E	131.79.	21	<.01	12962.35	-	-	1

Notes- AIC= Akaike Information Criterion; A= additive genetic; C= shared environment; E=non-shared environment. Best fitting models in bold

The same analyses were subsequently conducted controlling for gender and family income. Table 4.15 shows the results of genetic analyses on the covariation between parenting and CAI Coherence controlling for gender and family income. The ACE saturated models appeared to be the best fitting models for the data (see coefficients in Table 4.15). Compared to the ACE models without controls, differences in the model fits were non-significant (Parental sensitivity and CAI Coherence: $\Delta\chi^2(12) = 10.79$, $p = .54$; Parental negativity and CAI Coherence: $\Delta\chi^2(12) = 12.18$, $p = .43$). Similarly, the difference between the CE models with and without controls in relation to the association between Warmth/Positivity and CAI Coherence was not significant ($\Delta\chi^2(12) = 5.45$, $p = .94$). In addition, the effects of both income and gender were null to very modest (<1%) across all models.

***Table 4.15**.- Proportions of covariance between attachment security (CAI Coherence) and parenting (Sensitivity, Negativity and Warmth/Positivity) due to Common Additive Genetic (A), Shared Environment (C) and Non-shared Environment (E) controlling for gender and family income*

Variables	Model	Model Statistics				Model Parameter Estimates		
		Chi square	*df*	*p*	AIC	A	C	E
Sensitivity and Coherence	**ACE**	**19.68**	**29**	**.90**	**10153.29**	**.32** (.12-.57)	**.28** (.10- .49)	**.40** (.32 -.47)
	AE	25.94	31	.72	10155.55	.60 (.53 - .65)	-	.40 (.31 -.44)
	CE	26.99	31	.67	10156.61	-	.51 (.43 -.54)	.49 (.43-.54)
	E	175.27	33	<.01	5884.93	-	-	1
Negativity and Coherence	**ACE**	**22.01**	**29**	**.81**	**9061.49**	**.25** (.05- .57)	**.25** (.07 - .51)	**.50** (.40 -.59)
	AE	26.16	31	.71	9061.64	.52 (.44 - .59)	- -	.48 (.39-.54)
	CE	29.47	31	.77	9060.95	-	44 (.36 -.50)	.56 (.49-.62)
	E	126.01	33	<.01	9157.49	-	-	1
Warmth/Positivity and Coherence	**CE**	**13.61**	**31**	**.99**	**8554.37**	**-**	**.43** (.35 - .50)	**.57** (.49 - .64)
	E	116.17	33	<.01	8677.21	-	-	1

Notes- AIC= Akaike Information Criterion; A= additive genetic; C= shared environment; E=non-shared environment. Best fitting models in bold

Table 4.16 illustrates the results of genetic analyses on the covariation between parenting and IPPA total scores controlling for gender and family income. Even when these socio-demographic factors were controlled for, the ACE saturated models appeared to be the best fitting models for the association between attachment security and Parental sensitivity and Negativity (see coefficients in Table 4.16). The effects of both income and gender were null to very modest (<1%) across all models. Compared to the ACE models without controls, differences in the model fits were non-significant (Parental sensitivity and IPPA: $\Delta\chi^2(12) = 10.79$, p =.54; Parental negativity and IPPA: $\Delta\chi^2(12) = 12.18$, p =.43). Similarly, the difference between the CE models with and without controls in relation to the association between Warmth/Positivity and IPPA total scores was not significant ($\Delta\chi^2(12) = 5.63$, *p* =.93).

Table 4.16. *Proportions of covariance between attachment security (IPPA total scores) and parenting (Sensitivity, Negativity and Warmth/Positivity) due to Common Additive Genetic (A), Shared Environment (C) and Non-shared Environment (E) controlling for gender and family income*

Variables	Model	Model Statistics				Model Parameter Estimates		
		Chi square	*df*	*p*	AIC	A	C	E
Sensitivity and IPPA Total	**ACE**	**31.77**	**29**	**.35**	**14408.21**	**.32** (.12-.57)	**.28** (.10- .49)	**.40** (.32 -.48)
	AE	34.41	31	.19	14410.45	.59 (.53 - .65)	-	.41 (.31 -.44)
	CE	38.72	31	.16	14557.32	-	.51 (.42 -.56)	.49 (.41-.55)
	E	188.23	33	<.00	5884.93	-	-	1
Negativity and IPPA Total	**ACE**	**28.51**	**29**	**.49**	**13309.71**	**26** (.05- .59)	**.24** (.07 - .51)	**.50** (.42 -.57)
	AE	33.06	31	.36	13301.25	.51 (.44 - .59)	- -	.49 (.40-.54)
	CE	32.32	31	.14	13309.51	-	.45 (.36 -.50)	.55 (.50-.64)
	E	162.38	33	<.00	13433.57	-	-	1
Warmth/Positivity and IPPA Total	**CE**	**23.79**	**31**	**.81**	**12539.22**	**-**	**.43** (.36- .50)	**.57** (.49 - .63)
	E	131.53	23	<.01	12643.65	-	-	1

Notes- AIC= Akaike Information Criterion; A= additive genetic; C= shared environment; E=non-shared environment. Best fitting models in bold

4.4. Discussion

The first goal of the current study was to explore the extent of genetic and environmental contributions to the variation in the quality of parenting. The parenting variables of Sensitivity, Negativity and Warmth/Positivity were obtained from the adaptation of two of the most widely used observational measures (the FICS and the CARP) assessing a range of parental behaviours assumed to be relevant for attachment security. The assessment of parenting through observational measures on a very large sample is the main strength of the current study, as the presence of multiple coders and frequent checks on inter-rater agreement improves reliability of the results and reduces

systematic error present in self-report measures (e.g. O'Connor et al., 2018; Scott, Briskman, Woolgar et al., 2011).

Descriptive analyses revealed that intra-class twin-correlations were higher for MZ twins compared with DZ twins for both parental sensitivity and negativity. These findings indicate possible genetically-based child effects on these aspects of the quality of parenting. This was further supported by results of structural equation modelling, according to which evocative genetic effects on parenting roughly contributed to 30% of the variance of both parental sensitivity and negativity. These findings suggest that adolescent's genetically determined characteristics influence, at least in part, the quality of parenting they receive. These results are in line with previous studies reporting that the genetic characteristics of the child influence a wide range of parenting behaviours (Avinun & Knafo, 2014; Klahr & Burt, 2014).

Moreover, findings from the current study indicate that variance in parenting is also attributable to a significant effect of shared environmental experiences, amounting roughly to 25% for both sensitivity and negativity. That is, some aspects of parenting are likely to be experienced equally between siblings, possibly due to stable personality traits and characteristics of the parents.

With respect to parental warmth/ positivity, it was found that intra-class correlations were relatively high for both DZ and MZ twins. In particular, the almost identical magnitude of both within-twin and cross-twin correlation coefficients for DZ twin and MZ twins indicated that the effect of genes on this parenting variable were practically absent. Furthermore, these coefficients possibly indicate an important contribution of the shared environment. It has been reported that parents of non-identical twins may tend to exaggerate the differences between their children than what can be explained by genetic differences, that is a phenomenon known as contrast effect

(Saudino, 2003). Normally, contrast effects are assumed to reduce the dizygotic twin correlation relative to that in monozygotic twins and produce higher DZ than MZ variance (Eaves & Silberg, 2005). In the current study, it appeared that the observed parental warmth/sensitivity was not subject to the contrast effect, contrary to what it is expected, at least to some degree, in twin studies. Consistently with the systematic review by Klahr & Burt (2014), this validates the hypothesis that some parental qualities, such as different degrees of warmth, laughter, general positivity, kindness and enthusiasm –all aspects that are captured by the scales of Warmth and Positive Mood- are relatively stable characteristics of the parents' personalities, and are displayed relatively equally in the relationships with both twins, independently of their zygosity.

Taken together, twin correlations and genetic analyses in the current study clearly suggested that adolescents' individual characteristics explained by genes do not shape parental warmth and positivity in the same way they do with parental sensitivity and negativity. In other words, these findings emphasise that different characteristics of parenting present different rGEs: while to some degree adolescents' genes elicit parental behaviours expressed through sensitivity and negativity, parental warmth and positivity are likely to be more passively experienced. Considering that the vast majority of the assessed parent-child interactions in the current study took place with mothers, this is in line with previous studies (e.g. Niederhiser et al., 2004, 2007) showing that warmth tends to be a general pattern of behaviour in mothers, hence possibly displayed equally to all family members. However, findings from prior studies (e.g. Marceau et al., 2015) indicated that evocative *r*GE has a greater role for parental positivity in families with older adolescents than in families with younger adolescents, while passive *r*GE was shown to play a stronger role for parental positivity in families with younger adolescents. It is therefore possible that the rGEs found in the current study could change if analyses were conducted on an older sample of adolescent twins.

The second goal of the current study was to analyse the extent to which genetic and environmental factors underlie associations between the quality of parenting and adolescent attachment security, the latter being assessed both via the CAI and the IPPA. It is noted that within-twin correlations (i.e. the phenotypic correlations of parenting and attachment security for one twin) and cross-twin correlations (i.e. the means of the correlations between parenting for one twin and attachment security for the other twin) across all parenting variables (i.e. Parental sensitivity, Negativity and Warmth/Positivity) and attachment measures (the CAI and the IPPA) were relatively weak. In particular, correlations between parenting and CAI coherence were statistically significant only in relation to parental sensitivity, while parental negativity and warmth/positivity were not significantly associated with CAI Coherence. These results are in keeping with previous studies finding different degrees of correlations between parental sensitivity and warmth/positivity with adolescent attachment (e.g. Scott et al., 2011; Joseph et al., 2014).

On one hand, these findings validate the relatively limited contribution of the quality of parenting in relation to attachment security in adolescence compared to infancy, in line with previous studies finding low estimates of the variation of adolescent attachment security accounted for by parenting (Allen & Hauser, 1996; Matsuoka et al., 2016). On the other hand, these findings consolidate the role that parental sensitivity, unlike other aspects of the quality of parenting, has occupied in traditional attachment theory as an important determinant of attachment security across development (e.g. Beijersbergen et al., 2012), and possibly demonstrate the validity of the adapted measure in the current study. Because parental sensitivity was best explained by passive and evocative rGE, while parental positivity was exclusively explained by passive rGE, then it would make sense that a parent's sensitive response to their adolescent children may have more of an influence on the adolescents' attachment

organisation than would the parent's warmth. Indeed, the former is more recognised as a specific response to the individual adolescent, while the latter represents a general behavioural pattern or personality trait of the parent.

However, with respect to Parental negativity and Warmth/Positivity, it was found that both parenting variables showed significant phenotypic correlations with IPPA total scores. In other words, while parental negativity and warmth/positivity did not seem to affect the adolescent's unconscious attachment representations reflected in narrative coherence (assessed via the CAI), they were found to be associated with the adolescent's conscious representations of the overall quality of relationships with parents (assessed via the IPPA). These results once again highlight the discrepancies between the CAI and the IPPA, and consolidate the idea that the two instruments assess different aspects of attachment, as extensively reported in the second chapter.

Nevertheless, by combining results from phenotypic correlations and bivariate genetic analyses, it is noticeable that genetic factors played an important role in the association between parental sensitivity and attachment security, regardless of whether the latter was assessed via the CAI or the IPPA. Indeed, genes accounted for the covariance between parenting and attachment by more than 30% for both measures. This finding is in line with the study by Pike et al. (1996), which found common genes accounted for most of the association between parental negativity and adolescent adjustment. Moreover, this confirms the hypothesis by Fearon et al. (2014) that common genetic factors mediate the association between adolescent attachment and parenting. More specifically, based on the current findings, genetically determined characteristics in the adolescent may elicit different degrees of *sensitivity* in the parent, which in turn leads to changes in the adolescent's both conscious and unconscious attachment representations within the parental relationship.

Similarly, with respect to parental negativity, it was found that the ACE model was the best fitting model accounting for the association between this aspect of parenting and attachment. However, deletion of the genetic or the shared environmental factors did not significantly alter the goodness of model fit. This implies that findings of the current study regarding the role of genes and shared environment in the association between parental negativity and attachment security are inconclusive.

Finally, this study also highlighted the importance of the non-shared environment in determining both the quality of parenting and the association between parenting and attachment security. Indeed, univariate genetic analyses on parenting showed that roughly 35%-40% of the variance in parental sensitivity and negativity, and up to 57% of the variance in parental warmth/ positivity was accounted for by the non-shared environment. That is, the quality of parenting in parent-child relationships differs by a large extent among siblings within the same families. It is a known fact that differential parenting tends to increase as siblings grow older, mirroring their progressively increased autonomy and importance of relationships outside the family context (e.g. Allen & Land, 1999). As previously reported, it has also been documented that a progressively larger part of the variance in attachment security is attributable to the non-shared environment as age increases. This evidence was obtained through assessing adolescent attachment through both the CAI (Fearon et al., 2014) and the IPPA (see previous chapter). Based on results from the current bivariate analyses, the association between parenting and attachment security was accounted for by roughly 40- 60% by the non-shared environment. Combining these findings, it is possible to argue that differential parenting in adolescence has a significant impact on attachment organisation. In other words, the current investigation validates the hypothesis that the ongoing parenting contributes to some extent to the unique individual experiences involved in development of adolescent attachment security and insecurity.

Limitations and directions for future research

There were a few methodological limitations to the current study which should be considered and possibly addressed by future research.

Some of these limitations concerned the features of the sample being investigated.

Firstly, as it was mentioned in the previous chapters, the sample was predominantly white British and generally from a middle class background. This implies that disadvantaged communities and minority ethnicities were under-represented. As reported in the introduction of this chapter, the interrelation between parenting and attachment largely varies depending on the levels of risk within the family context (e.g. Joseph et al., 2014; O'Connor et al., 2018). Thus, despite the good power due to a large sample size, the sample's socio-demographic characteristics may limit the generalisability of the current findings.

Furthermore, 93% of the interactions during the HTRT took place between adolescents and their mothers. As a consequence, the findings of the current study might not be generalised to father-adolescent interactions. Considering the limited existing literature on adolescent attachment and quality of parenting of fathers, further research on it is needed for a more complete understanding of the matter.

Additionally, the majority of participants reported moderate to high scores of CAI coherence and IPPA total scores. This corresponds to secure or dismissing attachment classifications, with a low representation of preoccupied and disorganised classifications (see second chapter), which may be more prevalent in high-risk samples. Further

research is needed to test whether parenting and attachment present similar genetic and environmental influences in more diverse populations.

Other important limitations were in relation to the HTRT procedure and video recordings.

Firstly, it has been previously pointed out that the use of observational measures is the only way to assess the quality of interactions independently of the participants' biases and it is overall considered as a strength of the current study. Nevertheless, the participants' experience of being observed during the task might have reduced ecological validity of the current methodology. Indeed, to videotape parent-child interactions the camera was placed in front of the dyad and set up by a researcher who then instructed the pair to accomplish the HTRT, regardless of whether this took place in laboratory or at home. In this way, the dyad's attention was inevitably drawn toward the camera at least during the first part of their interaction. This could have been avoided by conducting the task in rooms already set up with a camera in a corner to minimise its obtrusiveness. While the majority of adolescents and their parents did not explicitly address the presence of the camera, a small number of dyads appeared to be preoccupied by it. For example, a few dyads would laugh nervously while looking at the camera; others would refer to possible reactions of the person who would watch the recording later on. In general, it is possible that some dyads never forgot to be observed throughout the task and therefore might have altered their behaviour in the attempt to present a socially desirable impression. Therefore, when interpreting the results, it has to be taken into account that the time for the participants to get used to the experience of being observed (8 minutes in total) was very limited. However, the way that parent and adolescent managed to overcome any awkwardness around the presence of the camera was itself considered as an indicator of their relationship, (e.g. through sensitively

responding to the uncomfortableness, through sarcasm, etc.) and was therefore reflected in the scores.

Secondly, the limited time of the HTRT also made it difficult to assess all scales of the FICS and the CARP for each participant, as some interactions did not provide evidence of aspects of the scales in that time. For example, part of the scores of sensitive responding was based on how the parent responded to the adolescent's verbal and non-verbal behaviour, such as signs that the adolescent is 'stuck' during the task. This simply did not happen in many interactions where both components of the dyad were equally involved.

Finally, it turned out to be challenging to obtain adequate inter-rater reliability in relation to some scales due to the coders' different cultural backgrounds. For instance, part of the score for Anger/Rejection was based on nonverbal signs of irritation, criticism, mistreatment. The coders' socio-cultural representations of anger and its manifestations varied considerably, which brought them to frequently adjust their scores taking into account both the criteria illustrated in the guidelines and other coders' judgements. These obstacles were minimised through frequent inter-rater reliability checks.

4.5. Conclusions

This study has the merit of elucidating the role of the current quality of parenting in determining genetic and environmental influences on attachment organisation in adolescence. Examination of different aspects of parenting brought to light different types of rGEs and phenotypic correlations. While the associations between attachment security and parental sensitivity and negativity seemed to be supported by both genetic

and environmental influences, genes were not found to contribute to the association between attachment security and parental warmth/positivity.

Importantly, the current findings show that the quality of parenting is significantly accounted for by the shared environment. Similarly, shared environmental influences account for an important degree of correlation between parenting and attachment, in line with classic attachment theory. In particular, maternal *sensitivity* appears to have an effect on adolescent attachment security, regardless of whether this is conceptualised as the adolescent's ability to think coherently about attachment experiences or the adolescent's conscious perception of the quality of their relationship with parents.

Finally, because the number of fathers participating in this study was limited, further research examining father-adolescent interactions is needed.

Chapter 5

Conclusions

The overall focus of this thesis was the exploration of the genetic and environmental influences on attachment organisation in adolescence.

As emphasised throughout the thesis, adolescence represents a key period in the life span for attachment organisation. In this life phase, Internal Working Models of attachment developed during infancy and childhood are modified under the influence of psychological, social and most likely biological forces. Attachment security in adolescence is linked to overall adjustment and risk for psychopathology, thus significantly impacting quality of life and wellbeing at this age, and at later stages (e.g. Scott et al., 2011; Allen et al., 2007). There is thus a pressing need to understand the factors that affect attachment at this stage of the lifespan.

Nonetheless, despite its importance, adolescent attachment organisation has been widely overlooked in the behavioural genetic literature. To date, the only well-powered behavioural genetic study on adolescent attachment security was carried out by Fearon et al (2014), finding that genes accounted for a large proportion of the variance in attachment security as measured via the Child Attachment Interview, while the role of the shared environment was negligible. These findings contrasted markedly with earlier behavioural genetic studies conducted with infants and young children, where genes were not found to play a significant role in determining attachment security, whereas the shared environment was found to be pre-eminent (Roisman & Frailey, 2008; Bokhorst et al., 2003; O'Connor et al., 2001). This shift was explained by the authors (Fearon et al., 2014) in terms of an increasingly predominant genetic bias in the organisation of attachment coming into play between infancy and adolescence, during a critical phase of developmental reorganisation and change. More specifically, an individual's genes were suggested to support the shift in attachment from a primarily behavioural and relational construct to one that is more cognitive in nature, resulting in a more generalised state of mind that over time becomes shaped in important ways by individual dispositions and vulnerabilities that are themselves partly heritable. Furthermore, the authors speculated about another possible route via which genes

influence attachment in adolescence – namely through gene-environment correlation (rGE). They argued that children's genetic propensities may gradually begin to evoke changes in the quality of care provided by their parents, which in turn leads to changes in the children's feelings of security. In other words, the quality of parenting displayed in daily interactions and adolescent attachment organisation could be accounted for by an evocative type of rGE.

Nonetheless, evidence of these hypotheses has never been provided before. Similarly, findings from Fearon et al (2014) have never been replicated by further well-powered behavioural genetic studies.

The three empirical studies presented in this thesis built on the seminal research carried out by Fearon et al. (2014), aiming to replicate these findings by using different assessment methods and investigate on some of the possible mechanisms underlying the increasing genetic influence on attachment security in adolescence. The normative sample of adolescents tested in the current studies was the same sample examined in the study by Fearon et al (2014), consisting originally of 582 same-sex twin pairs with an average age of 15.

5.1. The main findings

5.1.1. Study 1 - Measuring attachment security in adolescence: a comparison between the Child Attachment Interview and the Inventory of Parent and Peer Attachment

Fearon et al (2014) claimed that their findings were highly noteworthy because the tool used, namely the Child Attachment Interview, represents what many in the field of attachment would consider the most valid way to measure attachment in

adolescence (Shmueli-Goetz et al., 2008). One of the main strengths of the CAI consists in accessing aspects of attachment representations that are outside conscious awareness, through examining the adolescent's cognitive, emotional, and behavioural reactions to separation, intimacy, and perceived abandonment from their caregivers.

However, the CAI is only one of several approaches to assessing attachment security in young populations. Indeed, during adolescence the substantial intra-psychic transformations and the evolving constellations of relationships make the operationalisation of attachment far more complex than earlier phases. In current research on attachment in adolescence, researchers use a range of tools that tap into different components of attachment, without a clear scientific consensus over a "gold standard" measure (Jewell et al., 2019). As illustrated in depth in the second chapter, an alternative approach to interview-based measurement of attachment security consists in the administration of self-report measures. These tools are widely used by researchers, especially in the field of Social Psychology, as they combine validity of measurement with cost-and time-effectiveness. However, these two approaches (i.e. interview-based and self-reports) differ substantially, in that interviews are normally devised to trigger automatic and unconscious representations linked to attachment, whereas self-reports generally require more conscious processing regarding the perception of the quality of the relationships with specific attachment figures (Crowell, Fraley & Shaver, 2008).

These assumptions led to a critical question with respect to Fearon et al's (2014) original conclusions, namely whether the adoption of different instruments and methodologies to assess attachment security in adolescence could yield different

genetic and environmental contributions to adolescent attachment organisation. One of the fundamental research inquiries addressed in this thesis – more specifically, in the second study- was whether findings from Fearon et al. (2014) could be replicated through the administration of the Inventory of Parent and Peer Attachment (Armsden & Greenberg, 1987). Although the IPPA does not differentiate among attachment styles as classic attachment theorists would call for (Ainsworth et al., 1978), this instrument allows investigating the adolescent's conscious perception of the quality of relationships with mother and father separately, in addition to peer affiliations, in contrast to the CAI which does not yield statistically distinct information about different attachment relationships. The attachment- related components within in each specific relationship assessed via the IPPA are 1) perceived trust, referred to as understanding, respect and mutual trust; 2) communication, interpreted as the perceived extent and quality of communication within the relationship, and 3) alienation, intended as the negative affective experiences of anger or hopelessness resulting from unresponsive or inconsistently responsive attachment figures.

The first preliminary study presented in this thesis aimed to examine the associations between the different IPPA and CAI measures of parental attachment security. In line with prior studies (e.g. Venta et al., 2014), higher scores in IPPA Trust and Communication were associated with a secure attachment classification and higher scores for coherence in the CAI in relation to both parents. By contrast, scores on self-reported Trust and Communication progressively decreased across secure, dismissing and preoccupied participants according to the CAI attachment classification. This indicated that the quality of perceived trust and communication within parent-adolescent relationships are linked with, and may be indicators of, attachment security in adolescence as assessed using the CAI. However, it is important to note that the correlations between these scales of the IPPA and the CAI were not strong (r<.30).

Thus, although these measures seem to pick up linked processes, as one would hypothesise, they do not appear to be interchangeable or synonyms, and predominantly capture distinct constructs.

By contrast, lower scores for alienation were associated only with preoccupied attachment, with secure and dismissing adolescents in the CAI reporting similar average scores. It is notable that in this study, in line with previous research on normative populations, adolescents with dismissing attachment assessed via the CAI represented the majority of the participants (55.2%). This is likely to reflect a common trend in adolescence, namely consisting in a gradual and somewhat intentional shift in the focus of adolescents' attachment system from parents to peers and romantic partners. Additionally, no correlations were found between IPPA Alienation and CAI Coherence. These findings suggested that a certain degree of emotional disconnection from parents is not indicative of dysfunctional attachment and does not impact general attachment representations reflected in the adolescent's narratives. rThese findings possibly substantiate the importance of broadening the investigation of the mechanisms underlying adolescent attachment organisation beyond the family context, possibly including the quality of peer relationships, romantic relationships and other relationships that are part of the adolescent's individual experiences. Indeed, it has been widely documented that behavioural autonomy and self-determination are core developmental tasks of adolescence, which are linked to the adolescent's proclivity to extend their sources of safety and support beyond their relationship with caregivers (e.g. Allen & Manning, 2007). Findings from the first study presented in this thesis are in line with this notion and possibly support the idea that the exclusive focus on the current parent-adolescent relationship can be only in part indicative of a phenomenon as complex as adolescent attachment organisation.

The second goal of the first study was to establish whether a dimensional (based on the single subscales and total scores) or a categorical approach (based on different distributions of the scores) to the IPPA affords a better prediction of attachment status as assessed through the CAI. Although prediction of the CAI is not the only benchmark that could have been chosen, it is a useful one given their common theoretical underpinnings and the focus in this thesis on these measures and their inter-relations. Although it is commonplace to treat attachment constructs as categorical variables, this has been questioned by many authors, and also tends to reduce statistical power (e.g. Zachrisonn, et al., 2011). It is important therefore to consider whether a categorical approach yields more than an otherwise more statistical satisfactory continuous operationalisation. The models chosen to address this consisted of multiple linear regressions (with CAI coherence as response variable) and multinomial logistic regressions (with CAI classification as a response variable), with IPPA measures (total scores, subscales and classifications) as predictors - see second chapter for further detail. Model comparison showed that regression coefficients tended to favour IPPA total scores over all other measurements, whereas IPPA classifications as predictors did not improve the strength of the associations between IPPA and CAI measures. Although not conclusive on their own, these results alongside the statistical benefits of a continuous approach favoured the use of the continuous IPPA measures, which were utilised in all the later chapters of this thesis.

Nevertheless, the most critical result found through model comparison was the relative weakness of coefficients of determination in all candidate models in relation to CAI measures (both Overall Coherence and attachment classification). This corroborates the idea that the IPPA and the CAI tackle into distinct aspects of adolescent attachment organisation. This is in line with the assumption that the attachment construct in adolescence is inherently difficult to measure, given the fluidity

and complexity of attachment representations typical of this developmental phase. The choice to utilise either the CAI or the IPPA to test attachment security in adolescent populations should be determined according to specific research purposes and goals, as both tools provide valuable and complementary insights on different aspects related to attachment security. In addition, it is possible that latent variables which were not taken into consideration in the study mediate the impact of IPPA parental measures on CAI measures. In other words, it is plausible that important factors other than levels of trust, communication and alienation perceived within current parent-adolescent relationships affect the adolescent's ability to think about attachment in its generality – as assessed through the CAI. Once again, this suggests that important relationships and experiences outside the family context ought to be taken into account when examining attachment security in adolescence.

5.1.2. Study 2- A behavioural genetic study on parent and peer attachment security in adolescence

The findings from the first study informed the design of the second investigation presented in this thesis, namely an exploration of the genetic and environmental determinants of adolescent attachment through the administration of the IPPA. This study was the first of its kind to provide behavioural genetic evidence regarding the differential aetiology of attachment-related constructs in adolescent-mother relationships and adolescent-father relationships assessed separately. This distinction is important, as a significant body of research shows that the association between child outcomes and mothers' and fathers' quality of parenting are influenced by different types of rGEs (e.g. Marceau et al., 2013; Niederhiser et al., 2007; Videon 2005).

The results showed that all components of the perceived quality of relationships with both parents (trust, communication and alienation), as well as the association between maternal and paternal attachment were significantly influenced by genes. However, the distinct assessment of attachment security in relation to mother and father revealed different degrees of shared environmental influence in relation to these two outcomes. Indeed, while the contribution of the shared environment was negligible across IPPA maternal subscales, the same effect was consistently strong in relation to father trust, communication and total scores (33%). A small portion of the variance of father alienation (roughly 17%) was also accounted for by the shared environment. This implies that the attachment- related components within the father-adolescent relationship tend to be more similarly experienced between siblings compared to the same attachment components within the mother- adolescent relationship. Taken together, these results might be reflective of the fact that daily mother-child interactions are primarily, or more strongly, driven by adolescent's individual characteristics and behaviours, whereas the quality of father- adolescent relationships might be partly determined by fathers' reactions to stable factors affecting the family system, such as socio-economic status, quality of marital relationship or father's own personality traits, as reported in the literature (Pike et al., 2016; Niederhiser et al., 2007; 2004).

Another important goal of this study was to explore the genetic and environmental contributions to the association between the perceived quality of parental and peer relationships. Classic attachment theory posits that early interactions with caregivers form a blueprint for functioning in other key relationships. In particular, Internal Working Models of attachment developed in the context of relationships with caregivers are thought to play an important role in other meaningful relationships throughout the lifespan, including relationships with peers and romantic partners (e.g. Fonagy & Target, 1996). However, the quality and stability of peer relationships from

early adolescence are known to have a crucial impact on adult attachment security (e.g. Allen, Grande, Tan & Loeb, 2017) and other findings support the idea that, in the passage from childhood to adolescence, the increasing involvement of young people in social relationships and their rapidly developing cognitive skills may facilitate the reorganisation of the existing attachment system (e.g. Allen & Miga, 2010). Findings from the current work substantiate this hypothesis. Indeed, phenotypic correlations between parental and peer IPPA measures were relatively weak. Furthermore, the associations between parent and peer IPPA attachment-related components were found to be mainly influenced by genetic and non-shared environmental effects.

However, some shared environmental effects were found to account for part of the covariance between father and peer IPPA scores of trust and communication. In other words, the currently perceived level of trust and the quality of communication in the father-adolescent relationship of one twin predicts their own and the other twin's perceived level of trust and quality of communication in the relationship with peers. These findings imply that, to some extent, stable features affecting the current father-adolescent relationships are passively experienced by siblings and are to some extent replicated in their relationships with peers.

In summary, findings from the second study are partly in keeping with Fearon et al (2014), in that they confirm that genetic factors come to the fore during the recollection of attachment experiences, independently of the assessed attachment figure and the modality through which recollection is elicited – i.e. both via the IPPA and the CAI. This is in line with the assumption that genetic heritage becomes an increasingly predominant source of individual differences in complex traits throughout development

(Plomin, 2018) and that early stages of sexual maturation may constitute a 'switch-point' in the development of attachment strategies (Del Giudice, 2009). Therefore, while in early stages of the lifespan attachment formation appears to a great extent parent-driven, by adolescence individuals become increasingly capable of selecting, modifying and influencing their environment in an active way, possibly in virtue of a greater independence and behavioural autonomy from the family. Nonetheless, the significant contribution of the shared environment to the association between father and peer attachment suggests the additional hypothesis that attachment representations in adolescence are not entirely driven by genes and unique individual experiences. Instead, the current results find some evidence for classic attachment theories, according to which relationships with caregivers are driven primarily by interactions within those relationships and that the parent's personality and indeed their own attachment history, may play an important part in this process.

5.1.3. Study 3 - A behavioural genetic study on parenting and attachment security in adolescence

The third and final study of this thesis consisted of an exploration of the relative contribution of genetic factors to the quality of parenting and its association with adolescent attachment security. The main purpose of this research was to test the hypothesis by Fearon et al (2014), according to which adolescent attachment organisation could be determined by processes of evocative rGE, namely consisting of an increasing tendency of adolescent's genes to elicit parental behaviours that are relevant for attachment security (or insecurity).

To address this, an initial step was to examine the degree of genetic and environmental contribution to variation in the quality of current parenting in parent-adolescent interactions, the latter being assessed through observational measures of a range of parenting behaviours during a conflict resolution task. For this purpose, the Family Interaction Coding System and the Coding of Attachment Related Parenting were integrated and adapted to obtain 13 rating scales of parenting and dyadic measures. An exploratory factor analysis led to a three-factor structure of the quality of parenting, consisting of Parental Sensitivity, Negativity and Warmth/Positivity.

The dimensions of parental sensitivity, negativity and warmth/positivity reflected different degrees of genetic and environmental influence. Indeed, genetic effects on parenting were found to contribute to roughly 30% of the variance in both parental sensitivity and negativity, suggesting that adolescent's genetically determined characteristics influence some aspects of the quality of parenting they receive. Both parental sensitivity and parental negativity showed some influence of the shared environment and to a similar extent (30% and 31%, respectively). By contrast, parental warmth/ positivity was found to be largely accounted for by the shared environment (44%), while genetic influences on this parenting variable were effectively null. This indicates that parents' warmth and positive mood are linked to relatively stable characteristics of their personalities, and are displayed relatively equally in the relationships with both twins.

Subsequent analyses looked into the contributions of genetic and environmental factors underlying associations between the quality of parenting and adolescent attachment security, the latter being assessed both via the CAI

and the IPPA. Importantly, the three-factor structure of the quality of parenting found in this study – i.e. parental sensitivity, negativity and warmth/positivity - mirrors previous findings obtained by using observational measures to test the correlation between current parenting and attachment security in adolescents. According to this body of research, parental sensitivity and mutuality in the parent-adolescent dyad appear to be the most relevant characteristics in determining attachment security (Joseph et al., 2014; Scott et al. 2011; Roisman et al., 2011). In the current study, scores of mutuality represented one of the variables loading on Parent Sensitivity. By contrast, the literature has consistently reported non-significant associations between parental warmth and adolescent attachment security (Herschenberg et al., 2011; Kerns, et al., 2000) and parental negativity appears in general to exert negligible influence on adolescent attachment security (Scott et al., 2011; Herschenberg et al., 2011; Roisman et al., 2001).

Similar patterns of correlations were found in the current study, in particular when attachment security was assessed through the CAI. Indeed, significant correlations between parenting and CAI Coherence were found only in relation to parental sensitivity, while parental negativity and warmth/positivity were not significantly associated with CAI Coherence. These findings, when combined with the aforementioned studies from the literature, provide further evidence in support of the construct validity of the CAI and for the specific role of sensitivity in secure adolescent attachment.

A noteworthy finding from bivariate genetic analyses was the significant role played by genetic factors in the association between parental sensitivity and attachment security, the latter being assessed both via the CAI and the IPPA. More specifically, 31% of the covariance between CAI Coherence and Parental Sensitivity

and 34% of the covariance between IPPA Total scores and Parental Security were accounted for by genes. This in part substantiates the intuition by Fearon et al (2014) according to which adolescent attachment organisation could be determined by evocative rGEs. More specifically, genetically determined characteristics in the adolescent appear to elicit different degrees of *sensitivity* in the parent, which in turn are likely to influence adolescent's both conscious and unconscious attachment representations within the parental relationship assessed via the IPPA and the CAI, respectively.

It is noted that parental sensitivity did not appear to be entirely elicited by adolescents' genes, as shown by the relatively significant contribution of the shared environment to this parenting variable. Similarly, roughly 30% of the covariance between parental sensitivity and attachment security was accounted for by the shared environment, regardless of whether attachment security was measured via the CAI or the IPPA. This implies that attachment security for one twin could be in part estimated from the quality of parenting shown towards the other twin as well as from their own parenting. These findings show that attachment in adolescence is not entirely child-driven, but also in part determined by a quality of the environment that is parent-driven.

Furthermore, findings from the current study indicate that variance in parenting as well as the covariance between parenting and attachment security are also attributable to twin-specific environmental experiences. That is, the degree of parental sensitivity, negativity and warmth/positivity in parent-child relationships differ between adolescents 'within' the same families, possibly as a result of the twins gaining greater autonomy as they progress through adolescence. Indeed, the non-shared environment accounted for 37%, 40% and

56% of the variance of parental sensitivity, negativity and warmth/ positivity, respectively. Furthermore, the extent to which parents differentially interact with twins appears to be related to differences in attachment security.

In summary, this study confirmed that the relation between parenting and attachment security in adolescence is quite different to that observed in earlier phases. While observational studies and behavioural genetic evidence show that attachment security in early development is substantially driven by the quality of parental care, and particularly the shared environmental elements of that, the picture is clearly more complex in adolescence. More specifically, in infancy and early childhood, the association between the child's attachment styles and characteristics of the quality of parenting are mainly accounted for by environmental effects (Fearon et al., 2006; Niederhiser et al., 2004). By contrast, this study shows that, in adolescence, a combination of evocative, passive and active rGEs is likely to support the development of attachment organisation.

However, the results regarding the genetic and environmental effects on the association between parental negativity, warmth/positivity and attachment security were inconclusive, given the non-significant phenotypic correlations between these parenting variables and attachment measures, especially taking into account the inconsistencies between the CAI and the IPPA.

5.2. General conclusions and directions for future research

Findings from the studies presented in this thesis support the idea that adolescent attachment security reflects a generalised state of mind that is progressively determined by genes and unique individual experiences. However,

important differences emerged when considering different attachment figures and different assessment methods.

In the sections below, reflections and general conclusions are reported in relation to specific themes emerged throughout this work. Recommendations for future research are also provided.

5.2.1. The role of genes on attachment in adolescence

The studies illustrated in the current work are in line with studies on adolescents and adults indicating that inherited characteristics have a considerable influence on attachment and many other personality and relationship features beyond early childhood.

It must be pointed out that heritability estimates are probably conservative, because measurement unreliability would tend to inflate the estimate of unshared environmental influences and decrease the estimate of genetic effects. Findings of a strong genetic effect imply that even exposure to features of the family environment, or the social environment, may be at least in part under genetic influence. In other words, the current studies confirm that adolescents' individual differences in attachment are in part due to genes that drive environments selection, or responses from the environment are evoked in a way that matches the adolescents' own inherited qualities (Plomin & Bergeman, 1991).

In summary, the current findings provide further evidence regarding the progressive genetic bias in the organisation of attachment, which comes into play between infancy and adolescence. This is in agreement with the notion that the degree of influence that individuals have on their environment increases as

they grow up and acquire greater autonomy, as validated by findings of general patterns of greater heritability from adolescence through adulthood in relation to several phenotypes, including externalizing behaviours, anxiety symptoms, depressive symptoms and cognitive skills (Bergen et al., 2007).

However, an important limitation in the current studies, as well as of most behavioural genetic studies on attachment reported in the literature to date, is the use of cross-sectional designs. Non-shared environmental factors comprise measurement error, which is difficult to distinguish from true environmental effects when a cross-sectional design is used (Picardi et al., 2020). To minimise measurement error, the studies presented in this thesis used comparatively large sample sizes and were adequately powered for a reasonable range of genetic and environmental effect sizes. Having said that, power was limited for more complex analyses, such as the bivariate models tested in Chapter 3 and 4, and for estimating small to moderate genetic or environmental parameters.

Moreover, it is important to point out that results of twin studies apply to specific populations and environments. In fact, heritability can differ with variations in genetic or environmental variance across populations (Visscher et al. 2008)

The evidence regarding the increasing genetic influence on attachment patterns throughout development could be strengthened by longitudinal, genetically informative studies, allowing the estimation of genetic and environmental influences on attachment at different stages of development and test their stability and change.

5.2.2. The role of the environment on attachment in adolescence

The studies presented in this thesis are also in line with research indicating that non-genetic factors unique to each twin within a family are an important source of

variation in attachment security. Indeed, a substantial contribution of non-shared environmental factors to individual differences in attachment security has been found by twin studies on infants and young children (Bokhorst et al., 2003; O'Connor and Croft, 2001; Roisman and Fraley, 2008), on adolescents (Fearon et al., 2014) and adults (e.g. Brussoni et al., 2000; Crawford et al., 2007; Torgersen et al., 2007).

Furthermore, it has been reported that behavioural genetic studies on adolescents (Fearon et al., 2014) and adults (e.g. Caspers et al., 2007; Torgersen et al., 2007) are less supportive of a role for the shared environment in attachment security compared to studies conducted on younger populations. Indeed, the increasing effect of genes on attachment throughout development could be explained by a decreasing importance of shared environmental effects or passive gene-environment correlation (Bergen et al., 2007).

Nevertheless, in the second study presented in this thesis it was found that the shared environment supports some proportion of the variance in attachment-related aspects in the quality of father-adolescent relationship, as well as the association between these and similar attachment-related aspects in peer relationships.

In biological families, such as those used in twin studies, passive gene-environment correlation can mimic shared environmental effects. These findings, coupled with an increase in genetic influences on attachment, suggest that some shared environmental influences on attachment, especially in the relationship with fathers, persist into adolescence.

Future longitudinal studies should use large sample sizes in order to be adequately powered to test for shared environmental influences. In order to evaluate these influences, alongside twin studies it would be important to conduct adoption studies, as they allow us to exclude passive gene-environment correlation as an explanation of shared environmental effects. These studies would hence allow circumventing the underestimation of shared environmental effects that may occur in twin designs whereby both shared environmental and non-additive genetic influences are simultaneously present (Burt, 2009).

5.2.3. Assessing adolescent attachment security in relation to different attachment figures

Importantly, combined findings from the second and third study in this thesis support the idea that attachment security in adolescence is largely – although not entirely- independent from the quality of the current parent-adolescent relationships.

It is worth noting that both the CAI and the IPPA assess attachment security (or attachment-related components) with reference to *current* parental relationships. However, it is possible that, by adolescence, Internal Working Models of attachment formed within parent-child relationships during infancy and childhood are mostly consolidated, and the quality of current parent-child interactions are no longer central organisers of attachment. Indeed, although bonds with parents endure, early adolescents increase their engagement with peers in ways that may support the possible formation of peer attachment bonds. Quality of attachment may be differently established with parents and peers. Additionally, although parents continue to be a source of support and protection throughout adolescence, in this developmental phase they share significance with peers in determining attachment status.

Although some studies suggest that prematurely supplanting parents with peer attachment may represent a maladaptive process (Rosenthal & Kobak, 2010), it has been previously mentioned that dismissing attachment toward parents is a common outcome in normative adolescent samples. Furthermore, it is known that attachment styles in adulthood may be more influenced by recent interpersonal experiences than distal, early caregiving experiences (Fraley and Roisman, 2018). In addition, recent findings (O'Connor et al., 2018) have shown that current parenting toward adolescents is no longer a significant predictor of the adolescents' attachment organisation once measurement of parent sensitivity in the early years is controlled for. Adolescence may thus represent a phase of transition, in which attachment patterns become gradually independent from current parental relationships and are increasingly contaminated by significant bonds outside the family context. These arguments suggest that, when assessing attachment security in adolescent populations, it might be an error to focus exclusively on current interactions with caregivers.

To date, no behavioural genetic research has been carried out to investigate the genetic and environmental influences on attachment to peers in adolescence. In this thesis, the quality of adolescents' relationship with peers were examined only through the IPPA which, as previously reported, assesses specific perceived attachment-related components in the relationship with significant figures, but does not provide the whole picture of the complex phenomenon of adolescent attachment organisation. Future studies adopting twin designs should attempt to replicate the current findings by assessing adolescent attachment security toward significant figures within and outside the family context.

5.2.4. Assessing adolescent attachment security using different assessment methods

Findings from the first and third studies reported in this thesis confirm that the CAI and the IPPA, despite having solid evidence of being robust instruments, present substantial differences in terms of the construct they assess. This is in line with the lack of clear consensus regarding the operationalisation of attachment in adolescence. Indeed, the developing nature of cognitive and socio-emotional abilities in this developmental phase present important challenges in capturing such a complex construct. As a consequence, the currently available instruments designed to assess attachment security in adolescence are not fully apt to capture the “moving target” of the ongoing adjustments and reorganisations in attachment phenomena during this period of the lifespan. Similarly, there is controversy around the notion of a single latent attachment construct, given the great heterogeneity in measurement approaches (Jewell et al., 2019) and complexity of the underlying phenomena.

For instance, the CAI can rightfully be considered as one of the currently most valid instruments to assess attachment security in middle childhood and adolescence, as it elicits recall of attachment experiences both in emergency and non-emergency situations, accesses representations partly outside conscious awareness, and has consistent evidence of solid psychometric properties (e.g. Shmueli-Goetz et al., 2008; Borelli et al., 2014). However, the CAI was originally designed for children aged 7-13 and currently has been considered to have the best psychometric properties for early middle childhood (Jewell et al., 2019), but not for older teenagers. In addition, the exclusive focus of the CAI on current parental relationships might overlook important aspects of attachment organisation when administered to adolescents.

In order to overcome the aforementioned gaps in the operationalisation of attachment in adolescence, it has recently been suggested that researchers should aim to develop appropriate measures of well-validated lower-order attachment constructs, which are linked to higher-order domains relating to socio-emotional processes. A better understanding of how different attachment-related aspects play a role within broader psychological processes may have greater potential for research and clinical treatments than working with poorly-validated concepts and measures (Fonagy and Luyten, 2018).

Therefore, an integrated approach using different measurements of attachment security, including different attachment figures and attachment-related components, is highly encouraged. Future behavioural genetic studies on attachment in adolescence should hence attempt to replicate the current findings using different assessment methodologies, possibly combining interview-based measures (such as the AAI), projective measures (such as the AAP – George & West, 2011), behavioural assessments and self-reports.

5.2.5. The role of parental sensitivity on adolescent attachment organisation

Finally, the third study of this thesis revealed that parental sensitivity might still be somewhat important in determining attachment security in adolescence, in line with classic attachment theory. Traditionally, the relationship between attachment security and parental responsiveness and sensitivity in the early years has been theorized as follows: a caregiver who is able to notice their child's attachment cues and respond promptly and adequately provides the foundation of the child's secure attachment, in that the child gradually becomes confident that the caregiver will be available in times of distress and need (Ainsworth et al., 1978). Sensitivity continues to be essential

for the parent to maintain the role of safe base even during adolescence (Rosenthal & Kobak, 2010). However, the relationship between parental sensitivity and attachment organisation in adolescence can be differently conceptualised. As reported in the first study, the quality of communication and the level of mutual trust in the parent-adolescent relationship, as measured by the IPPA, appear to be linked to attachment security. These aspects reflect developmentally appropriate strategies to seek comfort and closeness in times of need. Although adolescents do not need the same degree of proximity with parents as in childhood, they can derive comfort from knowing that their parents are supportive even when they are not present, and hold on to the mental representation of a positive relationship with them (Moretti & Peled, 2004).

The third study revealed that parental sensitivity is in part due to stable characteristics of the parent, as shown by the high degree of shared environmental influence. At the same time, heritable traits in the adolescent also appear to evoke some degree of sensitivity in the parent, which in turn accounts for a significant proportion of the correlation between quality of parenting and adolescent attachment security.

However, it can be hypothesised that different rGEs could underlie the association between adolescent attachment security and the quality of parenting displayed by mothers and fathers, mirroring prior research showing that mothers and fathers exhibit different patterns of rGE in relation to their parenting (Niederhiser et al., 2007; 2004). The third study in the current thesis could not test this hypothesis, as the number of fathers who took part in the assessment was very limited (7%).

Further research is needed to assess the generalisability of the current findings, especially investigating the different effects of the quality of both mothers' and fathers' parenting on adolescent attachment organisation. Based on the finding from the

second study of different patterns of genetic and environmental contributions to the adolescents' perceived quality of relationship with mothers and fathers assessed via the IPPA, further investigations on this unexplored territory could lead to promising results.

5.2.6. Future challenges

Key future challenges for researchers are to identify the specific genetic and environmental mechanisms involved in shaping individual differences in adolescent attachment, and to examine how genes and the environment interact in this process. In this sense, further research should be aimed at investigating whether specific genotypes moderate the association between an environmental factor (e.g., caregiving features, social interactions, etc.) and attachment quality in adolescence.

Research on candidate-genes involved in variation in attachment style is continuing with investigations on genes involved in the dopaminergic system (e.g. Graffi et al., 2018; 2015; Luijk et al., 2011; Lachman et al., 1996), the serotoninergic system (e.g. Spangler et al., 2009; Barry et al., 2008), the oxytocinergic system (e.g. Leerkes et al., 2017; Heinrich & Dome, 2008), and other genes (e.g. Pappa et al., 2015). To date, however, this line of research has provided inconclusive and contradictory findings.

Regarding the non-shared environmental sources of variance in attachment in adolescence, future studies should investigate on experiences that are unique to, or experienced differently by, each particular twin within a family. Investigations on such experiences should be expanded beyond the role of the quality of parenting, to include life events, differences in social

experiences including those with romantic partners, and differences in family interactions, such as those between siblings or between parents.

Such assessments, combined with longitudinal design and adequate power, may increase the understanding of how attachment is transmitted across generations and how it is impacted by current experiences in close relationships.

In addition, since the sample used in the current studies was composed of adolescents coming from mostly White British, middle-class and low-risk families, it would be crucial for future studies to test a range of diverse populations to replicate and expand the current findings and assess their generalisability.

5.3. Clinical implications

Behavioural genetic investigations on attachment organization in adolescence do not only serve the purpose of increasing the understanding of the genetic and environmental aetiology of the phenotypic variations in attachment security. Crucially, the studies presented in this thesis may also potentially shed light on ways in which genetics can facilitate or hinder clinical interventions.

In general, findings of genetic influences on attachment security and quality of parenting in adolescence do not necessarily undermine the efficacy of psychological interventions aimed at promoting healthy and secure bonds in this developmental phase. Indeed, genetic influences on any measured phenotype ought to be conceptualised in terms of Gene- environment interactions, in which genetic dispositions work themselves out in interaction with the environment (Plomin & Bergeman, 1991). Thus, such

interactions may crucially open the door on individual differences in response to specific behavioural interventions. With respect to the studies presented in this thesis, replication of findings of a strong genetic influence on attachment security in adolescence might suggest that not only individual differences in attachment security, but also differences in the extent to which individuals benefit from attachment-based interventions may be in part genetically determined.

Moreover, the use of twin studies in intervention research- especially the so-called cotwin control studies (e.g. McGue, Osler, & Christensen, 2010) – can attenuate the need for traditional case-control randomized controlled trials to test for the efficacy of a specific intervention. Cotwin control studies can be carried out to control for genetics while investigating the relation between exposure to attachment-based interventions and related outcomes within pairs of identical twins who differ in exposure (Plomin & Haworth, 2010). Cotwin control is a powerful design to test the efficiency of behavioral interventions, especially for interventions that are too expensive for traditional between-subject randomized control trials. Indeed, because identical twins are highly similar for most traits, their within-pair variance is expected to be low and the relative variance in efficiency of the cotwin control intervention design is expected to be high, which guarantees adequate power without use of large samples (Plomin & Haworth, 2010).

To date, however, there are very few behavioural genetic studies which have incorporated behavioural interventions. Findings from the current studies may set the foundation for future cotwin control studies testing the efficiency of interventions aimed at promoting secure attachment in adolescent populations.

More broadly, the studies presented in this thesis clearly indicate that adolescents are not simply passive recipients of their relationships with significant figures, but influence their environment considerably, including parental and peer relationships. This

further supports the idea that any intervention should therefore address the single adolescent in interaction with and as part of a wider system of relationships, in which the adolescent plays an active role.

Within the parental relationship, adolescent attachment is the result of both the adolescent and parents' capacity to redefine their relationship by taking into consideration the individuation process and increasing autonomy of the adolescent, compatibly with developmental changes at the social, emotional and cognitive levels (Rosenblum, 2006). Findings from the current works suggest that such redefinition should be supported by good quality communication and trust within the parent-adolescent relationship. Supporting this no doubt requires paying attention, clinically, by what the young person brings to the relationship, as much as that of the parent.

On one hand, attachment security is achieved through parent-adolescent interactions that promote open communication of emotional states and related thoughts. Although it is likely that communication patterns within the parent-adolescent relationship stem from the foundation of earlier parenting, changes in styles and frequency of communication with parents are common in adolescence and therefore represent an important focus of intervention and support (Branje, Laursen & Collins, 2012). On the other hand, trust in the parents' availability in times of need is core during this period. Indeed, a fundamental aspect of adolescence is that physical proximity with parents is no longer necessary to promote feelings of protection and comfort. The combination of mutual trust and good quality of communication allows the adolescent to internalize a stable representation of their caregivers, which they can hold on to in their absence while exploring social contexts and forming other significant bonds outside the family (Gamble & Roberts, 2005). It is through new bonds and interpersonal relationships that the adolescent extends the physical environment to include exploration

of personal ideas and emotional states, and attachment becomes a state of mind which guides behaviour and stress regulation strategies (Larose & Bernier, 2001).

Because adolescence is a period of transformations that can result in the emergence or consolidation of psychopathology, supporting the co-construction of parent-adolescent relationships based on communication and trust may represent a key aspect of psychological interventions. Such interventions should be directed at both the adolescent and their caregivers to promote attachment security and reduce inadequate behaviours that maintain insecurities within the relationships.

The current studies highlight that interventions specifically focused on helping parents to develop sensitive and responsive skills toward their adolescent children might be beneficial in enhancing the attachment relationship. However, because adolescents' traits and behaviours can significantly influence parental sensitivity, these interventions should involve the parent-adolescent dyad to encourage teenagers and their caregivers to live a new relational experience, allowing them to reinterpret their representation of the relationship in light of the ongoing transformations (Dubois-Comtois et al., 2013).

As encouraged by the current findings, it would be fundamental to involve both mothers and fathers in such interventions, as both figures can impact adolescent attachment organisation in different ways. It is widely recognised that attachment theory and research have been slow to consider and investigate father-child attachment. However, the increase in fathers' involvement in parenting over the last decades demands greater attention to the structure and implications of father-child attachment throughout development, and certainly greater initiative in involving fathers in interventions aimed at improving adolescents' wellbeing (von Klitzing & White, 2020).

Finally, in this thesis it has been emphasised that peer relationships play a crucial role in adolescent identity formation, adjustment and arguably attachment organisation. Future attachment research should carry out evaluations of p*eer-led interventions* (i.e., interventions in which peers are involved in the delivery of the intervention). These have normally been designed to manage undesirable behaviours, such as substance use and delinquency, and promote desirable behaviours, such as helping and pro-social behaviours (Venstra & Laninga-Wijnen, 2022). Indeed, adolescents may *select* peers based on similarities in behaviours or proclivities, as reflected by the strong genetic effect on a range of behaviours and traits (McPherson, Smith-Lovin & Cook, 2001), possibly including attachment-related aspects (see second study). Furthermore, *peer influence* may lead adolescents to start behaving or thinking in ways that they might not otherwise do. Peer influence has been found across different behavioural domains in adolescence, such as internalising problems, victimisation and alcohol use (e.g. Neal & Venstra, 2021; Venstra & Huitsing, 2021; Hennerberg, Mushonga & Preston, 2020) and can arguably come into play among the mechanisms influencing attachment (re)organisation.

Findings of environmental influences on aspects related to the quality of peer affiliations certainly sets the opportunity for change and intervention. A better understanding of the impacts of peer relationships on attachment is needed, including behavioural genetic research investigating the genetic and environmental factors underlying the mechanisms of peer selection and influence on a range of attachment-related behaviours. The insights generated by such studies will inform peer-led interventions to generate positive behavioural and attitudinal changes in young people, with the ultimate potential to improve attachment security.

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APPENDICES

Appendix A: Adapted Warmth Scale

Warmth

Rate: Parent and child separately

This scale measures the degree to which the target is warm, enthusiastic, affectionate and kind towards the other. This can be demonstrated through friendliness towards the other and general positive affect. NON-VERBAL COMMUNICATION e.g. touching, kissing, hugging, holding hands; EMOTIONAL EXPRESSION e.g. miling, laughing, happy or good humoured.

1) The target RARELY OR NEVER displays examples of warmth for the other. He/she maybe MINIMALLY RESPONSIVE to the other and/or OVERLY COLD AND UNFRIENDLY and does not appear to be enjoying the interaction or the other's company. He/she does not go out of his/her way to be nice to the other.
2) The target displays SOME EVIDENCE of warmth. He/she is OCCASIONALLY caring AND/OR displays some evidence of enjoying the other's company. There is some evidence that the target is nice to the other.
3) The target displays MORE FREQUENT AND INTENSE warmth. He/she is ATTENTIVE to the other and displays more POSITIVE EMOTIONAL EXPRESSIONS (i.e. smiles, frequent eye contact and touching).

4) The target is USUALLY warm. He/she USUALLY displays high warmth and/or the target may display a high degree of touching, smiling, eye contact or laughing. The target is USUALLY NICE and FRIENDLY to the other.
5) The target is HIGHLY and CONSISTENTLY warm. He/she CONSISTENTLY offers a high degree of warmth; maintains eye contact, FREQUENTLY touches, smiles at or laughs with the other. The target is GENUINELY NICE and FRIENDLY to the other, even if the other is angry, rejecting or coercive.

Appendix B: Adapted Support Scale

Support

Rate: Parent and child separately

This scale measures the degree to which the target is actively interested in and concerned for the other's difficulties and needs. Attention is paid to what is communicated by the other and concern is shown to apparent difficulties the other may be facing. The parent/child appears to be invested in the other's wellbeing and holds the other's best interest in mind. BODY POSTURE (relaxed, sitting close, facing the other) SUPPORT such as responsiveness, showing concerns for the other's welfare, offering encouragement and help, offering to change behaviour for the other CONTENT of the statements such as "I'm concerned about..." or "you're doing much better"

1) The target RARELY OR NEVER displays examples support for the other. He/she maybe MINIMALLY RESPONSIVE to the other and/or OVERLY REJECTING OR DISMISSING and does not appear to be interested in the interaction or the other's company.

2) The target displays SOME EVIDENCE of support. He/she is OCCASIONALLY concerned or encouraging; is RESPONSIVE to the other and displays SOME INTEREST in the other (i.e. solicits other's opinions or concerns) or makes an occasional encouraging, enthusiastic or helpful remark.
3) The target displays MORE FREQUENT AND INTENSE support. He/she is RESPONSIVE and INTERESTED in the other and may offer to change his/her behaviour after hearing the other's needs. He/she displays more SUPPORT (i.e. interested in other's concerns, low level sympathy, some helpful advice or eliciting other's point of view even if it is in conflict with his/her own).
4) The target is USUALLY supportive. He/she USUALLY displays high support, actively soliciting information about the other's concerns, offering a high degree of encouragement and validation. The target usually appears to be invested in the other's wellbeing and holds the other's best interest in mind.
5) The target is HIGHLY and CONSISTENTLY supportive. He/she offers a high degree of support, help, encouragement, validation and approval; actively solicits the other's opinions and concerns. He/she consistently appears to be invested in the other's wellbeing, holds the other's best interest in mind and is able to offer to change their behaviour.

Appendix C: Adapted Problem-Solving Scale

Problem Solving

Rate: Parent and child separately

This scale assesses the degree to which the members of the dyad are able to progress toward the accomplishment of the task, i.e., the resolution of disagreements or problems under discussion. Take into account how clearly the target defines important aspects of the problems; the quality of suggested solutions; offers to compromise; and agreements on solutions. The target is rated based on how high up he/she progresses on the scale below. Assess process by which they work towards accomplishing the task as well as the outcome. The targets' scores are based on the highest level they reach in the interaction on any of the issues discussed (see clarification (a)).

1) Clear definition of the Problems(s): Score "1" if he/she does no more than clearly define the problem or topic of disagreement.
2) Defining Aspects of the Problem(s): Score "2" for the target is he/she goes beyond the definition of the topic to give reasons for why the problem developed

or to describe aspects of the problems discussed, or solicits this information from the other. OR a suggested solution may be rejected or not acknowledged by target without offering an alternative. The dyad may not have listened to and discussed each other's view-points, tried to generate solutions or agreed on an outcome.

3) Offering a Solution or Solutions to the Problems(s): Score a "3" for the target if he/she offers an APPROPRIATE and PLAUSIBLE SOLUTION to the disagreement or the problem, but may not have fully identified the problem, discussed the other's viewpoint, or tried to generate more than one solution. This can include reasonable arguments for why the status quo is acceptable. During problem-solving process target may subjugate own needs and/or appear to hold other's viewpoint as superior. OR a solution is agreed but the process of problem-solving was one sided (one person acquiesces).
4) Offering a Compromise OR Reaching a Vague or Unclear Resolution: Score "4" if the target may have identified the problem, understood the issues (discussed each other's view points), tried to generate solutions but if he/she OFFERS TO YIELD IN PART to a solution offered by the other or OFFERS TO COMPROMISE with the other, but in either case the other does not agree. OR Both targets receive "4's" if they identified the problem, understood the issues (discussed each other's view points), tried to generate solutions but agree to a solution that is very VAGUE (e.g. agreeing that the child will "do better"), or if one agrees that the other's solution is plausible but it is UNCLEAR whether he/she has agreed to actually try it.
5) Reaching a Resolution to the Problem(s): Score "5" for both members of the dyad when they have identified the problem, understood the issues (discussed each other's view points), tried to generate solutions, and agreed on an outcome or a

compromise. BOTH HAVE AGREED TO TRY A SOLUTION to a problem or have agreed to a compromise.

Clarification: Problem Solving:

- The targets score is based on the highest level he/she demonstrates across the whole tape. For example: A target offers solutions for one problem but is unable to move beyond describing aspects of other problems introduced. In this instance, the target would receive a “3” as it is assumed that if the target is able to find appropriate and plausible solutions to one problem, he/she possesses the skills necessary to find solutions to other problems.
- If the targets are discussing a problem that they have already resolved, they may be scored 5’s even if they did not decide on the solution during the eight-minute interaction. In order to be scored “5’s”, however, they must discuss what that solution was. They do not get credit if they just read the paper and state they have solved the problem already.

Appendix D: Adapted Sensitive Responding Scale

Sensitive responding

Rate: Parent only

Responsiveness emphasises the parent's awareness of the child's needs in the room and regarding topics discussed and sensitivity to his/her signals (verbal and nonverbal). Ideal sensitive responding involves initially noticing the child's cues/ signals; appropriate interpretation of these cues; responding in a timely manner and this response fitting the needs of the child.

Consider here how and when the parent responds to verbal and/or non-verbal cues elicited by the child during the course of the interaction.

Operationalisation Examples

a) Responsiveness to child's non-verbal seeking-behaviour. This category is used if the child gets "stuck" in the conversation and doesn't know what to say or how to continue the task, and sends clear behavioural cues/signals that he/she may need the parent's assistance. In these situations, a responsive parent will offer

verbal help in a prompt, contingent, warm, supportive, empathic, and/or interested manner.

b) Responsiveness to child's needing behaviour (emotional needs). This behaviour relates to situations where there is no clear agenda and the child doesn't send signals seeking any help from his/her arent, either verbally or nonverbally e.g. if child is unhappy, frustrated, lost and/or hurt; parent picks up on emotional needs and responds, e.g. by comfort, reassurance or validation. Or, if child comments on physical need; e.g. they are hungry, a responsive parent will promptly and appropriately offer the child a solution to the need.

c) Responsiveness to child's verbal seeking behaviour. If a child verbally refers to the parent asking for help and/or assistance or comments how difficult a certain task might be, a responsive parent ill offer either verbal or instrument help in a prompt, contingent, warm, supportive, empathic and/or interested manner (e.g. looking at sheet and trying to help child with task)

d) Responsive Engagement. Responsive parents will make enthusiastic comments and praise the child's ideas. Responsive parents will keep an attentive attitude towards child's conversation. This attitude on the part of the parent is basically a child-focused one: letting child take lead/direction of conversation, "following" the child.

e) Sensitive Child Mindedness – Mentalization. Sensitive parents are aware of the child's motional/affective states. They can recognise the child's internal mental state and use mental state language that shows awareness of what the child might be thinking and feeling, e.g. suggesting that the child is bored, worried, sad, excited. These assertions may also appear in the form of linkages the parent makes between a past event in the child's life that has an obvious relation to the child's current affective state- i.e. validating current feelings and feelings relating

to past events. Responsive parents are not entrenched in their position regarding a topic and are able to 'shift' perspective during a conversation upon discussion. In the task, they are able to revise their thinking having acquired new understanding from their child; in effect understanding another's position but not cancelling out their own perspective. This skill also relies on following and responding to a child's cues.

f) Responsive Facilitation Responsive/ facilitative parent will "pick up" that child is stuck with not knowing what to do (e.g. with task itself or in issues raised by the task), and will provide assistance to the child even if not directly requested.

g) Encouraging/Promoting Autonomy. Responsive parents will perform behaviours and/or make verbalisations in order to encourage their children to carry out tasks by themselves. They can encourage autonomy by asking the child's opinion and providing solutions that promote autonomy.

Scores

1) Unresponsive/Insensitive Parent.

Note: There has to be: a) clear pervasiveness (i.e. presence for most of the time) of absence of responsive behaviours displayed by the parent as defined above; or b) one modest example of responsiveness against a background of pervasive and intense non-responsiveness. Specific examples are shown below:

- Parent does not respond to the child's verbal or non-verbal seeking behaviours. Example: child directly requests help with task and the parent does not make a responsive comment or does not offer responsive instrumental help attuned to the child's needs.

- Disengaged parent. Example: during the task, parent is silent most of the time,

is passive towards the task; not taking the initiative to interact with the child and, if child does not “invite” the parent to complete the task with her/him, the parent will accept this type of “arrangement” keeping himself/herself distanced and dismissed from what the child is doing. On the other and, the parent can be very talkative but nevertheless is still unresponsive to the child.

- Absence of child mindedness (mentalization). Example: In a situation where the child shows obvious signs of frustration or boredom with regards to the task, his/her parent does not comment on this emotional state.
- No facilitation: Example: The parent does not encourage the child to perform a task if it’s obvious to the observer that the child is able to do it alone. Also, if the child presents the parent with some ideas as to how to move the task along, the parent will not provide support to the child’s ideas.

2) Minimally Responsive/Sensitive Parent.

   Note: There may be e.g. one or two examples of responsiveness. However, the degree of pervasiveness and degree of intensity indicates predominantly nonresponsive behaviours towards the child. A ‘2’ differs from a ‘1’ in showing at least two modest examples of responsive behaviours amidst a general pattern of non-responsive behaviours.

3) Somewhat Responsive/Sensitive Parent.

   Note: To score a 3, the parent will show some scattered evidence of responsiveness, but this will not constitute a strong/obvious sign of responsiveness on their part. Overall, he/she is more non-responsive than responsive; or he/she shows two strong examples of sensitive responsiveness amidst a strong pattern of insensitive responsiveness.

4) Moderately Responsive/Sensitive Parent.

   Note: The intensity/frequency in which responsive behaviours are displayed is

balanced by the intensity/frequency by which non-responsive behaviours are displayed. Thus, several examples of responsive behaviours will be balanced with several examples of non-responsive behaviours. The overall impression would be that this is a parent that is partly responsive and partly non-responsive; neither style dominates.

5) Good Responsive/Sensitive Parent.

   Note: There is an overall pattern in which responsive behaviours are greater/more prominent than non-responsive behaviours. Thus, the general style is responsive. These examples of responsive behaviours are clear examples and unambiguous. This is offset by modest and infrequent examples of non- responsive behaviours.

6) Very Good Responsive/Sensitive Parent.

   Note: There is a consistent pattern where episodes of responsive behaviour are displayed. The parent/child consistently shows signs of responsiveness as defined above. However, although consistently exhibiting signs of responsiveness, there may be at least one example where responsive behaviour might be expected but is not seen.

7) Extremely Responsive/Sensitive Parent.

   Note: The parent/child either displays all the above criteria or those that are displayed must be extreme manifestations of responsive behaviour. The various types of responsive behaviour are pervasive and unambiguous to the observer.

Appendix E: Adapted Mutuality Scale

Mutuality

Rate: Parent and child DYADICALLY

This code is a dyadic-based one. The intention is to code the quality of the interaction between parent and child but seeing both of them as a unique feature of the relationship (i.e. parent and child interacting are not separate things).

Operationalisation Examples

a) Seeking parent's involvement in the task. There has to be clear evidence that as the child initiates a conversation, he/she will spontaneously "invite" the parent in order to allow them to be part of the process of the task and their thinking. The child will feel comfortable if the parent gets involved in the conversation (e.g. they may allocate a task for the parent to complete).
b) Both parent and child interacting together. Through interactive-reciprocal dialogue/turn-taking, the parent and child are able to have a cooperative conversation. It is clear that the purpose of their conversation is to find a solution to the specified problem; not for them to simply get their view point across/ have

their own way. Despite having different viewpoints, they are able to have some "give and take", allowing them to cooperate on the task.

c) Shared attention. Through appropriate eye contact and/or attentiveness to each other's comments and actions regarding the task. They are able to respond accordingly and maintain a joint attention on the topic.

d) Reciprocated positive affect. e.g. if child looks at the parent smiling, the parent reciprocates this same behavior immediately or with a complimentary behaviour such as shared laughter.

e) Mirroring/ matching. Parent and child are observed to be oriented towards each other, and not mismatched in positioning. They are working as a team to embellish the discussion and achieve the goal (the task is based on an area of disagreement so the focus is not about having "fun", but the parent and child are seen to be on the same level, with a sense of being "in it together"). They are not shutting each other down, but working together to reach conclusions.

f) Fluid conversation. This is the opposite of "dead air" (i.e. moments of silence). Both parent and child keep a joint conversation on the task. Comments made by parent not ignored by the child and vice-versa; or the parent and the child do not follow "different directions" in discussion.

g) Coordinated Shared Body Orientation. Parent and child keep closeness to each other, their bodies are coordinated/oriented towards one another during the task. They appear to be engaged in a shared task rather than separate activities.

Scores

1) No Mutuality.

Note: There has to be clear pervasiveness of absence of mutual behaviours elicited by the dyad as defined above. Specific examples are shown below:

a) No child initiated activity with parental involvement.

b) There is no interactive-reciprocal dialogue/turn-taking. Example: The parent and child do not co-ordinate their efforts in order to move the task along.

c) No shared attention. There is no eye contact and/or there is a lack of attentiveness to each other's comments and actions regarding the task.

d) No reciprocated positive affect. e.g. if child looks at the parent smiling, the parent does not reciprocate with the same behaviour or complimentary behaviour.

e) No mirroring/ matching. Parent and child do not match/imitate each other's behaviours and/or verbalisations during the task.

f) No fluid conversation. The interaction is infused with "dead air".

g) No coordinated/shared body orientation.

2) Minimal Mutuality

Note: There is pervasive non-mutuality, but slight evidence of mutuality. A '2' differs from a '1' in showing at least one clear but modest example of mutual behaviours amidst a general pattern of non-mutual behaviours. However, the degree of pervasiveness and degree of intensity indicates predominantly nonmutuality.

3) Some Mutuality.

Note: Generally, this dyad is more non-mutual than mutual.

4) Moderate Mutuality

Note: The intensity/frequency in which mutual behaviours are displayed is balanced by the intensity/frequency by which non-mutual behaviours are displayed. Thus, several examples of mutual behaviours will be balanced with several examples of non-mutual behaviours. The overall impression would be that this is a dyad that is partly behaving

mutually and partly non-mutually; neither style dominates.

5) Good Mutuality

Note: There is an overall pattern in which more mutual behaviours are displayed than non-mutual behaviours. Thus, the general style is mutual. These examples of mutual behaviours provide strong evidence of mutuality. However, there are also modest signs of non-mutual behaviours.

6) Very Good Mutuality

Note: There is a consistent pattern where episodes of mutual behaviour are displayed. This is a dyad that consistently shows signs of mutuality as defined above. However, although consistently exhibiting signs of mutuality, there may be at least one example where mutual behaviour is expected but not seen; or despite pervasive and clear evidence of mutuality, there is a slight indication of nonmutuality.

7) Extreme Mutuality

Note: This dyad must either display all the above criteria or those mutual behaviours that are displayed must be extreme manifestations of mutuality. The various types of mutual behaviours are pervasive and unambiguous to the observer.