Anxiety and depression in adolescents: Exploring social, neuropsychological and hormonal influences

Christine Longinotti

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Abstract

Depression and social anxiety increase in prevalence during adolescence and are linked to long-term difficulties. The aetiology of increased onset of depression and social anxiety during adolescence is likely to be complex, encompassing social, biological and neuropsychological factors. The present study aimed to investigate some of these factors, in terms of parental attachment, stage of puberty and emotional lateralization.

One hundred children aged 9 to 14 undertook the chimeric faces test, evaluating their lateralization for facial emotion processing. Children also completed self-report measures to assess their levels of depression and social anxiety, stage of puberty and parental attachment. Data were entered into hierarchical regression analyses, with either depression or social anxiety as outcome variables. Known predictors were entered at Block one with emotional lateralization, stage of puberty and parental attachment entered at Block two. Interactions between laterality, attachment and puberty were entered into Block three.

The results showed that higher parental attachment trust was linked to higher depression scores. Furthermore, the interaction between laterality and parental attachment trust was also shown to be a significant predictor. This revealed that higher attachment trust scores were predictive only when children had bi-lateral or left hemisphere lateralization for emotional processing. For social anxiety, both higher parental attachment trust and parental attachment alienation were linked to higher social anxiety scores. There was no effect of the interactions for social anxiety. Additionally there was no unique effect of puberty or lateralization for either depression or social anxiety.

The results provide insight into the complex aetiology of depression and social anxiety, suggesting that they are related to similar but subtly different predictors. The study also revealed that social factors were more important than either biological or neuropsychological factors, suggesting targets for clinical intervention when working with young children and adolescents with depression and social anxiety.

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Introduction

Overview

Estimates suggest that approximately one in five adolescents will experience a psychiatric disorder (Costello, Mustillo, Erkanli, Keeler, & Angold, 2003). Depression and social anxiety are two such disorders, which are known to increase in prevalence during adolescence (Paus, Keshavan, & Giedd, 2008). Depression is a mood disorder, in which individuals may experience feelings of sadness, loss of interest in pleasurable activities, reduced motivation and feelings of hopelessness (Castiglia, 2000). Individuals with social anxiety disorder experience significant difficulties with social situations, and fear negative judgement from others, social embarrassment and humiliation (Erath, Flanagan, & Bierman, 2007).

The reason behind the increased emergence of these disorders during adolescence is not fully understood. However, the reasons are likely to be complex and comprise a variety of factors. A longstanding debate between the impact of nature versus nurture has suggested that no one factor alone is likely to account for the aetiology of depression and social anxiety alone. The fact that both depression and social anxiety increase in prevalence during adolescence suggests a role for social, biological and neuropsychological factors in the aetiology of these disorders. This suggests there may be important links between these factors that impact on both depression and social anxiety.

The relationship between a child and their primary caregiver is seen as important for the basis of good psychological well being (Armsden & Greenberg, 1987). Attachment relationships are known to undergo change during adolescence, with children going through a process of social re-orientating (Blakemore & Mills, 2014; Larson, Richards, Moneta, Holmbeck, & Duckett, 1996). This involves parental relationships remaining important, but the focus shifting to peer relationships (Lieberman, Doyle, & Markiewicz, 1999). Difficulties with parental attachment have been implicated in both depression (Abela et al., 2005; Lee & Hankin, 2009) and social anxiety (Brumariu & Kerns, 2008). With the changes occurring to social relationships at this time, attachments may take on increased importance. This suggests one area that may reveal factors related to the emergence of depression and social anxiety in adolescence.

Puberty has been suggested to be a time of increased likelihood for "storm and stress", particularly in Western cultures (Arnett, 1999). A number of studies suggest the increased incidence of depression and social anxiety during adolescence is related to puberty rather than age (Angold, Costello, & Worthman, 1998; Oldehinkel, Verhulst, & Ormel, 2011; Patton & Viner, 2007; Reardon, Leen-Feldner, & Hayward, 2009). Prior to puberty, boys and girls show similar levels of depression and social anxiety (Paus et al., 2008). This changes after the onset of puberty, with girls being more likely to receive both a diagnosis of depression (Maughan, Collishaw, & Stringaris, 2013; Thapar, Collishaw, Pine, & Thapar, 2012) and social anxiety (Wittchen, Stein, & Kessler, 1999). Puberty increases the reactivity of the brain to emotionally salient information such as faces (Hare et al., 2008; Ladouceur, 2012) and adolescents have been shown to be more sensitive to processing the emotional

nature of stimuli (Monk et al., 2003). Furthermore, there is also evidence that adolescents employ different brain areas to adults when processing emotional faces (Monk et al., 2003). This has been argued to lead to inaccurate perception of emotional expressions, which may contribute to the emergence of depression and social anxiety (Paus et al., 2008).

Emotional recognition has also been shown as an area that may change during adolescence, and has similarly been linked to depression and social anxiety. Hemispheric lateralization for processing of emotions is one area of emotional processing that has received increasing attention in recent years. There is now evidence that both attachment (Escobar et al., 2013) and hormonal factors (Bourne, 2014; Bourne & Gray, 2009) impact on emotional lateralization for facial expressions. However, emotional lateralization has not been studied in an adolescent population that is currently experiencing puberty. Previous research has suggested there are links between emotional lateralization, attachment and hormonal factors. It is therefore possible that interactions between these factors during adolescence impact on the emergence of depression and social anxiety.

Experiencing depression during adolescence has been linked to a number of negative outcomes, affecting social and academic functioning and relationships (Hazell, 2007). Social anxiety is also linked with a number of negative events for adolescents, including increased risk of school refusal, school drop out, and poorer school performance (Spence, Donovan, & Brechman-Toussaint, 1999; Stein & Kean, 2000). Moreover, children with social anxiety have been shown to have fewer social networks and poorer social skills (Deardorff et al., 2007; Kashdan & Herbert, 2001).

Previous research has shown that experiencing depression during adolescence is linked with a high rate of continuation into adulthood (Forbes & Dahl, 2005; Rao & Chen, 2009; Weir, Zakama, & Rao, 2012). Estimates suggest recurrence in 47% (Curry et al., 2011) to 70% (Thapar et al., 2012) of adults. Similar findings have been reported in social anxiety (Stein & Stein, 2008), which has been associated with poor psychosocial outcomes in adults (Chavira & Stein, 2005). Due to the negative consequences that result from experiencing depression and social anxiety in adolescence, it is thought to be important to understand more about factors related to these disorders.

Depression during childhood and adolescence

Depression has been widely researched in children and adolescents. A diagnosis of depression in childhood encompasses symptoms similar to adults (Kessler, Avenevoli, & Ries Merikangas, 2001), including low mood, loss of interest in activities, fatigue, and difficulties concentrating (American Psychiatric Association, 2013). Additionally, irritability, boredom and physical complaints may be seen (American Psychiatric Association, 2013; Shanahan et al., 2014). Many children experience some symptoms of depression. However, clinical diagnosis is less common (Lack & Green, 2009), with only 0 to 2% of preadolescent children receiving a diagnosis (Egger & Angold, 2006; Lack & Green, 2009). During the early teenage years, the reported prevalence of depression rises considerably (Kessler et al., 2001). The prevalence has been estimated at approximately 4 to 6% of adolescents (Costello et al., 2003; Costello, Erkanli, & Angold, 2006). The peak age of onset for depression occurs between 13 to

14 years (Joinson et al., 2012; Lack & Green, 2009) usually during mid-puberty (Angold et al., 1998) and following menarche in females (Patton et al., 1996). The emergence of depression during adolescence is a robust finding, seen throughout a variety of Western countries (Wade, Cairney, & Pevalin, 2002). In adult populations, depression is more prevalent in females than males, at a ratio of approximately 2:1 (Kessler, 2003). This female bias is not present in childhood (Thapar et al., 2012), but develops during adolescence (Angold & Costello, 1993; Costello et al., 2006). This sex difference begins to emerge around age 12 (Angold & Costello, 1993), particularly following the onset of puberty (Angold, Costello, Erkanli, & Worthman, 1999). These findings suggest that changes occurring during puberty may be important for the onset of depression.

Social Anxiety during childhood and adolescence

Individuals with social anxiety experience worries regarding social interactions with others. Three core aspects are thought to encompass social anxiety: fear of negative evaluation, distress in new social situations and avoidance of social situations (La Greca & Stone, 1993). It has been argued there is a distinction between social anxiety and social phobia (Rapee & Spence, 2004). Social anxiety has come to refer to the general fears and avoidance of social interactions (Storch, Masia-Warner, Crisp, & Klein, 2005), whereas social phobia is more severe (Rapee & Spence, 2004) consisting of an enduring fear of social situations (Storch et al., 2005). However, the two terms have been frequently been used interchangeably (Freitas-Ferrari et al., 2010). Further, the criteria required for a diagnosis of social anxiety in children has changed over recent years (Chavira & Stein, 2005). Presently, clinical diagnosis

requires fear, anxiety and avoidance regarding social situations, affecting academic and social functioning (American Psychiatric Association, 2013). Additionally, crying or tantrums, clinging to a parent and being unable to speak in social situations may be seen in children (American Psychiatric Association, 2013).

Throughout the lifespan, social anxiety disorder is thought to be the most common anxiety disorder (Stein & Stein, 2008) across a number of Westernized countries (Stein & Kean, 2000). The prevalence of social anxiety has been estimated at 2.4% in preschool children aged 2 to 5 (Egger & Angold, 2006) and between 0.08 to 0.9% in pre-adolescent children aged 5 to 11 (Cartwright-Hatton, McNicol, & Doubleday, 2006). However, it has been noted that only a handful of studies have specifically examined social anxiety in preadolescent children, and these studies have used a variety of diagnostic criteria. This may therefore account for the very low rates reported in preadolescent children.

As with depression, reported rates of social anxiety increase between late childhood and early adolescence (Beesdo et al., 2007; Chavira & Stein, 2005; Deardorff et al., 2007; Kessler et al., 2005). Social anxiety seems to have a peak age of onset of approximately 11 to 13 years (den Boer, 2000; Kessler et al., 2005; Stein & Stein, 2008). However, prevalence estimates vary widely based on the type of diagnostic criteria used (Chavira, Stein, Bailey, & Stein, 2004; Wittchen et al., 1999). With this in mind, prevalence rates for social anxiety have varied from 3% to 6.8% in a sample of 6 to 18 year olds (Busch et al., 2002; Chavira et al., 2004). Like depression, social anxiety has been shown to be more prevalent in females, at a ratio of roughly 2:1 (Beesdo et al., 2009). This sex difference has been consistently demonstrated to

emerge during adolescence (Beesdo et al., 2009; Bosquet & Egeland, 2006; Chavira & Stein, 2005; Inderbitzen & Hope, 1995) and has been linked to advancing pubertal status (i.e. as children progress from early puberty to late puberty) (Deardorff et al., 2007).

Co-morbidity of depression and social anxiety

Previous research has shown that co-morbidity is common between depression (Thapar et al., 2012) and social anxiety (Chavira & Stein, 2005; Rapee & Spence, 2004; Stein, Torgrud, & Walker, 2000). There is some evidence to suggest depression and anxiety share some common risk factors (Karevold, Roysamb, Ystrom, & Mathiesen, 2009). This is perhaps to be expected, due to the high levels of co-morbidity between the disorders. However, it has also been shown that depression and social anxiety have risk factors that do not overlap. For example, depression, but not anxiety, has been linked to family adversity (Karevold et al., 2009). Additionally anxiety disorders have also been shown to have more diverse risk factors than depression, such as having smaller social network and a traumatic family history, with only external locus of control common between the two (Beekman et al., 2000).

There is also evidence that subtle differences in risk factors exist between depression and social anxiety. For example, when looking at social factors related to depression and social anxiety, it was found that negative *interactions* with best friends was linked to social anxiety, whereas negative *qualities* in best friends was linked to depression (La Greca & Harrison, 2005). This shows that depression and social anxiety may be related to similar factors, but differences may exist within those factors that are subtle

in nature. Research that has considered depression and social anxiety together, or not controlled for co-morbidity, may therefore have missed unique predictors, or wrongly attributed predictors to both disorders.

Summary

Depression and social anxiety are rarely diagnosed in early childhood, but prevalence greatly increases during adolescence. Experiencing depression and social anxiety in childhood has been linked to negative events such as school drop out and poorer school performance, having a long-term impact on the individual. The diagnostic criteria of depression and social anxiety are relatively similar to those seen in adults, and there is evidence that the disorders often continue into adulthood. Although the disorders are often co-morbid, it is thought that there may be different factors that lead to the onset of depression and social anxiety. This begins to shed some light on the potential complexity of the emergence of depression and social anxiety at this time.

Attachment

Interactions between various social, biological and neuropsychological factors are likely linked to the emergence of depression and social anxiety. One social factor that may play a role is attachment. Attachment is thought to be a way for the infant to maintain proximity to the caregiver whilst vulnerable (Bowlby, 1969). Modern attachment theory advocates that based on early relationships, individuals develop

templates (known as 'internal working models') that influence how social information is perceived, processed and responded to (Escobar et al., 2013). These attachment styles are frequently employed in attachment-relevant situations, and impact on interpersonal relationships (Fussell, Rowe, & Mohr, 2012).

Attachment processes are thought to begin to develop from birth, or even prenatally (Brandon, Pitts, Denton, Stringer, & Evans, 2009). Initially, children are thought to become attached to their primary care giver, only beginning to attach to other figures at approximately two to six months of age (Mizukami, Kobayashi, Ishii, & Iwata, 1990). These early attachments have been typically seen as crucial in forming a foundation on which all further relationships will be based (Lieberman et al., 1999).

Attachment was initially thought to develop during the early years, and then remain stable throughout an individual's lifetime (Lieberman et al., 1999). However, more recently, it has been suggested that attachments can change over time (Armsden & Greenberg, 1987; Del Giudice, 2009; Fussell et al., 2012; Laible, Carlo, & Raffaelli, 2000). A critical time for a change in attachment styles is adolescence (Del Giudice, 2009). Attachment to parents is important during childhood, with interactions with peers less important prior to adolescence (Blakemore & Mills, 2014). As children transition into adolescence, it has been noted that a process of social re-orientating occurs, as children spend increasing amount of time with peers rather than family members (Blakemore & Mills, 2014; Larson et al., 1996). During this time, interactions with peers become increasingly important, as children begin to seek autonomy from parental figures (Lieberman et al., 1999). It has been argued that peer relationships, particularly romantic relationships forming towards the end of

adolescence, can also act as a basis for attachment (Allen & Miga, 2010). Importantly, some authors have argued that parental attachments remain important during adolescence, and peer attachments serve a similar but distinct function during adolescent development (Blyth, Hill, & Thiel, 1982; Kerns, Klepac, & Cole, 1996; Laible et al., 2000). Parental relationships are also seen as providing the foundation on which peer relationships are based (Laible et al., 2000).

Typically, research looking at attachment has considered attachment styles. Research has often classified participants as falling into one of four categories. Traditionally four different attachment styles have been proposed (Ainsworth, Blehar, Waters, & Wall, 1978): i) *secure attachment*, where children use their caregiver as safe base and seek comfort, ii) *insecure-avoidant attachment*, where children treat the caregiver as unavailable and do not seek comfort, iii) *insecure-ambivalent attachment*, where children become easily distressed and seek comfort but distress remains, iv) *disorganized attachment*, where children may exhibit aspects of all attachment styles, seeing their caregiver in both a positive and negative way. These attachment styles are typically evaluated in the first two years of life. Attachment has often been evaluated through the use of clinical observation or interview, such as through the Strange Situation Protocol for children aged 12 to 20 months old (Ainsworth et al., 1978) or the Adult Attachment Interview which is used for adult participants (George, Kaplan, & Main, 1984).

Evaluation of attachment in infancy typically requires observations of parent and child interactions. At this early stage of development, it is impossible for the infant to give insight into their experience of attachment. However by adolescence, children

are able to provide information about their own perception of their attachments. During adolescence, self-report measures have been employed to evaluate attachment, although the number of available measures is limited (Gullone & Robinson, 2005). Self-report information from adolescents may provide important insights into how adolescents themselves see the world.

One such self-report measure is the Inventory of Parent and Peer Attachment - Revised (IPPA-R) (Gullone & Robinson, 2005). The IPPA-R is one of few self-report measures that allow adolescents to provide insight into their personal feelings about their attachment relationships (Gullone & Robinson, 2005). Whereas attachment is usually considered in discreet attachment categories, the IPPA-R looks at psychological security that is derived from both parent and peer attachments (Gullone & Robinson, 2005). The primary caregiver is thought to act as a secure base for the child to explore the world (Bateman, Brown, & Pedder, 2010). The primary caregiver is also thought to provide psychological security to the child, in the form of providing comfort and help (Armsden, McCauley, Greenberg, Burke, & Mitchell, 1990) and allowing development of cognition and managing affect (Waters & Cummings, 2000).

The IPPA-R evaluates three subscales: trust, communication and alienation. Trust evaluates mutual understanding and respect, whereas communication evaluates good quality communication (Johnson, Ketring, & Abshire, 2003). For these subscales, a higher score represents a better quality of attachment between the child and their caregiver. Conversely the alienation subscale evaluates feelings of isolation and alienation between the child and their caregiver (Johnson et al., 2003). In this case a

higher score represents more alienation and thus a poor quality of attachment. This can be used to give a picture of adolescents' view on their attachment relationship with their parents or caregivers.

Attachment and emotional disorders

Attachment has been implicated in playing a role in the development of mental health disorders. A number of studies have suggested that attachment, particularly insecure attachment, is related to the emergence of both depression (Abela et al., 2005; Lee & Hankin, 2009) and social anxiety (Brumariu & Kerns, 2008) during adolescence. Insecure attachment has been frequently shown to have an influence on the development of depression during childhood and adolescence (Abela et al., 2005; Allen, Porter, McFarland, McElhaney, & Marsh, 2007; Lee & Hankin, 2009). As such, it has been seen as a risk factor for the development of depression (Armsden et al., 1990) and has been linked to low self-esteem and a negative attributional style in adolescents (Armsden et al., 1990; Gamble & Roberts, 2005). Ambivalent and anxious attachment styles have also been implicated in the development of depression during adolescence (Lee & Hankin, 2009). There is evidence that insecure attachments are linked to social anxiety in children (Bar-Haim, Dan, Eshel, & Sagi-Schwartz, 2007; Brumariu & Kerns, 2008; Colonnesi et al., 2011) and that this relationship between attachment and anxiety becomes stronger in adolescence (Colonnesi et al., 2011). In particular, an ambivalent attachment with the mother has been shown to be related to social anxiety (Brumariu & Kerns, 2008). This work suggests that when parents are unavailable or intermittently available, children cannot

rely on their caregivers, which causes fear and distress (Bosquet & Egeland, 2006; Brumariu & Kerns, 2008).

Attachment and emotional recognition

The development of a secure attachment has been linked to face-to-face interactions between the primary caregiver and infant (Blehar, Lieberman, & Ainsworth, 1977; Bowlby, 1969; de Haan & Nelson, 1997; Nakato et al., 2011). Newborn infants show a predisposition for recognising the maternal face over other faces (Pascalis, de Schonen, Morton, Deruelle, & Fabre-Grenet, 1995). The way a caregiver interacts with their child is thought to have an impact on both attachment and emotional recognition. As infants interact with their primary caregiver, they learn skills important for the social world, such as sharing and understanding the emotions of others (Meltzoff & Brooks, 2008). Inconsistent responding in the caregiver has been linked to insecure attachment (Jaffari-Bimmel, Juffer, van IJzendoorn, Bakermans-Kranenburg, & Mooijaart, 2006), possibly leading to difficulties in social and emotion situations.

A number of studies have looked at the impact of attachment on facial emotional recognition in adults (e.g. Niedenthal, Brauer, Robin, & Innes-Ker, 2002; Suslow, Dannlowski, Arolt, & Ohrmann, 2010; Suslow et al., 2009). Individuals with different attachment styles have been shown to detect the extinction of a facial expression at different rates (Niedenthal et al., 2002). Participants were shown pictures of emotional faces that gradually transitioned to neutral faces, with participants indicating when the expression had faded. Individuals with fearful-avoidant

attachments were the first to note extinction of facial expressions, whereas individuals with dismissive and preoccupied attachments identified this extinction later. Furthermore, when distress was invoked, those who were insecurely attached took longer to see negative expressions fade. This seemed to demonstrate an attachment related bias for facial expressions.

While the relationships between attachment and emotional recognition has been widely studied in adults, there is less work completed exploring these relationships throughout childhood and adolescence. Attachment has been shown to impact on the ability to recognise facial emotions between 6 and 11 years old, with insecurely attached children less accurate at recognising facial emotions (Steele, Steele, & Croft, 2008). However, children rated as having disorganized attachment were found to be proficient at reading emotions. Steele, Steele and Croft (2008) argued that children with disorganized attachment might be primed towards negative emotion, citing evidence of a link between hypervigilence to negative emotions in maltreated children (e.g. Pollak, Cicchetti, Hornung, & Reed, 2000). It has been shown individuals with social anxiety are hypervigilant to evidence of social threat (Eastwood et al., 2005), suggesting a possible link between disorganized attachment and social anxiety. Unfortunately, it appears that the specific relationship between disorganized attachment and social anxiety has not been studied in children (Colonnesi et al., 2011), making this hypothesis only speculative.

A universal left-side cradling bias has been found for mothers holding infants (Salk, 1960; Scola, Arciszewski, Measelle, & Vauclair, 2013; Sieratzki & Woll, 2002), with up to 80% of mothers holding their infant towards the left side of their body (Watling,

Workman, & Bourne, 2012). This left-sided cradling bias has been shown to be important for the caregiver to monitor the child's facial emotions (Bourne & Todd, 2004; Hendriks, van Rijswijk, & Omtzigt, 2011; Sieratzki & Woll, 2002). Hendriks, van Rijswijk and Omtzigt (2011) used dolls with attached cameras to investigate the left-siding cradling bias, showing that the position in which a caregiver holds their child affects the visibility of the caregiver's face for the child. The cameras demonstrated that the infant had better visibility of the mother's face when held to the left side. This demonstrated that mothers who held dolls to the left side of their body had better visibility of the doll's face than mothers who held dolls to the right side of their body. Additionally, mothers who held dolls to the left side of their body had better visibility of the doll's face than mothers who held dolls to the right side of their body. The left-sided cradling bias therefore appears to allow a caregiver to monitor their child's emotions and be more responsive, fostering better attachments. In addition, the left-sided cradling bias promotes better emotional recognition in the child (Hendriks et al., 2011), as children need to be exposed to faces to develop emotional recognition skills (Vervloed, Hendriks, & van den Eijnde, 2011). Therefore, it is thought that by caregivers allowing their child to see more of their face, children can experience and learn more about emotional expressions, enhancing their emotion recognition skills.

A left-sided cradling bias has also been linked to lateralization of emotional processing. Women who display a left-sided cradling bias for their children have been shown to be more right hemisphere lateralized themselves (Bourne & Todd, 2004; Vauclair & Donnot, 2005). In addition, mothers who were experiencing psychological difficulties such as depression have been shown to have a reduced left-side cradling

bias (Weatherill et al., 2004). This possibly suggests a role for maternal depression in affecting a child's ability to accurately recognise emotions. It has also been shown that individuals who have been cradled on the left-side demonstrate a right hemisphere bias when completing an emotional recognition task (Vervloed et al., 2011). In contrast, individuals cradled on the right side have a reduced right hemisphere bias for emotional recognition (Vervloed et al., 2011).

The right hemisphere has been shown to be the dominant hemisphere in children under 3 years old (Chiron et al., 1997), when attachment styles are forming. This has been demonstrated by looking at resting cerebral blood flow in children under age 3 (Chiron et al., 1997). It has been suggested that the increased cerebral blood flow in the right hemisphere during infancy supports this hemisphere to develop right hemisphere functions earlier than left hemisphere functions (Chiron et al., 1997). This suggests emotional recognition and lateralization may be developing at this early stage, implicating mother-infant interactions in affecting this process.

It has been suggested that lateralization can change over time, which may be linked to changing attachments. One variable that has been shown to have an impact on emotional lateralization is relationship status (Bourne & Jonauskaite, 2015). Bourne and Jonauskaite (2015) showed that male participants evidenced stronger lateralization than females, but only if they were in a relationship. The authors suggested that the sex difference often seen in emotional lateralization studies might be mediated by additional factors, in this case relationship status. Another factor that has been suggested to impact emotional lateralization is attachment. It has been suggested that lateralization may change as a function of whether an individual is

securely or insecurely attached (Fussell et al., 2012). Supporting this is a recent electroencephalographic study that demonstrated attachment affects right hemisphere emotional processing, showing that adolescents with insecure attachments had an attenuated N170 component over the right hemisphere (Escobar et al., 2013). The authors suggested that the findings demonstrated that insecurely attached adolescents found it more difficult to discriminate between emotions.

Summary

One psychosocial factor that may play a role in the emergence of depression and social anxiety at this time is attachment. Attachment styles begin forming in infancy, and provide a working model for interpersonal relationships throughout the lifespan. Attachment has been implicated in the development of emotional disorders, with insecure attachments linked to the development of both depression and social anxiety. It has been shown that attachment styles can also have an impact on emotional processing, particularly for facial processing. In adult studies, individuals with insecure attachments are shown to preferentially attend to negative expressions. There is also some evidence that insecurely attached children exhibit difficulties with facial processing. Hemispheric lateralization and attachment also appear to impact upon each other. Evidence for this has come from the left cradling bias seen in mothers with infants, alongside studies with adolescents and adults showing that lateralization can change based on attachment style. Attachment therefore seems to play an important role in the development of emotional disorders, whilst also affecting emotional processing.

Puberty

One biological factor that may impact depression and social anxiety is the onset of puberty. The terms 'puberty' and 'adolescence' are often used interchangeably (Sisk & Zehr, 2005), however they differ in important ways. Adolescence generally begins at the onset of puberty, resulting in changes to cognitive, physical and behavioural processes (Blakemore, Burnett, & Dahl, 2010; Sisk & Foster, 2004). Conversely, puberty denotes the development of primary sexual characteristics such as testes and ovaries as well as secondary characteristics such as breasts and pubic hair (Ladouceur, 2012). Puberty is marked by a series of endocrinal changes resulting in increased amounts of sex steroid hormones such as testosterone and estradiol (Peper, van den Heuvel, Mandl, Hulshoff Pol, & van Honk, 2011; Sisk & Foster, 2004; Sisk & Zehr, 2005). Luteinizing hormone is also widely regarded as one of the first markers of puberty onset (Peper et al., 2008).

There are several stages of puberty, beginning with prepuberty occurring at approximately 6 to 9 years in females (Ladouceur, 2012), followed by mid-puberty occurring at around the time breast buds appear in girls and testicles enlarge in boys, around age 11 (Patton & Viner, 2007). Late puberty is then thought to occur around the age of 13 to 14, accompanied by menarche in females and spermarche in boys (Patton & Viner, 2007). Age of pubertal onset generally occurs a year later in males than females (Ladouceur, 2012), although overall there is variation of approximately four to five years in puberty onset (Patton & Viner, 2007). Due to the changes

occurring during both adolescence and puberty, it is likely that factors from both these areas play a role in the onset of depression and social anxiety.

Brain changes during puberty

It was previously assumed that the human brain underwent a process of development during childhood that was largely completed by adolescence (Mills, Lalonde, Clasen, Giedd, & Blakemore, 2014). It is now known that the brain continues to develop into adolescence and adulthood (Sowell, Thompson, Tessner, & Toga, 2001). During adolescence, the brain undergoes a process of significant restructuring (Goddings, Burnett Heyes, Bird, Viner, & Blakemore, 2012; Konrad, Firk, & Uhlhaas, 2013; Lenroot & Giedd, 2006; Shaw et al., 2008). This has been linked to the influence of hormones during puberty. Pubertal hormones are known to affect physical bodily changes (Peper et al., 2011), but there is now also evidence they have an important effect on brain development and organization during adolescence (Neufang et al., 2009; Peper et al., 2011; Sisk & Foster, 2004; Sisk & Zehr, 2005; van Wingen, Ossewaarde, Backstrom, Hermans, & Fernandez, 2011). Areas of the brain related to social cognition are known to be involved in restructuring during adolescence, which may impact the processing and recognition of facial emotions (Blakemore, 2008; Carey, Diamond, & Woods, 1980) and increase the risk of developing emotional disorders (Angold et al., 1999).

The gray matter of the brain comprises the unmyelinated neurons of the brain that make up the cerebral cortex (Lezak, Howieson, Bigler, & Tranel, 2012). The cerebral cortex makes up the cortical structures of both the right and left brain hemispheres

(Lezak et al., 2012). One of the most frequently reported neurobiological changes during adolescence concerns the gray matter. The gray matter of the brain is known to follow a U-shaped pattern of development (Giedd et al., 1999). This comprises an increase in gray matter volume during childhood, which peaks during adolescence and is followed by a decline into adulthood (Blakemore, 2008). When looking at the social brain network, it has been reported that the gray matter continues to develop into adolescence, before declining in adulthood (Mills et al., 2014). This again suggests that puberty related changes to the gray matter during adolescence might impact on emotional recognition and the development of emotional disorders.

Puberty, brain changes and emotional disorders

The amgydala resides in the temporal lobe, the gray matter of which has been shown to develop until age 16 to 17, before beginning to decline (Giedd et al., 1999). The amygdala is one structure composed of gray mater thought to be heavily involved in emotional processing (Sergerie, Chochol, & Armony, 2008) and has been shown to be activated in facial processing (Morris et al., 1998). Individuals who suffer damage to the amygdala during childhood have difficulties recognising complex emotions (e.g. fear), whereas individuals who suffer damage later do not (Adolphs, Damasio, Tranel, & Damasio, 1996; Adolphs, Tranel, Damasio, & Damasio, 1994; Adolphs, Tranel, Damasio, & Damasio, 1995, Herba & Phillips, 2004).

In individuals with depression, the amygdala has been shown to display hyperactivation to faces, especially fearful faces, in comparison to a healthy control group (Sheline et al., 2001). The amygdala has also been shown to increase activation

in response to angry, disgusted and fearful faces in adults with social anxiety (Phan, Fitzgerald, Nathan, & Tancer, 2006). This suggests a hyperactivity of gray matter regions in response to socially threatening faces in individuals with social anxiety. Similar findings have been reported in adolescents when viewing fearful faces, but not happy faces (Killgore & Yurgelun-Todd, 2005). Adolescents in this study did not have social anxiety, but rather scored highly on measures related to social anxiety including peer rejection, humiliation and performing in public. This suggests altered amygdala responses may be seen even in subclinical levels of social anxiety. Further to this, it has been shown that gray matter is reduced in individuals with depression and anxiety. Gray matter reductions were evidenced in the anterior cingulated cortex and prefrontal cortex in individuals with depression and in the amygdala and hippocampal regions when depression and anxiety were co-morbid (Bora, Fornito, Pantelis, & Yucel, 2012). Taken together, these studies suggest that changes to the gray matter can impact on depression and social anxiety.

Sex differences have been noted across gray matter development. Peak age of gray matter volume typically occurs around age 11 to 12 (Blakemore, 2012), linked to sex steroids (Peper et al., 2011). Peak gray matter thickness is achieved in females approximately one year before it is achieved in males (Giedd, 2004). Males have also been shown to have larger gray matter volumes than females, although cortical thickness does not differ (Mills et al., 2014). Areas of the temporo-parietal junction gray matter have also been shown to reach peak surface area in females two years earlier than in males (Mills et al., 2014). Estradiol has been linked to decreased gray matter across several brain areas in female, but not male, brains (Peper et al., 2009). Testosterone has also been shown to have differential effects on males and females,

being linked to an increase in gray matter volume in males but a decrease in females (Bramen et al., 2011). This fits with evidence showing that males have larger amygdala volumes and gray matter densities in adulthood (Sergerie et al., 2008). In line with the idea that pubertal hormones may affect brain structure and organization, advanced pubertal stage has been shown to predict loss of gray matter in females, even when age is controlled (Bramen et al., 2011). As gray matter changes have been implicated in emotional recognition in depression and social anxiety, sex differences may differentially affect ability to recognition emotions during adolescence.

Puberty, brain changes and emotional recognition

The ability to recognise emotions from faces develops between the age of 4 for basic emotions, and by the age of 11 for more complex emotions (Herba & Phillips, 2004). At this point, discrimination of facial emotions reaches accuracy levels similar to adults (Durand, Gallay, Seigneuric, Robichon, & Baudouin, 2007). It may be expected that the ability to recognise facial expressions would improve over time in a linear fashion. However, several studies have presented evidence of a "dip" or plateau in recognition of facial emotions during early adolescence (e.g. Carey et al., 1980; Chiang, Ballantyne, & Trauner, 2000; Chung & Thomson, 1995; McGivern, Andersen, Byrd, Mutter, & Reilly, 2002; Thomas, De Bellis, Graham, & LaBar, 2007). Children's ability to recognise emotional faces has been shown to typically improve between 8-10 years, followed by a dip between 12-14 years and recovery by 16 years (Carey et al., 1980; Chung & Thomson, 1995). Additionally, children aged 11 to 12 years old have been shown to have slower reaction times to emotional faces than children aged 10 years old, which recovers by age 15 (McGivern et al., 2002).

There is evidence this transient dip in the ability to recognise and process emotional information is related to changes occurring during puberty (McGivern et al., 2002). The finding that the structure of the brain undergoes significant changes after the age of approximately 9 to 10 years old (Giedd et al., 2006), following the onset of puberty, seems to implicate puberty as a crucial time for these changes. In line with this hypothesis, there is evidence emotional processing is related to brain changes occurring during puberty (Blakemore, 2008; Thomas et al., 2007). For example, one study showed improved performance on an emotional recognition task was related to age-related activation of gray matter areas involved in emotional processing (Cohen Kadosh, Johnson, Dick, Cohen Kadosh, & Blakemore, 2013). In the study by Cohen Kadosh and colleagues (2013), participants were asked to complete three face-related processing tasks. These included detecting an identity, recognising an emotional expression and detecting a face with a particular eye gaze. It was found that adolescents, who activated less gray matter areas than adults, were less accurate at completing the expression recognition task than adults.

There is some evidence from studies with adults that suggests hormones may affect performance on emotional processing tasks (Peper et al., 2011; Sisk & Foster, 2004; Sisk & Zehr, 2005; van Wingen et al., 2011). For example, women who cannot produce estrogen have been shown to have difficulties processing facial emotions, particularly threat-related expressions (Lawrence, Kuntsi, Coleman, Campbell, & Skuse, 2003; Scherf, Behrmann, & Dahl, 2012). Studies have also examined women across the menstrual cycle. During times of high progesterone (e.g. during the mid-luteal phase of the menstrual cycle) women have been shown to perceive faces

displaying fear and disgust with averted gaze as more intense than faces with direct gaze (Conway et al., 2007). This finding was not replicated during times of low progesterone (e.g. during the follicular phase of the menstrual cycle). Emotional recognition has also been found to be more accurate when progesterone is lower (Derntl, Kryspin-Exner, Fernbach, Moser, & Habel, 2008).These findings may suggest that emotional processing is not fully developed by childhood, but develops into adolescence. Moreover it appears that hormones play an important role in the ability to effectively process emotions during adolescence.

It has also been suggested that hormones may affect emotional lateralization (Bourne, 2014, Bourne & Gray, 2009). Research has shown that there is evidence of lateralization fluctuations across the menstrual cycle (Hausmann & Güntürkün, 2000). Stronger lateralization patterns have been found during the follicular phase when progesterone was low, whereas weaker lateralization patterns were found during the luteal phase when progesterone was high (Hausmann & Güntürkün, 2000). Exposure to prenatal hormones has also been used to provide clues regarding the relationship between hormones and lateralization. 2D:4D ratio has been shown to be a good indicator of prenatal hormone levels (Manning, Scutt, Wilson, & Lewis-Jones, 1998). This involves looking at the relative lengths of the ring and index fingers, with a shorter index (4^{th} Digit: 4D) finger compared to a ring finger (2^{nd} Digit: 2D) indicating higher testosterone (Bourne, 2014). This measure has been used to show that male participants exposed to higher levels of prenatal testosterone demonstrate stronger right hemisphere lateralization for emotional processing (Bourne, 2014; Bourne & Gray, 2009). This effect is particularly pronounced for emotions such as disgust and surprise (Bourne, 2014).

At present, the majority of work that has been conducted looking at hormones and emotional lateralization has considered the effect of hormonal exposure in utero (e.g. Bourne, 2014; Bourne & Gray, 2009) or fluctuations during the menstrual cycle (e.g. Hausmann & Güntürkün, 2000). More recent work has also identified laterality changes during pregnancy, which coincided with changing hormone levels at this time (Jonauskaite & Bourne, 2014). Jonauskaite and Bourne (2014) also demonstrated that lateralization returned to pre-pregnancy levels by three months post-partum, implicating hormones in lateralization changes. However, current studies examining lateralization of emotional processing have typically examined children up to 11 years old and then in early adulthood (from 19 years) onwards. This relationship has therefore not been examined in children who are currently going through the stages of puberty. To gain a greater understanding of the effects of hormones on emotional lateralization, puberty would be the ideal time to explore this relationship.

Summary

Emotional facial recognition was previously assumed to reach adult levels by late childhood. However more recent evidence suggests that developments may continue into adolescence and adulthood. The brain is now known to undergo a significant process of restructuring during adolescence. Puberty occurs during adolescence, accompanied by a predominance of sex steroid hormones, occurring at the same time as the increase in depression and social anxiety. Puberty hormones have been implicated in affecting the structure and organization of the brain. Hormonal changes have also been linked with changes to emotional recognition and lateralization, but

this has predominantly been studied in adults. It is therefore presently unclear whether there are changes in lateralization during adolescence. Changes occurring to the brain during puberty therefore indicate an interesting context in which to study factors related to depression and social anxiety in adolescence.

Recognition and processing of emotions

It has been suggested there are six universal emotions: Anger, disgust, fear, happiness, sadness and surprise (Ekman, 1972). These are thought to be innate, and can be recognised from a young age (Horstmann, 2003). Emotional facial expressions can efficiently summarize information about what others are feeling and doing (Niedenthal & Brauer, 2012). Being able to quickly recognise, understand, and process emotions is important for social interactions (Lemerise & Arsenio, 2000), social communication (Batty & Taylor, 2003) and adjusting behaviours relative to social cues (Pollak, 2008). Emotional processing encompasses the cognitive processes in which the brain recognises and interprets emotion. Difficulties with emotional processing have been linked to emotional disorders such as depression and social anxiety (Herba & Phillips, 2004).

Facial expressions are thought to be one of the most important nonverbal channels for guiding and informing social behaviour (Adolphs, 1999). In line with this, newborn infants seem to show an innate preference for faces (Campos, Thein, & Owen, 2003; Mondloch et al., 1999). However the ability to accurately recognise facial emotions develops over time. From the age of approximately eight months, facial expressions can reinforce behaviour, and help infants learn how to respond in social situations

(Campos et al., 2003). Using the visual cliff experiment, facial expressions have been shown to regulate the infant's behaviour. Infants often refuse to cross a sheer drop covered with glass in response to fearful faces, but cross in response to a happy face (Campos et al., 2003). Experience of facial expressions during childhood is known to have an important impact on the ability to accurately discriminate facial expressions (Pollak & Sinha, 2002). During childhood, children learn to perceive emotional information from faces, process that information, and then react in accordance (Pollak, 2008). This suggests that early social interactions are important for allowing children to learn how to read facial emotions.

Facial expressions continue to perform a functional role throughout the lifespan. Evidence from this comes from individuals with brain damage, who have been shown to often have difficulties using facial expressions to make accurate social judgements (Adolphs, Tranel, & Damasio, 1998). For example, Adolphs and colleagues (2005) described an individual who was unable to make social judgements in response to negative facial expressions, leading to indiscriminately friendly behaviour. This made it difficult for the individuals to sense danger from others, providing an example of how difficulties reading facial expressions may lead to social problems.

Emotional recognition in adults with depression and social anxiety

There is a substantial body of evidence demonstrating that individuals with depression and social anxiety process emotional information differently to those who do not have depression and social anxiety (Delle-Vigne, Wang, Kornreich, Verbanck, & Campanella, 2014; Demenescu, Kortekaas, den Boer, & Aleman, 2010). Previous

research suggests that individuals with depression and social anxiety are more sensitive to small changes in emotional expressions, and can often misinterpret emotional information.

Depression has been linked to information processing biases, particularly a mood congruent bias for negative information (Delle-Vigne et al., 2014; Fales et al., 2008). In this sense, a mood congruent bias refers to the idea that individuals with depression are more likely to attend to negative information and perceive information as negative, in line with their own mood. A number of studies that have looked at emotional facial processing in individuals with depression support a negative mood congruent processing bias (Bourke, Douglas, & Porter, 2010; Delle-Vigne et al., 2014; Ritchey, Dolcos, Eddington, Strauman, & Cabeza, 2011). Evidence suggests that people with depression demonstrate poorer accuracy when identifying happy faces compared to healthy controls (Surguladze et al., 2005). In addition, depressed individuals have been shown to recognise neutral faces slower than sad faces (Lappänen, Milders, Bell, Terriere, & Hietanen, 2004) and direct more attention to sad expressions (Gotlib, Krasnoperova, Yue, & Joormann, 2004). Together, this research suggests that individuals with depression are hypersensitive to sad stimuli.

Adults with depression have also been shown to find it more difficult to recognise happy or angry emotions when these are presented at a lower intensity, but can accurately detect sad emotions at a lower intensity (Joormann & Gotlib, 2006). This suggests that individuals with depression are hypersensitive towards expressions of negative emotion, needing a lower intensity of the emotion to be able to detect it. Conversely, they may find it difficult to disengage from this to detect other emotions

such as happiness, thus requiring a greater intensity of the emotion for accurate identification. It has been suggested that the evidence showing that individuals with depression preferentially attend to negative information is likely to be a contributing factor to negative social interactions (Bourke et al., 2010).

Ambiguous facial expression have often been shown to be interpreted in a negative way by individuals with depression (Bourke et al., 2010). Lappänen and colleagues (2004) investigated whether depression was related to a processing bias towards neutral faces compared to happy and sad faces. This study demonstrated that depressed adult participants were less accurate at identifying neutral faces. Other studies that have used neutral faces to examine facial recognition have also reported evidence of a negative interpretation bias in individuals with depression (Bouhuys, Geerts, & Gordijn, 1999; Douglas & Porter, 2010). Furthermore, there has been evidence that adults with severe depression have difficulty recognising some facial emotions (Douglas & Porter, 2010). In the study by Douglas and Porter (2010), adults with depression displayed the usual negative interpretation bias, with neutral faces more likely to be interpreted as sad. In addition, adults with depression also had difficulty in the recognition of disgust, an effect that was not seen in healthy controls. Together, these findings suggest that people with depression may have a bias towards perceiving ambiguous emotional expressions in a negative way (Bourke et al., 2010).

Individuals with social anxiety may also display atypical emotional processing. Previous research has shown that adults with social anxiety have been shown to be hypersensitive to facial emotions that indicate disapproval or threat (Eastwood et al., 2005). Women with social anxiety have been shown to be able to detect negative and

threat-related facial expressions at lower intensities compared to both control participants and individuals with depression (Arrais et al., 2010; Joormann & Gotlib, 2006). To further support this, attentional tasks have demonstrated that socially anxious individuals detect unhappy faces faster than positive faces. This was shown during a task in which participants had to locate a happy or sad face when presented with neutral faces acting as distractors (Eastwood et al., 2005; Mogg, Philippot, & Bradley, 2004). This finding was revealed despite the authors using simple 'smiley' faces, rather than human facial displays of emotion. Individuals with high levels of social anxiety have also been shown to take longer to recognise happy expressions compared to people with low social anxiety (Silvia, Allan, Beauchamp, Maschauer, & Workman, 2006). Finally, adults with high social anxiety are more likely to perceive emotional expressions of others as negative, especially when those expressions were neutral (Winton, Clark, & Edelmann, 1995). These results fit with the suggestion that individuals with social anxiety anticipate other people as threatening and critical (Clark & Wells, 1995; Silvia et al., 2006).

Emotional recognition in children with depression and social anxiety

There is some limited evidence that children with emotional disorders show altered facial emotional processing. A bias towards negative emotions was found in depressed children and adolescents, although only when negative emotional expressions were presented at low intensity (Schepman, Taylor, Collishaw, & Fombonne, 2012). This suggests a particular hypersensitivity to negative emotions in depressed children. Children of mothers that have experienced recurrent depression have been argued to be at higher risk of also developing depression (Goodman &

Gotlib, 1999). Joormann, Talbot and Gotlib (2007) therefore looked at attention to emotional faces in children aged 9 to 14 with mothers who experienced recurrent depression and children with mothers who had not experienced depression. This study found that children of mothers who experienced depression had a selective attention bias for sad facial expressions, whereas the control group showed an attention bias for happy facial expression.

Neuroimaging studies have also shown that, at a neural level, emotional processing is altered in children and adolescents with depression. Children with major depressive disorder aged 13 to 18 were shown to have reduced differential activation of the insular cortex in response to sad expressions (versus happy expressions) compared to a healthy control group (Henje Blom et al., 2015). This reduced differential activation was also shown to correlate with higher severity of depression symptoms. Another study used fMRI to evaluate brain activity in children aged 12 to 19 with major depressive disorder and healthy controls (Hall et al., 2014). The study by Hall and colleagues (2014) used happy and fearful facial emotions, and controlled for co-morbid anxiety. The results demonstrated that for the adolescents with major depressive disorder, there was increased amygdala activity in response to fearful faces but also lower right hemisphere activation in widespread areas. However, another study looking at girls aged 8 to 16 found reduced activation in the amygdala when viewing fearful faces, compared to a healthy control group (Thomas et al., 2001). Together these findings suggest facial processing is altered in children and adolescents with depression.

Few studies have looked specifically at emotional recognition in social anxiety in children and adolescents. In the studies that have looked at socially anxious children and adolescents, the ability to identify emotions through facial expressions also seems altered (Blair et al., 2011). Using fMRI, Blair and colleagues (2011) demonstrated that, compared to a healthy control group, both adults and adolescents with social anxiety showed increased activation in amygdala and anterior cingulate cortex when viewing angry and fearful faces. The authors argued that these results demonstrated that patterns of activation seen in adults are also present in children, suggesting these pathways are already in place by adolescence. A longitudinal study looked at neural correlates of social anxiety in children aged 8 to 9 and the same children as adolescents aged 14 to 15 (Battaglia et al., 2012). The authors found that increased cerebral activity at age 8 to 9 was linked to increase social anxiety symptoms at age 14 to 15, and this effect was particularly notable for angry expressions. Results from neuroimaging studies therefore suggest emotional recognition is altered in children and adolescents with social anxiety.

Socially anxious children and adolescents have also been shown to be more likely to report seeing an emotion on a neutral face (Melfsen & Florin, 2002). However, there was no difference in whether the socially anxiety participants reported seeing positive or negative facial expressions on neutral faces (Melfsen & Florin, 2002). In addition, children and adolescents with social anxiety were shown to take longer to make decisions about facial emotions (Melfsen & Florin, 2002). The authors argued this may be related to cognitive style, with individuals with social anxiety are more cautious towards facial displays of emotions. Other studies have reported similar findings. In a study where children were asked to identify different facial emotions,

socially anxious children were again shown to be less accurate at identification and also reported more anxiety after completing the task (Simonian, Beidel, Turner, Berkes, & Long, 2001). There may even be a difference between genders for this relationship, with socially anxious girls being shown to be significantly less accurate at recognising disgust, compared to socially anxious boys (Lee, Herbert, & Manassis, 2014). Together, these findings therefore suggest emotional recognition is affected in children with social anxiety.

Sex differences in emotional recognition

There is evidence of sex differences in emotional recognition. In adults, there is evidence that females are more proficient at emotional recognition than males (Hall, 1978). Evidence of a female advantage for facial emotional recognition has been shown in adults (Hall, 1978; Hampson, van Anders, & Mullin, 2006) as well as infants, children and adolescents (McClure, 2000). This is a robust finding, in which women have been shown to be more accurate (Thayer & Johnsen, 2000) and faster (Rahman, Wilson, & Abrahams, 2004) at identifying both positive and negative facial emotions (Hampson et al., 2006). Women have also been shown to be able to recognise emotional expressions with more sensitivity (Katsikitis, Pilowsky, & Innes, 1997) than males.

Girls have been shown to demonstrate an emotional recognition advantage in preschool and adolescence (McClure, 2000). Reasons for this difference has been linked to differences in parental and peer scaffolding, beginning from the first year of life (McClure, 2000). There has been evidence to suggest caregivers show subtle

differences between socializing boys and girls to emotions (McClure, 2000). This has been shown preverbally, with mothers being more expressive, particularly for positive emotions, towards their daughters rather than their sons (Fogel, Toda, & Kawai, 1988; Malatesta et al., 1989). This suggests one pathway in which sex differences in emotional recognition may emerge.

Theories of emotional lateralization

Interest in the relationship between emotional processing and brain maturation has increased in recent years. One area that has interested researchers is the extent that emotional processing is lateralized between the right and left-brain hemispheres. Emotional processing has been shown to become increasingly right hemisphere lateralized during early development. Whereas a right hemisphere advantage does not exist by five years of age, this advantage is present by 10 to 11 years of age (Workman, Chilvers, Yeomans, & Taylor, 2006). Studies with children typically show a link between increasing right hemisphere lateralization and an improved ability to process emotions, leading to both improved accuracy (Workman et al., 2006) and faster reaction times (Bourne, 2008a). Additionally, increased lateralization also appears to be related to children's understanding of how facial emotions may not adequate represent internal feelings (Watling & Bourne, 2007). However, whether lateralization has a casual role on the ability to recognise emotion is still unclear.

It is now generally accepted that the right brain hemisphere plays some role in emotional processing (Bourne & Vladeanu, 2013; Watling et al., 2012). However the extent to which all emotional processing is lateralized to the right hemisphere is

debated. This has led to the emergence of three different models of asymmetry in emotional processing: The approach-withdrawal hypothesis, the valence hypothesis and the right hemisphere hypothesis. However, the majority of research has primarily focussed on the right hemisphere hypothesis and the valence hypothesis (Alves, Fukusima, & Aznar-Casanova, 2008).

Approach-withdrawal Theory

The approach-withdrawal theory of emotional processing theorises that both brain hemispheres are differentially involved in emotional processing (Davidson, Ekman, Saron, Senulis, & Friesen, 1990). It has been proposed that each cerebral hemisphere is differently specialised for approach and withdrawal behaviour, with the left hemisphere overseeing approach behaviour and the right hemisphere overseeing withdrawal behaviour (Davidson, 1992, 1995). This theory emerged from the observation that children who reach out for objects often do so with their right hand, corresponding to the left brain hemisphere (Davidson, 1992). It has also been suggested that different emotions trigger approach (e.g. happiness, surprise) and withdrawal (e.g. disgust, anger, fear, sadness) behaviour (Davidson et al., 1990). In line with this, it has been hypothesized that different brain hemispheres underpin processing of different emotions (Davidson et al., 1990). Positive emotions are seen as more likely to trigger approach behaviour, with negative emotions more likely to trigger withdrawal behaviour (Davidson, 1992). As such, it has been hypothesised that the left hemisphere processes positive (approach) emotions, and the right hemisphere processes negative (withdrawal) emotions (Davidson, 1992).

Valence hypothesis

The valence hypothesis is similar to the approach-withdrawal theory in many ways, but also has important differences. The valence hypothesis suggests emotional processing occurs within both brain hemispheres, dependent on the type of emotion being processed (Davidson, 1995). It is therefore similarly suggested that the left hemisphere processes positive emotions, whereas the right hemisphere processes negative emotions (Davidson, 1992, 1995). However unlike the approach-withdrawal theory, it is the emotional valence of the stimuli that determines which hemisphere processes the emotion (Alves et al., 2008; Killgore & Yurgelun-Todd, 2007).

This theory evolved from observations of individuals with brain damage. This has shown that individuals with left-hemisphere lesions were more likely to experience negative mood (Starkstein, Robinson, & Price, 1987), whereas those with right-hemisphere lesions were more likely to experience positive mood (Starkstein et al., 1989; Starkstein et al., 1987). Another study examined right-handed stroke patients with either right or left sided lesions (Robinson, Kubos, Starr, Rao, & Price, 1984). Individuals with localised left brain damage experienced more severe depression than individuals with localised right brain damage. However, in these studies the location of the lesion was also important, and may have impacted on the results.

The valence hypothesis has gained support across several paradigms with healthy participants, including neuroimaging studies (e.g. Canli, Desmond, Zhao, Glover, & Gabrieli, 1998; Dolcos, LaBar, & Cabeza, 2004), electroencephalogram (EEG) studies (e.g. Aftanas, Varlamov, Pavlov, Makhnev, & Reva, 2001; Davidson & Irwin,

1999; Wheeler, Davidson, & Tomarken, 1993) and behavioural studies (e.g. Jansari, Rodway, & Goncalves, 2011; Jansari, Tranel, & Adolphs, 2000). In one functional magnetic resonance imaging (fMRI) study (Dolcos et al., 2004), healthy participants were asked to look at images showing either showing positive, negative or neutral situations and rate the pleasantness of the image. The results demonstrated that the left dorsolateral prefrontal cortex was activated when the emotion was positive, whereas the right ventromedial prefrontal cortex was activated when the emotion was negative. Similarly, in another fMRI study (Canli et al., 1998) healthy participants viewed positively or negatively valenced images. When controlling for arousal the images evoked, the authors found that there was increased blood flow over the right hemisphere for negatively valenced images. Conversely, positively valenced images increased blood flow over the left hemisphere.

EEG studies have also provided some support for the valence hypothesis. One study (Aftanas et al., 2001) looked at event related synchronization (representing an increase in amplitude and rhythmic activity) and desynchronization (representing a decrease in amplitude and reduced rhythmic activity) in healthy participants who viewed images that were positively, negatively or neutrally valenced. The authors demonstrated that in the first 700 milliseconds there was greater right hemisphere synchronization for negatively valenced images, and greater left hemisphere synchronization for positively valenced images. Another study (Wheeler et al., 1993) compared baseline activation to that seen after individuals had viewed positive and negative emotional film clips. When the clips demonstrated positive affect, left frontal activation was demonstrated, with negative affect demonstrating the opposite pattern.

In addition to other methods, behavioural studies have also provided support for the valence hypothesis. In one study, participants were shown images of two faces, where one face contained a neutral expression, whereas the other contained a neutral expression morphed with an emotional expression. The face containing the emotional expression appeared on either the right or left side, as a chimeric face. Participants then decided which of two faces best matched an emotional label. Positive emotions were identified more accurately if presented on the right side (corresponding to the left hemisphere), whereas negative emotions were identified more accurately if presented on the left side (corresponding to the right hemisphere) (Jansari et al., 2011; Jansari et al., 2000).

Although there is some support for the valence hypothesis, studies using neuroimaging and EEG have often not used emotional facial images as their stimuli. Instead, studies have utilized emotional words or more general emotional images, such as those from the IAPS (e.g. images of snakes, accidents, illness, and landscapes).

Right hemisphere hypothesis

The right hemisphere hypothesis posits that the right hemisphere plays a dominant role in the recognition of all emotions (Alves et al., 2008; Borod et al., 1998; Killgore & Yurgelun-Todd, 2007). A right hemisphere bias for processing emotional faces has been found across many studies with children and adults (e.g. Aljuhanay, Milne, Burt, & Pascalis, 2010; Chiang et al., 2000; Indersmitten & Gur, 2003; Levine & Levy,

1986; Watling & Bourne, 2013). As early as the turn of the century, there was observations that damage to the right brain hemisphere resulted in reduced emotional expression recognition (Mills, 1912). This was supported by early work looking at hemispheric lateralization in participants throughout the lifespan (Levine & Levy, 1986). The study by Levine and Levy (1986) demonstrated that although there was evidence of right hemisphere lateralization in older adults, this effect was weaker in the youngest children (aged 5 to 6). More recent studies with adults with right hemisphere brain damage have also supported this hypothesis. Borod and colleagues (1998) looked at individuals with right brain damage, left brain damage and healthy controls. They asked participants to identify emotions presented across a range of emotional channels, including facial expressions. Individuals with right brain damage were shown to be impaired on these tasks, compared to individuals with left hemisphere damage and healthy controls. Similar findings have been reported for both adults (Adolphs et al., 1996; Kucharska-Pietura & David, 2003) and children (Bava, Ballantyne, May, & Trauner, 2005) with unilateral brain damage.

Support for the right hemisphere hypothesis has come from studies employing a variety of different techniques, including neuroimaging (e.g. Nakamura et al., 1999; Narumoto, Okada, Sadato, Fukui, & Yonekura, 2001), electroencephalography (EEG) (e.g. Batty & Taylor, 2006; Taylor, McCarthy, Saliba, & Degiovanni, 1999) and behavioural tasks (e.g. Workman et al., 2006, Watling & Bourne, 2013). Using functional magnetic resonance imaging (fMRI), it has been shown that selectively attending to facial emotion activates right hemisphere regions in adults (Narumoto et al., 2001). In a positron emission tomography study (Nakamura et al., 1999), adult participants were asked to look at a range of facial emotions and label them as

'positive', 'neutral' or 'negative'. Cerebral blood flow was significantly activated over the right inferior frontal cortex during this task.

EEG studies have also supported the right hemisphere hypothesis. In one such study, processing of faces was compared with processing of cars and images of scrambled faces and cars (Taylor et al., 1999). This showed that adult participants demonstrated a clear right hemisphere bias for processing of intact faces, although the evidence for this relationship was weaker in children. However a further study demonstrated increased right hemisphere activation in response to faces as children reached 10 to 13 years of age (Batty & Taylor, 2006). This may suggest that a right hemisphere bias for processing of facial emotions develops over time.

One behavioural measure widely employed with children and adults is the chimeric faces test. Participants are presented with a vertically split image of a face, with one side displaying an emotional expression and the other side a neutral expression. For example, the image may contain a face with the emotional expression on the right and a neutral expression on the left. Another image then contains the reverse pattern and participants are asked to decide which face looks more emotional. An example of this task for the emotion happiness can be seen in Figure 1. This task relies on the cross nature of the visual system, where images presented to the left visual field are processing by the right hemisphere, and images presented to the right visual field are processed by the left hemisphere. A right hemisphere bias is assumed if individuals choose the image with the emotional expression presented on the left side of the face (Bourne, 2010). Chimeric face stimuli can be presented as separate trials or, more commonly, mirror images of the face stimuli can be presented simultaneously

(Bourne, 2010). Although both versions of the chimeric faces test have been shown to be reliable, presenting the chimeric stimuli together promotes higher reliability (Bourne & Gray, 2011).

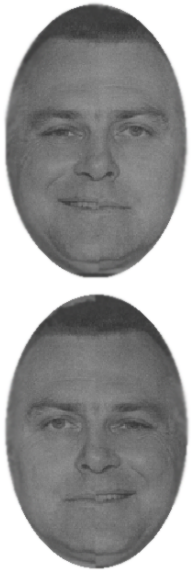


Figure 1. Example happiness trial from the chimeric faces test.

The ecological validity of the chimeric faces test has been previously debated (e.g. Butler & Harvey, 2006). It has been questioned whether actors who pose for photographs and evoke images are representative of authentic facial emotions (Indersmitten & Gur, 2003). It has also been argued that participants may not engage typical face processing mechanisms for faces that look obviously chimeric, as with the stimuli typically used in the chimeric faces test (Burt & Perrett, 1997). However, other authors have argued that the use of realistic photographic images of faces provide a good degree of ecological validity for the measure (Luh, Rueckert, & Levy, 1991).

Previous research has used other methods of examine hemispheric lateralization, including fMRI (Nakamura et al., 1999; Narumoto et al., 2001), EEG (Batty & Taylor, 2006; Taylor et al., 1999) and divided visual field behavioural tasks (Heller & Levy, 1981). Functional MRI studies involve participants completing a task (e.g. to assess the emotional expression on a face) whilst changes in blood flow in the brain are measured. Similarly, EEG studies involve measuring event related potentials (a form of electrophysiological brain response) during a task, such as an emotional recognition task. Divided visual field tasks are based on the assumption that when a stimulus is presented to a particular visual field, it is received and processed by the contralateral hemisphere of the brain (Beaumont, 1983; Bourne, 2006). It is therefore proposed that visual field effects will reflect distinctions in hemispheric processing that occur at an early point in time. Participants complete this task on a computer, where they are presented with a series of trials in which they are required to fixate on the centre of the screen, followed by stimulus presentation to one visual field and are asked to make a response. A full review of divided visual field tasks can be found in Bourne (2006).

Each of these paradigms can provide information on hemispheric lateralization, but each also comes with limitations. For example, practical and financial considerations are important for EEG and fMRI studies, particularly when recruiting a large number of participants. Functional MRI and EEG studies also require specialist equipment, which is not always available (Bourne, 2006). These methods can be inconvenient for participants as participation is often time consuming, and requires participants to travel to a specific site for participation. As a behavioural measure, divided visual

field tasks are generally more accessible than neuroimaging studies. However, due to the nature of these divided visual field tasks fixation and distance from the screen also needs to be controlled, requiring the use of a chin rest (Bourne, 2006). Practically, this can be challenging when conducting research in a setting such as a school. Alternatively, the chimeric faces test can be administered in a school environment with only the use of a laptop or desktop computer.

In addition to practical limitations, each paradigm also has methodological drawbacks. Tasks in fMRI studies can potentially be more ecological valid than the chimeric faces test (e.g. including moving images or videos). However, this also increases heterogeneity of brain activity, making it more difficult to be sure that the lateralization effects are due to the emotional recognition element of the task (Brown et al., 2014). EEG studies have similarly been shown to have methodological drawbacks, which have been thoroughly reviewed in Davidson (1988). For example, Davidson (1988) notes that eye and muscle artefacts can affect reliability of indices of hemispheric asymmetry. Furthermore, the location of the electrodes requires extra consideration in studies of hemispheric asymmetry, as the magnitude of asymmetry can be biased by incorrect placement (Davidson, 1988). With divided visual field tasks, a response to the stimuli presented to each visual field is required. It is possible this response has some impact on the measured hemispheric asymmetries (Beaumont, 1983; Bourne, 2006). This clearly shows that all measures of hemispheric lateralization present both strengths and weaknesses.

The chimeric faces test has been shown to be a valid and reliable measure of lateralization. Chimeric stimuli have been used with patients who have undergone

corpus callosotomy (Levy, Trevarthen, & Sperry, 1972). Corpus callosotomy involves sectioning of the corpus callosum, separating the two hemispheres of the brain (Asadi-Pooya, Sharan, Nei, & Sperling, 2008). Despite the hemispheres being unable to communicate, participants demonstrated a preference for emotions presented on the left-hand side, supporting right hemisphere lateralization (Levy et al., 1972). More recently, the chimeric faces test has been used with adults (Kucharska-Pietura & David, 2003) and children (Bava et al., 2005) with unilateral brain damage. These studies used the chimeric faces test to demonstrate that individuals with right hemisphere damage displayed attenuated right hemispheric lateralization, whereas individuals with damage to the left hemisphere demonstrated a typical lateralization pattern. A reliability estimate of .893 was found for right hemisphere processing biases when using chimeric facial stimuli, showing good reliability for the measure (Luh et al., 1991). Together this suggests the measure is both valid and reliable at detecting lateralization.

Prior to work by Christman and Hackworth (1993), the chimeric faces test had only been used with happy expressions. Recognition of happiness reaches adult levels by 5 years of age (Gao & Maurer, 2009). Right hemisphere lateralization also appears to emerge at this age (Workman et al., 2006), possibly presenting a bias for the paradigm. Christman and Hackworth (1993) therefore expanded the chimeric faces test to include both positive and negative expressions, showing the chimeric faces test could evidence a right hemisphere bias with both positive and negative emotional expressions. Workman and colleagues (2006) expanded on this by including the six universal Ekman emotions in their Chimeric stimuli, and similarly demonstrated a right hemisphere processing bias across emotions. This demonstrated no evidence of a

hemisphere advantage in children aged 5 to 6. However, by age 10 to 11 a hemispheric advantage was present for all six emotions, similar to the hemispheric advantage seen in adults. In addition, Workman and colleagues (2006) demonstrated that lateralization for happiness and sadness developed earliest.

Emotional lateralization in adults with depression and social anxiety

Processing of facial emotion appears to be atypical in individuals with emotional disorders (Bistricky, Ingram, & Atchley, 2011). Looking at neural differences in emotional processing of individuals with depression and social anxiety may therefore shed some light on the development and maintenance of emotional disorders. If the recognition of emotional faces is different in individuals experiencing depression and social anxiety, lateralization may also be different in comparison to healthy controls. This may shed some light on whether neural changes give rise to the affective and social symptoms for people experiencing emotions disorders, as well as informing treatment options (Bourke et al., 2010).

Research has suggested that lateralization for emotional processing is altered in adults with depression. The findings of these studies support suggestions that that individuals with depression preferentially attend to negative emotions, which impacts on right hemisphere activation. Firstly, greater resting activation of the right hemisphere has been reported in several studies examining individuals with depression (Hecht, 2010; Otto, Yeo, & Dougher, 1987; Reischies, Hedde, & Drochner, 1989). Increased right hemisphere activation has also been shown during emotional processing tasks, particularly when viewing negative emotions (Fu et al.,

2008; Yecker et al., 1999). Conversely, reduced activity has been noted in the left hemisphere during an emotional processing task (Grimm et al., 2008). EEG studies have therefore demonstrated differential activation for emotional processing in individuals with depression. However, increased right hemisphere activation has not always been found. During an fMRI study, individuals with major depressive disorder were shown to exhibit a reduced response to all facial expressions, with the exception of sadness (Lawrence et al., 2004). Participants were asked to look at faces displaying happiness, sadness and fear, which had been modified to display either 50% or 100% intensity of the emotion. Lawrence and colleagues (2004) demonstrated that there were trends towards increased activation of the left hemisphere in individuals with depression when looking across all emotional expressions, but results did not quite reach significance.

Research has also explored emotion processing using behavioural tasks, which have demonstrated inconsistent differences between individuals with depression and healthy controls. Using the chimeric faces test to compare depressed individuals with healthy controls, it was found that right hemisphere activation was decreased compared to healthy controls (Kucharska-Pietura & David, 2003). This study only used happy and sad chimeric faces, limiting conclusions about a wider range of emotions such as disgust or anger. In support of this finding, Bourne and Vladeanu (2013) examined emotional lateralization in participants with depression using the chimeric faces test displaying six different emotions. This study demonstrated that female participants with higher depression scores demonstrated weaker right hemisphere lateralization for processing emotional faces. The findings were most apparent for negative emotions. In some cases it was even found that lateralization

was reversed, with depressed individuals being more strongly lateralized to the left hemisphere. The fact that this finding was only present in females is of interest, especially considering that depression is more prevalent in females (Weissman et al., 1996).

Although research looking at lateralization in social anxiety is more limited, the initial picture appears equally complex. Firstly, a number of studies have found an increase in the strength of the right hemisphere lateralization for emotional processing in individuals with social anxiety (Cooney, Atlas, Joormann, Eugene, & Gotlib, 2006; Engel, Bandelow, Gruber, & Wedekind, 2009; Kolassa & Miltner, 2006; Mogg & Bradley, 2002). In a recent review, it was concluded that there is evidence hyperactivity of the right hemisphere in individuals with social anxiety, across emotional processing tasks (Engel et al., 2009). One study (Kolassa & Miltner, 2006) examined early processing of angry faces in individuals with social phobia through EEG, examining the N170 component, chosen due to its involvement in facial processing. The authors reported enhanced right hemisphere activation in individuals with social anxiety in response to angry faces, compared to healthy controls and participants with a spider phobia. Similar findings were reported by Mogg and Bradley (2002) in a behavioural task with individuals scoring highly on measures of social anxiety and fear of negative evaluation. Individuals high on social anxiety responded significantly faster to masked threatening facial expressions compared to those low on social anxiety. A right hemisphere bias was assumed, as this finding was particularly prominent when threatening images were presenting to the left visual field. Furthermore, Cooney and colleagues (2006) demonstrated increased right hemisphere activation in individuals with social anxiety in response to neutral faces.

The authors suggested the neutral faces might have been emotionally ambiguous, with socially anxious individuals interpreting this ambiguity as threat-related. These findings support research from emotional recognition studies that suggest individuals with social anxiety are hypervigilant to threat-related information.

As with depression, research from other studies has failed to find an increase in right hemisphere activation in individuals with social anxiety. The chimeric faces test has been used to demonstrate that individuals with higher social anxiety scores show evidence of weaker right hemisphere lateralization, or even left hemisphere lateralization, for processing emotional faces (Bourne & Vladeanu, 2011). However, Bourne and Vladeanu (2011) reported that the effect of weaker right hemisphere lateralization was only significant for male participants. This is an interesting finding, as social anxiety is typically reported to be more prevalent in females (Beesdo et al., 2009). It was argued that this finding might relate to differences in the speed of interhemispheric transfer, differences in strategies used to complete the task between males and females, or perhaps differences in hormonal exposure (Bourne & Vladeanu, 2011).

Social anxiety is thought to include fear of negative evaluation, humiliation and embarrassment, alongside worries of conveying a negative social impression (Moscovitch, 2009). Some studies have therefore looked at individual components of social anxiety. Fear of negative evaluation is an integral part of social anxiety, and includes worries about how one is evaluated by others, and fears that this evaluation will constitute social disapproval (Bourne & Watling, 2015; Moscovitch, 2009). Using the chimeric faces test, individuals reporting higher fear of negative evaluation

have been shown to be more strongly lateralized to the right hemisphere, particularly for faces displaying angry, happy and sad emotions (Bourne & Watling, 2015). This finding was also present for fearful emotions, although only in females. However, other studies have found mixed results when looking at fear of negative evaluation. In another study (Ewbank et al., 2009) individuals with high levels of fear of negative evaluation displayed increased right amygdala activation to angry faces, whereas fearful faces were associated with increased left amygdala activation. These findings suggest that even when components of social anxiety are examined, the results are inconsistent.

Emotional lateralization in children with emotional disorders

It is known that the ability to recognise emotions from faces develops throughout childhood, with accuracy increasing alongside lateralization (Workman et al., 2006). This suggests that emotional recognition skills and emotional lateralization develop concurrently. It may also be the case that emotional lateralization and emotional recognition are influenced by one another, but currently the picture is not clear on how this process may take place. Unfortunately, there is only very limited research examining this relationship in children.

Hemispheric asymmetry has recently been studied in adolescents with major depression (Trinkl et al., 2015). Trinkl and colleagues (2015) used an emotional go/no-go task (in which participants are asked to make a motor response towards one presented stimuli, and withhold a response to another stimuli) with positive and negative faces. Although there was no evidence of a behavioural difference between

depressed adolescents and controls, depressed adolescents showed reduced left hemisphere (and therefore increased right hemisphere) activation in response to emotional faces. In terms of social anxiety, increased activation of the amygdala has been reported in adolescents with social anxiety in response to viewing fearful faces (Beesdo et al., 2009). This suggests some changes to the social neural network in adolescents with social anxiety. However, to this author's knowledge, no study has yet examined hemispheric lateralization in children and adolescents with social anxiety disorder.

Sex differences in emotional lateralization

As previously discussed, females have been reported to show an advantage for processing emotional faces (Hall, 1978; Katsikitis et al., 1997; Rahman et al., 2004; Thayer & Johnsen, 2000). Sex differences have also been reported for studies examining emotional lateralization. Studies have often demonstrated there is an effect of valence (i.e. whether the emotion is positive or negative) related to laterality in female participants, but not in male participants (e.g. Rodway, Wright, & Hardie, 2003; van Strien & van Beek, 2000). This has been argued to support the finding that women demonstrate greater lateralization effects than males (Rodway et al., 2003). Studies examining the right hemisphere hypothesis have shown that right hemisphere lateralization is stronger in adult male participants (Bourne, 2005, 2008a; Proverbio, Brignone, Matarazzo, Del Zotto, & Zani, 2006; Sergerie et al., 2008). Although females seem to show an advantage for emotional processing and recognition, lateralization in females appears to be more bilateral distributed (Bourne, 2005). Psychological gender may also play a role, as adults who were scored as having a

more masculine psychological gender have been shown to demonstrate stronger right hemisphere lateralization (Bourne & Maxwell, 2010). Interestingly, this increased strength of lateralization was not found in children aged 6 to 10 years old (Watling & Bourne, 2013). However, in this study sex was shown to interact with strength of lateralization. This demonstrated that, for boys, strength of lateralization predicted greater accuracy on the emotion-processing task, whereas this relationship was not present for girls. This suggests a sex bias for laterality may develop over time, mirroring developments in emotional recognition.

Summary

Emotional recognition is an important skill that helps navigate the social world. Difficulties with emotional processing have been linked to emotional disorders. Individuals with depression seem to display a mood congruent bias for negative emotional information, whereas individuals with social anxiety seem to show an attentional bias to socially threatening information. Emotional lateralization is one facet of emotional processing that is gaining increasing interest. Currently two main theories underpin emotional lateralization, suggesting either that emotions are processed bilaterally in the brain or that the right hemisphere is dominant for emotional processing. Research looking at emotional lateralization in depression and social anxiety has reported mixed findings. For both depression and social anxiety, studies have demonstrated both an increase and a decrease in activity in the right hemisphere during emotional processing across different paradigms. This shows that although findings for emotional recognition are fairly consistent across depression and social anxiety, the relationship between these disorders and emotional

lateralization is more complex. Sex differences also exist in lateralization, developing over the course of childhood. However whether there is a link between neurobiological changes, puberty and changes to emotional processing has not yet been explored alongside childhood depression and social anxiety.

The present study: An overview

Depression and social anxiety are two mental health disorders that increase in prevalence during adolescence. The present study aimed to elucidate some of the mechanisms that contribute to the development of depression and social anxiety during adolescence.

In terms of social factors, insecure attachment has been linked to both depression and social anxiety. Adolescence is an important social period for children, with a process of social re-orientating occurring. However, parental attachment continues to remain important at this time. As such, it may be that changes occurring to attachment processes at this time are related to the onset of depression and social anxiety. Furthermore, parental attachment is thought to change during adolescence (Kerns et al., 1996; Laible et al., 2000). It has also been suggested attachment can impact on emotional recognition and lateralization, with attachment linked to changes in facial emotional processing (Bourne & Jonauskaite, 2015; Fussell et al., 2012). This suggests that parental attachment may be an important risk factor for depression and social anxiety. The present study therefore looked at child reported parental

attachment to determine the impact on depression and social anxiety using the Social Anxiety Scale for Children-Revised (SASC-R).

In terms of biological factors, hormones are known to change over the course of puberty, particularly between the ages of 10 to 16 years (Sizonenko, 1978). Hormonal influences occurring during puberty have been implicated in the increased prevalence of depression and social anxiety at this time (Angold et al., 1998; Deardorff et al., 2007; Patton et al., 1996). In addition, the brain is known to undergo a process of restructuring during puberty (Giedd et al., 1999), which has been theorized to be related to the hormonal changes that are occurring (Sisk & Foster, 2004; Sisk & Zehr, 2005). As hormonal factors play an important role in brain restructuring during adolescence, they may also impact on factors such as emotional recognition and lateralization (e.g. Bourne & Gray, 2009; Doty, Kisat, & Tourbier, 2008; Hausmann & Güntürkün, 2000). This suggests a possible interaction between hormonal changes and facial emotional processing. Hormones were therefore considered in the present study as a biological factor that may impact on depression and social anxiety.

Studies that have looked at hormonal related changes to lateralization have often not used direct measures of hormones, but have used proxy variables to infer hormonal changes. For example Bourne and Gray (2009) looked at changes to lateralization based on prenatal hormonal exposure. This study used 2D:4D digit ratios as a proxy variable for higher prenatal testosterone exposure, as it has been well established that lower 2D:4D ratios are linked to higher prenatal testosterone exposure (Bourne & Gray, 2009). In addition, another study examined the effects of hormone replacement therapy on asymmetry on an odour memory discrimination test (Doty et al., 2008).

This study did not measure hormonal levels directly, but compared individuals using hormone replacement therapy to those not using hormone replacement therapy as a proxy for hormonal differences.

Dramatic change in levels of hormones is a major hallmark of puberty (Blakemore et al., 2010). It has therefore been argued that hormonal fluctuations that naturally occur during puberty afford an ideal time to examine the effects of hormonal changes in adolescents (Little, 2013). For previous research that has examined hormonal changes in adolescents, stage of puberty (measured as Tanner Stages) has often been used as a proxy variable for hormonal influences (Herting, Gautam, Spielberg, Dahl, & Sowell, 2015). The development of secondary sex characteristic during puberty, as reflected in the Tanner pubertal stages, has been shown to consistently reflect hormonal changes (Angold & Worthman, 1993). In support of this, it has been demonstrated that self-report measures of pubertal stage correlate well with hormonal changes (Shirtcliff, Dahl, & Pollak, 2009). Based on this, Shirtcliff and colleagues (2009) argued that self-reported pubertal stage could be an adequate proxy variable when direct measurement of hormonal levels is unavailable.

A number of studies have used pubertal stage as a proxy variable when examining hormonal effects during adolescence on emotional and facial processing. In one study, facial preferences were examined in children aged 4 to 17 years old (Boothroyd, Meins, Vukovic, & Burt, 2014). This study examined the effect of neurobiological changes during puberty on perceptions of facial attractiveness. Information on pubertal status was obtained from mothers' report for younger children, and self-reported pubertal status obtained from older children. These reports were then used to

infer dehydroepiandrosterone (DHEA) levels. DHEA is a hormone involved in puberty that is later converted into testosterone and estriadiol (Boothroyd et al., 2014), which both have important roles during puberty.

Another study (Little et al., 2010) looked at how hormonal changes during puberty affect visual preferences for masculine faces in girls. Hormones levels were not directly assessed, rather children were allocated a stage of puberty based on their age, and comparisons were made to adults who had completed puberty. The results of the study demonstrated that peri-pubescent children had no preference of masculinity of faces, but this preference emerged by early adulthood. There was also a decline in this preference post-menopause, after reproductive age. The authors therefore concluded that hormonal changes associated with puberty (and menopause) are likely to have an important impact on facial preferences.

The effect of psychophysiological changes during puberty, including the effects of hormones, has been examined in relation to appetitive and defensive motivation (Quevedo, Benning, Gunnar, & Dahl, 2009). This involved participants looking at affective pictures from the International Affective Picture System (IAPS), and having their startle response for an auditory probe measured. The authors also took measures of thrill seeking, stress and anxiety and pubertal status. In this study, pubertal status was obtained by self-report of participants as well as parental report. The authors explained that they used self-reported pubertal status as it has been previously shown that self-report is linked to changes of pubertal hormones (e.g. Brooks-Gunn, Warren, Rosso, & Gargiulo, 1987; Shirtcliff et al., 2009). The results of the study

demonstrated that startle magnitude was associated with anxiety and stress, but only for children who were in the stage of mid to late puberty.

The present study aimed to use stage of puberty as a proxy variable for hormonal changes that would be occurring at that time. It has been suggested that this is an acceptable way to infer hormonal influences when direct measurement is unavailable (Herting et al., 2015; Little et al., 2010), and this method has been adopted in several studies (e.g. Boothroyd et al., 2014; Little, 2013; Quevedo et al., 2009). Self-report measures that assess stage of puberty have also been shown to demonstrate good correlations with hormonal changes (Shirtcliff et al., 2009). It was therefore felt that using a self-report measure of puberty status in the present study would act as a non-intrusive way to infer the impact of hormonal changes occurring at this time.

Regarding neuropsychological factors, previous studies have shown that emotional processing becomes increasingly lateralised across development (Workman et al., 2006). However, these studies have only examined children up to 11 years old, and then adult participants, missing out an important stage of development. It has been hypothesised both attachment and factors related to puberty (e.g. hormones) may impact laterality, but this has not been examined at an age when mood and anxiety disorders typically emerge. The present study used the chimeric faces test to examine the lateralization for emotional faces using the six Ekman emotions. The chimeric faces test has demonstrated good validity and reliability and benefits from being able to be used in schools with children in the age group under evaluation. This was done by exploring overall laterality incorporating all six emotions, moving beyond work

that only looked at laterality for the processing of happy facial expressions of emotion.

It was hypothesised that parental attachment, hormones and emotional lateralization would all play a role in the increase in prevalence of depression and social anxiety during adolescence. Previous studies have looked at factors such as attachment, hormones and laterality on mood disorders, but none have looked at all these factors together in one study. The present study aimed to address this by looking at these factors in tandem. In addition, this is the first study to examine these factors together within this particular age group.

Healthy children across three age groups (9 to 10 years old, 11 to 12 years old and 13 to 14 years old) were recruited to take part in the study, allowing examination of differences in children who were pre to mid puberty and those who were late to finished puberty. Two hierarchical regression analyses were employed to examine possible predictors for depression and social anxiety separately in this age group. This allowed co-morbid depression and social anxiety to be controlled for, as well as other factors known to impact on depression and social anxiety (e.g. age and sex). The aim of the hierarchical regression analyses was to see which of the additional factors (attachment, puberty and lateralization) would be predictive. In addition, it was anticipated that factors would be equally predictive and likely impact on each other. The hierarchical regression also allowed examination of the effect of interactive predictors.

It was anticipated that attachment, puberty and lateralization would all act as unique predictors for both depression and social anxiety. Interactions between variables were also expected to lead to novel results. As such, the following hypotheses were proposed:

1) Children that reported lower scores for the domains of parental attachment communication and trust, but higher scores for parental attachment alienation would demonstrate higher scores for depression and social anxiety.
2) Children at a higher stage of puberty would demonstrate higher scores for depression and social anxiety, independent of age.
3) Children that were less strongly right hemisphere lateralized would demonstrate higher scores on measures of both depression and social anxiety.
4) Lateralization and puberty would interact and lead to higher scores for depression and social anxiety.
5) Lateralization and puberty would interact and lead to higher depression and social anxiety scores.

Potential clinical implications of the present study

Due to the evidence that depression and social anxiety often continue into adulthood (Stein & Stein, 2008; Weir et al., 2012), prevention of the disorders emerging is thought to be important (Thapar et al., 2012). It is therefore important to examine this at a time when the prevalence of depression and social anxiety increases, as well as a

time when there are considerable biological changes (i.e. brain maturation, puberty), as well as social changes (i.e., adolescence, attachment).

Social, biological and neuropsychological factors have all been implicated in contributing to the emergence of these disorders. It is hoped that by investigating these variables in late childhood and adolescence, will provide further information regarding risk factors for depression and social anxiety. This may allow examination of factors relevant at the beginning of puberty, and throughout the later pubertal stages. Moreover, as depression and social anxiety are thought to have a complex aetiology, it is hoped that looking at interactions between factors may provide fresh insights into risk factors that can be tackled clinically.

Although it is hoped that depression and social anxiety can be better prevented through research and clinical work, it is also important to consider treatment aspects of depression and social anxiety. Currently, Cognitive Behavioural Therapy (CBT) is seen as the gold standard of treatment for depression in adults (NICE, 2009) and has been also recommended when for treating depression in children (NICE, 2015). CBT is also recommended as the gold standard for treatment of social anxiety in both children and adults (2013). There has been evidence of good treatment responses for CBT in both depression and social anxiety (Hofmann, Asnaani, Vonk, Sawyer, & Fang, 2012). However some people do not benefit from cognitive behavioural approaches (Hollon, Thase, & Markowitz, 2002) and relapse rates remain high (Campanella, 2013). It is thought that by understanding more about the social, biological and neuropsychological factors affecting emotional disorders, treatment can be improved.

Method

Participants

One hundred and fifteen participants were recruited for the study (75 girls, 40 boys). Participants comprised twenty-five 9 to 10 year olds (M_{age} = 9.87, 14 females), forty-three 11 to 12 year olds (M_{age} = 12.00, 21 females) and forty-seven 13 to 14 year olds (M_{age} = 13.95, 40 females). Participants were recruited from primary and secondary schools throughout the South and North East of England. Participants aged 9-10 were recruited from one primary school, based in South East England. Participants aged 11 to 14 were recruited from three secondary schools, two of which were community secondary schools based in South and North East England and the other secondary school was a private girls' grammar school based in South East England. The majority of participants (97.4%) indicated that English was their first language. Participants received a small token (e.g. pencil topper or sticker) for participating.

Each school was consulted on the type of consent forms that would be sent out to parents, choosing between an opt-out and an opt-in consent form. All schools requested an opt-out consent form be sent to parents or guardians (see Appendix 1), which had been approved by the Royal Holloway Ethics Committee. These consent forms explained the purpose of the study, and what the child would be asked to do if they were to take part. The parent or guardian was asked to return a reply slip to the class teacher (see Appendix 2) if they wanted their child excluded from taking part in

the research. Reply slips were collected from class teachers when visiting the school. Children that parents had asked to be excluded from the research did not take part in the study. Children were asked to give verbal assent to participate prior to taking part in the study. One child decided to not participate on the day of testing and therefore did not take part in the study.

Recruitment

Primary and secondary schools throughout South and North East England were first contacted by letter (see Appendix 3), which acted as an introduction to the study. This letter was followed up with a phone call to the head teacher approximately one week after the letters had been sent. Once the school had agreed to participate, a visitation date was arranged. Schools were asked to distribute consent forms to parents, and to collect reply slips prior to the visitation date. Parents received information about the study and were given the opportunity to opt-out of the research by returning the reply slip accompanying the consent form.

Inclusion Criteria

Participants were included in the study if they were i) aged 9 to 14, ii) had been given permission to participate by their parent or guardian, iii) gave verbal assent to participate. Schools were contacted to request for participants of the target age groups to take part, with the particular year groups that took part selected by the school. Participants were asked to provide their date of birth to determine their age, and whether they fit into the inclusion criteria.

Exclusion Criteria

Participants were excluded from the study if they were i) left handed, ii) below 9 years of age, iii) above 14 years of age, iv) not given permission by their parents or guardians to participate in the study.

Only right-handed participants were included in the final analyses. Handedness has been consistently shown to affect degree of lateralization across a range of tasks (e.g. Lavidor, Hayes, & Bailey, 2003; Pujol, Deus, Losilla, & Capdevila, 1999). Handedness has also been shown to have an effect on hemispheric lateralization for emotional faces (Bourne, 2008b). In the study by Bourne (2008b), it was found that male participants that were more strongly right-handed were also more strongly right lateralized when completing the chimeric faces test. To rule out handedness as a confounding factor in the present study, participants were asked to indicate which hand they used to complete three tasks: writing their name, brushing their teeth and throwing a ball. Participants that indicated that they completed any of these tasks with their left hand were excluded from the final analysis. Overall, 14 participants were excluded due to handedness (six = 9 to 10 years old, four = 11 to 12 years old, four = 13 to 14 years old), leaving a sample of 101 participants that were eligible to be included in the final analysis.

A priori power calculation

Power calculations were performed to estimate the number of participants that would be needed to detect an effect. Power was computed with the use of the G*Power 3.1 program. Power calculations were based on the assumption of a medium effect size.

This was based on previous research looking at emotional lateralization in children and adolescents aged 6 to 10 years old, which utilized the chimeric faces test (Watling & Bourne, 2013). This resulted in a Cohen's f^2 of 0.12, indicating a medium effect size. The present research employed two hierarchical regression analyses, one with depression as the outcome variable and one with social anxiety as the outcome variable. Power analysis calculated that 109 participants would be needed to give a power of .80, with an α of .05 for each hierarchical regression analysis.

Post hoc power calculation

Once the data had been collected, a post-hoc power analysis was performed to determine the power of the study using G*Power 3.1. Separate power analyses were conducted for depression and social anxiety. For depression, a Cohen's f^2 of 0.18 was revealed, indicating a medium effect size. Based on this effect size, the study was shown to have a power of .81. For social anxiety, a Cohen's f^2 of 0.33 was revealed, which was indicative of a medium to large effect size. Based on this effect size, the study was shown to have a power of .98. This suggests that the study had adequate power to detect an effect for both depression and social anxiety, with power above the cut off of .80.

Ethical Approval

An application to conduct the research was submitted to the Ethics Committee at Royal Holloway, University of London in July 2014. Ethical approval was granted in August 2014 (see Appendix 4).

Materials and measures

Participants were asked to complete several tasks, presented via computer. These tasks included i) questions regarding demographic information ii) the chimeric faces test containing the six Ekman emotions (happiness, sadness, surprise, fear, disgust and anger) iii) questionnaire measures evaluating social anxiety, depression, stage of puberty and parental attachment. For data collection via computer, children completed all tasks either on a laptop (15.6inch screen) or computers in the ICT suites (17inch monitors). Each child had their own monitor and responded to items presented on screen using a mouse. The computer program used was developed using LiveCode software, which allowed for simultaneous presentation of stimuli and questions, as well as recording responses given by the children. All participants completed the chimeric faces test and completed demographic information (see Appendix 5) via computer. In the event that ICT suites were unavailable for the full duration of the tasks, pen and paper versions of the questionnaires were available and completed by the children taking part. These packs contained the Social Anxiety Scale for Children – Revised (SASC-R; La Greca & Stone, 1993 (see Appendix 6), the Children's Depression Inventory—Short Version (CDI:S; Kovács, 1983, 1992) (see Appendix 7), the Inventory of Parent and Peer Attachment (IPPA-R; Gullone & Robinson, 2005) (see Appendix 8) and The Self-Administered Rating Scale for Pubertal Development (Carskadon & Acebo, 1993) (see Appendix 9 and Appendix 10), which are described in further detail below.

Handedness assessment

Children were shown a picture of a left and right hand, presented via computer screen, and asked to click on the hand they used to: i) write their name ii) throw a ball iii) brush their teeth. Participants were asked which hand they used to complete these tasks, and asked to click on a picture of a right or left hand using the right mouse button. Children completed one question per screen, making the judgement separately for each task. A screenshot demonstrating how children were asked about handedness in regards to brushing their teeth can be seen in Figure 2.

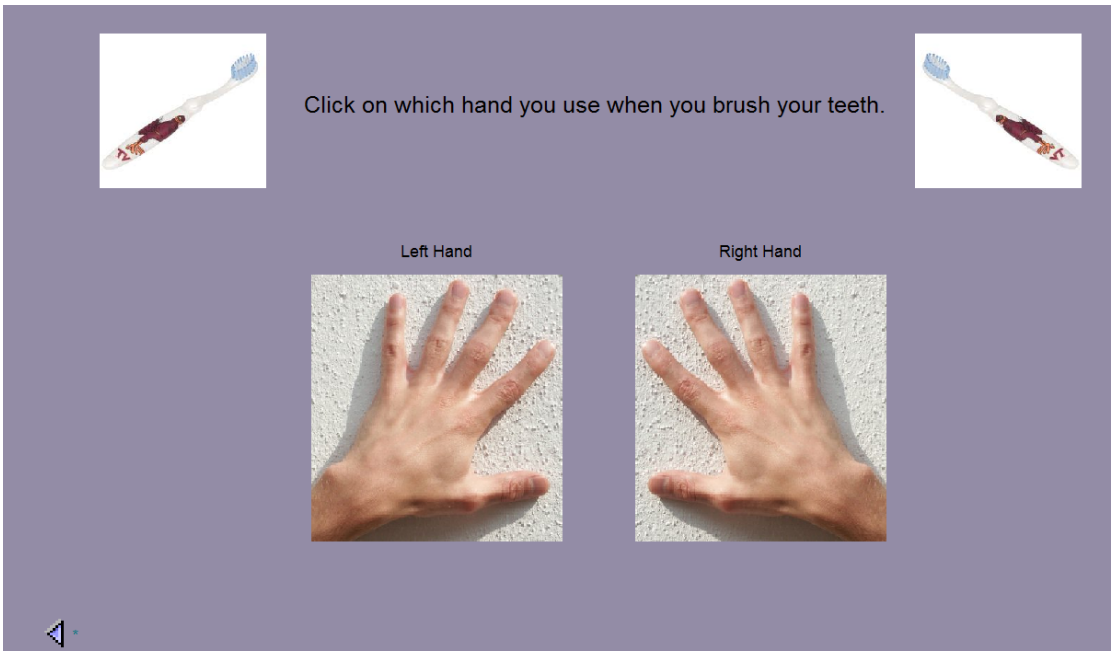


Figure 2. Example screenshot of a handedness question.

Hemispheric Lateralization

The chimeric faces test was used to assess laterality of emotional processing. This is a behavioural measure used to determine whether a hemispheric bias is present when

looking at emotional faces. The chimeric faces test has been shown to be a reliable and valid measure of emotional lateralization, as previously discussed in the introduction.

Chimeric face stimuli were the same as those used by Workman and colleagues (Workman et al., 2006) and others (e.g. Bourne, 2010; Watling & Bourne, 2007, 2013). These utilized the Ekman emotional faces (one male and one female face) for each of the six emotions: anger, disgust, fear, happiness, sadness and surprise. These faces were static greyscale images, presented on a white background. The chimeric stimuli comprised front facing images of male and female faces that were vertically split down the middle. One side of the face (either the left or right side) displayed the emotional expression, with the other side of the face displaying a neutral expression. Two copies of each face were simultaneously presented for each trial, one displayed above the other. One of the facial images displayed an emotion on the right hand side of the face and a neutral expression on the left hand side, and a second version displayed the reverse pattern. Examples of the chimeric faces stimuli presented in the task can be seen in Figure 3 for stimuli of male faces and Figure 4 for stimuli of female faces.

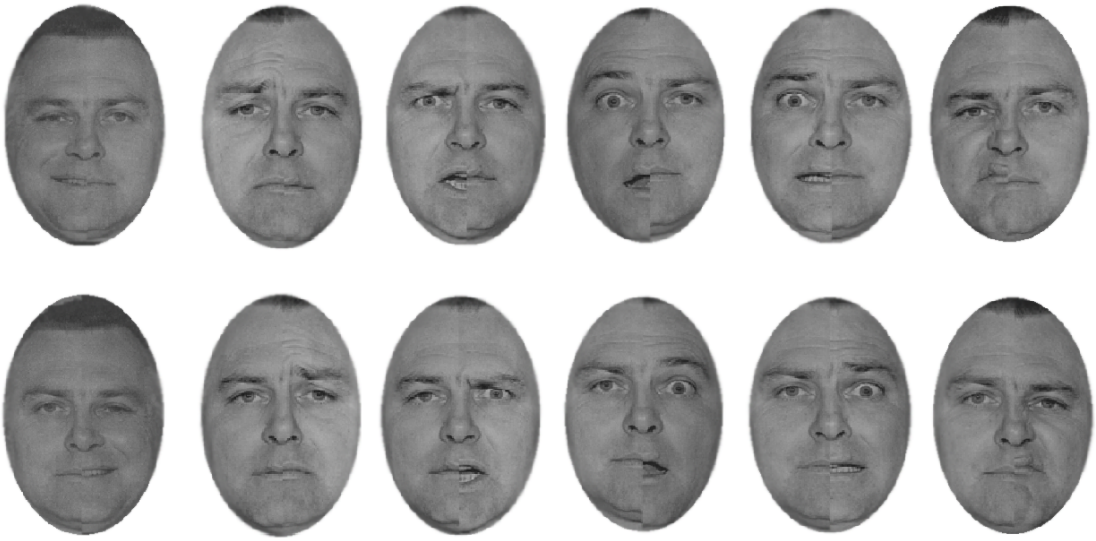


Figure 3. Example of chimeric face presentation (male). From left to right the vertical pairs represent: happy, sad, anger, surprise, fear and disgust.

Figure 4. Example of chimeric face presentation (female). From left to right the vertical pairs represent: happy, sad, anger, surprise, fear and disgust.

Faces were presented centrally. Each facial image subtended approximately 4.5° horizontally and 7° vertically at a viewing distance of 52cm. The presentation of the

stimuli was counterbalanced. Participants completed 24 trials per emotion. This included six chimeras with the emotional expression on the top-right and six chimeras with the emotional expression on the bottom-right and the reverse pattern for emotions presented on the left. Each emotion presented together in a blocked design.

Participants were asked to click on the face that looked more emotional of the two presented. For each trial, participants first saw a blank screen. The chimeric face images were then presented on the screen, with the mouse located in the centre of the screen between the two chimeric faces. This allowed upwards motion to click the top image and downwards motion to click the bottom image. Participants clicked their answer via a mouse connected to the computer. Participants used the left mouse button to click on the face they thought was more emotional. A right hemisphere bias was has been shown when individuals choose the image with the emotional expression presented on the left side of the face, which corresponds to the right brain hemisphere (Bourne, 2010).

Previous work has assessed hemispheric lateralization in terms of laterality quotients. Laterality quotients were measured on a continuum ranging between -1 to +1. In the analysis, -1 indicated that participants were completely left-hemisphere dominant for facial processing, whereas +1 indicated that participants were completely right-hemisphere dominant for facial processing. A score of 0 represented participants who demonstrated a bilateral pattern for facial processing. Laterality quotients were computed in the following way for each emotion:

$$\frac{\text{(Number of LVF choices - (Total number of trials - Number of LVF choices))}}{\text{Total number of trials}}$$

The number of times an individual chose the face with the emotional expression presented to the left visual field was calculated across all 144 trials. The total number of trials that participants chose the face with the emotional expression presented to the left visual field was then divided across the total number of trials (144) to give an overall laterality score.

Social Anxiety

Social anxiety was evaluated using the SASC-R (La Greca & Stone, 1993). This is a 22-item self-report measure, comprising 18 items used to evaluate three aspects of social anxiety in children and four filler items (e.g. "I like to play sports"). Eight items assess fear of negative evaluation (e.g. "I worry about what other children think of me"), six items assess social avoidance and distress specific to new situations (e.g. "I only talk to children that I know really well"), and four items assess generalized social avoidance (e.g. "It's hard for me to ask other children to do things with me"). Children are asked to indicate how much they feel the items are true for them on a five-point Likert scale, with response options comprising: "not at all", "hardly ever", "sometimes", "most of the time" and "all of the time". All items were scored from one ("not at all") to five ("all of the time"). The SASC-R total score was obtained by summing together all 18 items assessing social anxiety symptoms to give an overall total score out of 90. Total score for the SASC-R can range from 18-90, with scores closer to 90 indicating the presence of higher social anxiety.

Validity and reliability

The revised version of the measure has been examined for validity and reliability (La Greca & Stone, 1993). The measure has been shown to have acceptable internal consistency, with a Cronbach's alpha of >.65 for all three aspects of social anxiety evaluated in a sample of 587 children aged between 9 and 13 years old (La Greca & Stone, 1993). In addition, La Greca and Stone (1993) demonstrated that the revised measure correlated well with the previous Social Anxiety Scale for Children, ranging between .62 and .94 for the three aspects of social anxiety evaluated by the measure. The SASC-R has also been shown to have good discriminant validity in a sample of 150 children aged 11 to 12 (Kristensen & Torgersen, 2006). The study by Kristensen and Torgersen (2006) revealed a Cronbach's alpha ranging between .90-.96 for the three aspects of social anxiety evaluated by the measure. In addition, the measure has been shown to have the ability to accurately identify the presence of social anxiety disorder in children of this age group, in line with parental rating of social anxiety (Kristensen & Torgersen, 2006). Together, these studies show that the measure is appropriate for evaluating social anxiety in samples similar to the one used in the present study.

Depression

Depression was evaluated using the CDI-S (Kovács, 1983, Kovács, 1992). This is a 10-item self-report measure used to examine the presence of depression in children. The measure consists of 10 items evaluating depression, asking children to pick which

sentence is "most true" for them, from three presented options. For example, children are asked: "Which sentence is most true of you? i) I am sad once in a while, ii) I am sad many times, iii) I am sad all the time". To preclude children from guessing the aim of the questionnaire, the standard CDI-S was presented alongside 10 "foil" items such as "Which sentence is most true of you? i) I do not like swimming ii) I like swimming a bit iii) I like swimming a lot". The measure is one of the most commonly used measures for evaluating depression in children, for both research and clinical purposes (Lee, Krishnan, & Park, 2012). The measure is based on the Beck Depression Inventory, with items reworded to be more suitable for children aged 8 to 13 years old (Kovács & Beck, 1977; Smucker, Craighead, Craighead, & Green, 1986). All items were scored from zero for items that do not indicate depression (e.g. "I am sad once in a while") to two for items indicating symptoms of depression (e.g. "I am sad all the time"). Scores can range from 0 to 20, with scores closer to 20 indicating the presence of more depression symptoms. The total depression score was obtained by summing together the ten items from the CDI-S.

Validity and reliability

A number of studies have assessed the reliability and validity of the CDI. The measure has been shown to have acceptable validity, internal consistency and reliability across samples of children aged 7 to 18 years old (e.g. Carey, Faulstich, Gresham, Ruggiero, & Enyart, 1987; Cole, Martin, Peeke, Henderson, & Harwell, 1998; Craighead, Curry, & Ilardi, 1995; Kovács, 1992; Saylor, Finch, Spirito, & Bennett, 1984). Kovacs (1992) reported a Cronbach's Alpha of .80, suggesting good

internal consistency. The measure has been shown to have acceptable discriminant validity, based on samples of children aged 9 to 18 years old (Carey et al., 1987; Cole et al., 1998; Craighead et al., 1995). The measure has also been shown to have discriminant validity in children aged 8 to 14 years, across a range of ethnic backgrounds (Cole et al., 1998). In the study by Cole and colleagues (1998), 1054 children were assessed, showing that both convergent and discriminant validity did not differ between White and Black ethnic populations. The measure was also shown to identify patients with depression with a high degree of accuracy when examining 107 children aged 12 to 18 years old (Craighead et al., 1995). The measure could discriminate the children with depression from the children with anxiety and conduct disorder.

The reliability of the measure has been assessed across 1252 children aged 8 to 16 years old (Smucker et al., 1986). For test-retest reliability, 145 children aged 10 to 11 years old were administered the CDI, and administered it again after three weeks. Test-retest correlations were .77 for males and .74 for females, demonstrating adequate retest reliability. Smucker and colleagues (1986) also demonstrated that the internal consistency of the measure was .84 for males and .87 for females in a subsample of 615 children aged 8 to 13 years old, suggesting the measure has good internal consistency. Retest reliability has also been assessed with 108 nonclinical children aged 7 to 12 years old (Finch Jr., Saylor, Edwards, & McIntosh, 1987). The children completed the CDI, and then completed it again after two, four and six-week intervals. Reliability coefficients were .82 at two weeks, indicating good reliability, but dropped to .66 and .67 for later intervals.

Parental Attachment

Attachment to parents was measured using the parent subscale from the IPPA-R (Gullone & Robinson, 2005). The IPPA-R is a revised version of the Inventory of Parent and Peer Attachment (IPPA) developed by Armsden and Greenberg (1987). Whereas the IPPA was developed for use with children during mid to late adolescence, the IPPA-R has been validated for use with younger children (Gullone & Robinson, 2005). The full IPPA-R measure contains 53 self-report items, adapted specifically for children and young adolescents. The measure contains two scales, one that evaluates parental attachment and one that evaluates peer attachment. Only the parental scale was utilized in the present study. The parental scale contains 28-items to assess communication, trust and alienation between the parents and child. Ten items assess trust (e.g. "I trust my parents"), ten items assess communication (e.g. "I like to get my parents' view on things I am worried about"), and eight items assess alienation (e.g. "I don't get much attention at home"). Children are asked to rate these statements on a five point Likert scale comprising the following responses: 'never true', 'hardly ever true', 'sometimes true', 'mostly true' and 'always true'. Items were scored from one ('never true') to five ('always true'), with five items reverse scored (e.g. "I wish I had different parents"). Following this, a score for each sub domain was calculated by summing items from items assessing that sub domain. The responses were summed together to give an overall total out of 50 for trust and communication, and out of 40 for alienation. This score was then divided by the total number of items in the domain, which gave a final score that ranged from one to five. Scores closer to five indicated better parental attachment in the domains of trust and communication, and poorer parental attachment in the domain of alienation.

Validity and reliability

The revised version of the measure has been shown to be reliable and valid with 281 children aged between 9 and 15 years of age, recruited from primary and secondary schools (Gullone & Robinson, 2005). Cronbach's alpha coefficients for the parental subscale were good, with coefficients for the domains of trust, communication and alienation in adolescents ranging from .76-.83 and for children ranging from .79-.85, indicating acceptable to good internal consistency (Gullone & Robinson, 2005). Gullone & Robinson (2005) also found moderate correlations between the parental scale of the IPPA-R and self-esteem (.51 for children and .65 for adolescents), which was used to support the validity of the measure.

Puberty

Stage of puberty was measured using The Self-Administered Rating Scale for Pubertal Development (Carskadon & Acebo, 1993). This is a five-item (for boys) or six-item (for girls) self-report questionnaire that asks children questions about several factors related to pubertal development. The measure asks different questions regarding pubertal development for boys (e.g. "Have you begun to grow hair on your face?") and girls ("Have you begun to menstruate (started to have your period)?". Items are measured on a four-point scale, based on whether puberty related changes had: not yet started (one point); barely started (two points); definitely started (three points); seemed complete (four points). The scores are processed separately for boys and girls. Children are classed within a stage of puberty designed to be similar to Tanner stage ratings (Marshall & Tanner, 1969, 1970). Tanner stages range from I –

V, classifying male genital growth, female breast growth and public hair for both boys and girls. The scoring criterion varies for boys and girls. For boys, scores on items relating to body hair growth, voice change, and facial hair growth are used to compute pubertal stage. For girls, scores on items relating to body hair growth, breast development, and menarche are used to compute pubertal stage. Boys and girls are also classed into puberty categories differently, according to the criteria outlined in Table 1. For the purpose of the present study, children were classified as either being in early or late puberty. Children who fell between pre-puberty and mid puberty were classified as falling into the 'early puberty' group, whereas children who fell between late and post puberty were classified as falling into the 'late puberty' group.

Validity and reliability

The validity and reliability of the measure has been assessed with 698 children aged 9 to 16 years old (Carskadon & Acebo, 1993). For the student rated version of the measure, Cronbach's alpha coefficients ranged from .67 - .70, demonstrating that reliability ranged from acceptable to good. The measure was also deemed to be valid as there was a strong correlation (r = .86) between results from the self-report and ratings made by physicians that were blind to self-report results.

Table 1. The Self-Administered Rating Scale for Pubertal Development scoring criteria for boys and girls.

Puberty category	*Scoring criteria*
Boys	
Prepuberty	*3*
Early puberty	*4 to 5 (no 3 point responses)*
Mid puberty	*6 to 8 (no 4 point responses)*
Late puberty	*9 to 11*
Post puberty	*12*
Girls	
Prepuberty	*2 and no menarche*
Early puberty	*3 and no menarche*
Mid puberty	*Greater than 3 but no menarche*
Late puberty	*Equal to or less than 7 and menarche*
Post puberty	*8 and menarche*

Appropriateness of materials

Prior to recruitment, three mothers and their children (parental age = 25-35, child age 9 to 11 years old) completed questionnaires (see Appendix 11 and Appendix 12) evaluating the correspondence for parents and debrief forms for children. The aim of this was to ensure that the information was worded in an accessible way, and that the

correspondence materials were appropriate for the intended participants. Parents and children were based in South East London and came from Asian British and Black African backgrounds. The results demonstrated that parents preferred the opt-out consent form, and indicated they would allow their children to take part in the study. The results also indicated that parental materials were appropriate for the intended audience. Results from the child questionnaires indicated that the forms made sense, and children were able to say a few words about what the study involved. The debrief form was therefore also deemed suitable for the intended audience.

Procedure

Participants completed all measures over one session, lasting approximately 30 minutes. Participants were initially given verbal information about the study, and were asked to give verbal assent to participate. Participants were ensured their information would be kept confidential, that participation was voluntary, and that they could stop or withdraw their participation at any point. Questions about demographic information, the chimeric faces test and the questionnaire measures were all presented via computer using the LiveCode program. All children initially completed the demographic information. The LiveCode program then randomly assigned the order of presentation of the chimeric faces test trials and questionnaires. Instructions for each individual task were presented via computer screen. Children entered their responses by using the left mouse button to click on their desired response presented on the computer screen. The LiveCode program collected participant responses, which were placed into a text file on the computer system. This file was then placed onto an encrypted memory stick. Once participation had finished, children were

verbally debriefed about the purpose of the study (see Appendix 13) and older children were provided with a debrief sheet in easy to understand language (see Appendix 14). Children were also encouraged to ask any questions they had about the study.

For data collected from three schools, all information was collected via computer. For these schools, participants were either seen in small groups of four in a quiet room or in the school's ICT suite. Due to technical issues in one school, only demographic information and the chimeric faces test was presented via computer, with children completing all accompanying questionnaires in paper format. For this school, children completed the computer-based tasks in a quiet room in groups of four, whilst the other children completed the paper-based questionnaires in their usual classroom.

Results

Analysis overview

All analyses were undertaken with the use of the IBM Statistical Package for Social Sciences (SPSS) Version 21. Only participants who indicated they were right handed were included in the analyses. In addition, one participant did not provide answers to the attachment questionnaire or social anxiety measure. This resulted in a total of 100 participants who were included in the final analysis. Data met the required assumptions for all parametric analyses employed.

Participant characteristics

Demographic variables were first evaluated. This demonstrated that for the overall sample, the majority of participants were female, of White British ethnicity and going through mid to late puberty. Participant demographic characteristics by each age group can be seen in Table 2.

Table 2. Participant demographic characteristics by each age group and for the total sample.

	Age Group			
	9-10 (*n* = 18)	11-12 (*n* = 39)	13-14 (*n* = 43)	Total Sample (*n* = 100)
Mean child age (years)	*9.84*	*12.06*	*13.99*	*12.49*
	(SD = .24)	*(SD =.43)*	*(SD =.32)*	*(SD =1.56)*
Sex (% female)	*50%*	*51.3%*	*83.7%*	*65%*
Race (%)				
White British	*11.1%*	*97.4%*	*93.0%*	*80%*
White Other	-	-	*4.7%*	*2%*
Black British	*11.1%*	*2.6%*	-	*3%*
Black Other	*33.3%*	-	-	*6%*
Asian British	-	-	*2.3%*	*1%*
Mixed	*22.2%*	-	-	*4%*
Other	*22.3%*	-	-	*4%*
Puberty Status (%)				
Pre Puberty	*22.2%*	*2.6%*	-	*5%*
Early Puberty	*33.3%*	*23.1%*	-	*15%*
Mid Puberty	*44.4%*	*53.8%*	*23.3%*	*39%*
Late Puberty	-	*15.4%*	*67.4%*	*35%*
Post Puberty	-	*5.1%*	*9.3%*	*6%*

Means and standard deviations for overall laterality quotients and questionnaire results were also computed for the total sample and by age group (see Table 3).

Table 3. Means (and standard deviations) of predictor variables by age group and for the overall sample.

	Age Group			
	9-10 (n =18)	*11-12 (n = 39)*	*13-14 (n = 43)*	*Total Sample (n = 100)*
Overall laterality quotient	*.08 (SD = .18)*	*.24 (SD = .27)*	*.15 (SD = .26)*	*.17 (SD = .26)*
Attachment (communication)	*4.01 (SD = .62)*	*3.89 (SD = .67)*	*3.56 (SD =.90)*	*3.77 (SD = .78)*
Attachment (trust)	*4.54 (SD = .53)*	*4.40 (SD = .54)*	*4.03 (SD = .84)*	*4.27 (SD = .71)*
Attachment (alienation)	*1.83 (SD = .69)*	*2.02 (SD = .77)*	*2.21 (SD = .84)*	*2.07 (SD = .80)*
Social anxiety score	*41.27 (SD = 12.69)*	*41.95 (SD = 15.13)*	*47.12 (SD = 14.40)*	*44.05 (SD = 14.5)*
Depression score	*10.11 (SD = 1.60)*	*6.33 (SD = 3.99)*	*7.30 (SD = 3.79)*	*7.43 (SD = 3.80)*
Children meeting depression clinical cut off (%)	*89%*	*56.4%*	*62.8%*	*65%*
Children meeting Social Anxiety clinical cut off (%)	*16.6%*	*23%*	*33%*	*48.7%*

The present sample included school children that were not formally assessed for a diagnosis of clinical depression or social anxiety. However, both the CDI-S and SASC-R have suggested clinical cut off scores that can indicate possible clinical depression and social anxiety.

For the CDI-S, a clinical cut off score of 8 is suggested to identify individuals who potentially reach clinical criteria for depression (Kovacs, 1985). However some more recent estimates suggest a clinical cut off as low as 3 to ensure all individuals with clinical depression are identified (Allgaier et al., 2012). Using the more conservative estimate suggested by Kovacs (1985), more than half the sample of children were meeting or exceeding the clinical cut off value. By looking at each age group in the present sample, some interesting findings emerged. Firstly, younger children were more likely to be meeting criteria for clinical levels of depression, with the majority of the sample meeting the clinical cut off score. Over half of the sample was also meeting the cut off in both the middle and oldest age group. This suggests that in the present sample, the youngest children were more likely to report clinical levels of depression. This is contrary to previous studies, where it has been reported that depression scores tend to increase as participants increase in age (Paus et al., 2008), with a typical age of onset of around 13-14 years old (Joinson et al., 2012; Lack & Green, 2009).

For the SASC-R, the clinical cut off score for social anxiety differs between boys and girls. For boys, a cut off score of 50 is advised, whereas for girls a cut off score of 54 is advised to identify individuals with clinical levels of social anxiety (La Greca & Stone, 1993). Just under half of the total sample reported clinical levels of social

anxiety. When looking at scores by age group, interesting findings once again emerged. In the youngest age group, boys were more likely to report social anxiety than girls. This changed in the middle and oldest age group, where a far larger number of girls were reporting levels of clinical social anxiety compared to boys. This is consistent with the finding that social anxiety is more prevalent in females rather than males, which emerges after puberty onset (Beesdo et al., 2009). Furthermore, the percentage of children meeting cut off scores for clinical levels of social anxiety increased with age. This is similar to previously reported findings that have shown social anxiety increases with age (Paus et al., 2008) and onset is typically seen around age 11-13 years of age (den Boer, 2000; Kessler et al., 2005; Stein & Stein, 2008).

Preliminary Analyses

A set of preliminary analyses was conducted on the data prior to the main analysis, to examine whether findings in the present research represented those of previous studies. One-sample t-tests were also used to determine whether there was evidence of a left visual field (right hemisphere) bias for emotional processing. One-way ANOVA analyses were employed to examine differences in attachment (communication, trust, alienation). As these analyses were not used to specifically test the research questions, Bonferroni corrections for multiple tests were not applied.

Laterality Quotients

Previous research has shown that a right hemisphere bias often exists for laterality for emotional faces. However, there has been evidence to suggest there is a dip in emotional recognition in adolescence. This may suggest changes to emotional lateralization in this population. To determine whether there was evidence of a right hemisphere bias, and whether this was affected during adolescence, laterality quotients were examined for the overall sample and as a function of age.

Overall sample

Laterality quotients were analysed for the full sample. This was done using one-sample t-tests for overall laterality quotients (across happy, sad, surprise, disgust, fear, anger), comparing scores to zero (which represented no visual field bias). This revealed that participants across age groups showed a left visual field (right hemisphere) bias for laterality across emotions ($t(99) = 6.67$, $p = <.001$).

As a function of year group

A one-way ANOVA was performed, looking at overall laterality by year group (Year five, Year seven and Year nine). This revealed that overall laterality quotient differed by year group ($F(2,98) = 3.15$, $p = .047$). Participants in the youngest year group, Year five, did not demonstrate any evidence of a left visual field (right hemisphere) bias for overall laterality quotient ($t(18) = 1.30$, $p = .210$). Participants in the older age groups, Year seven and Year nine, were both shown to demonstrate a left visual field (right hemisphere) bias for overall laterality quotients. However, participants were

most right hemisphere lateralized at 11 to 12 years old ($t(38) = 5.44$, $p = <.001$), with evidence of a small dip at 13 to 14 years old ($t(42) = 3.74$, $p = .001$).

Attachment scores

One-way ANOVA analyses revealed a significant difference of overall attachment score between year groups ($F(2,97) = 3.79$, $p = .026$). This demonstrated that older children reported significantly lower parental attachment, as expected from previous research showing the importance of peer attachments in adolescence. In particular, scores for the domain of attachment trust were significantly lower in older children ($F(2,97) = 4.76$, $p = .011$). Scores reported by participants for attachment communication decreased in older children, but this did not quite reach significance ($F(2,97) = 2.88$, $p = .061$), although the results trended in the expected direction. Finally scores for attachment alienation did not significantly differ between year groups ($F(2,97) = 1.61$, $p = .205$).

Analysis of the hypotheses

Exploratory data analysis

To test the hypotheses of the study, hierarchical regression analyses were employed to examine predictors for depression and social anxiety. In order to perform hierarchical regression analysis to test the hypotheses, it was first important to ensure that the data met the underlying assumptions required to undertake hierarchical regression analysis. It has been suggested that there are five main assumptions when conducting

a regression analysis (Field, 2013; Osborne & Waters, 2002). These are: i) Ensuring there is a linear relationship between the independent and dependent variable ii) ensuring normality of the residuals iii) ensuring errors are independent, iv) ensuring there was not significant heteroscedasticity, v) ensuring there is no multicollinearity between variables.

Ensuring linearity and homoscedasticity

When using multiple regression analysis, it is assumed that the relationship between the outcome and predictor variables is linear (Field, 2013; Osborne & Waters, 2002). If the relationship is non-linear, this can lead to increased chance of Type I and Type II errors (Osborne & Waters, 2002). One way of ensuring there is a linear relationship is by examining the plots of the standardized residuals alongside plots as a function of the standardized predicted values (Osborne & Waters, 2002). This was done for the present dataset, which showed a linear relationship between both the predictor and outcome variables of depression (Figure 5) and social anxiety (Figure 6).

It was also important to ensure that the error variance of variables was the same across all levels of the predictor variables, ensuring homoscedasticity. Significant heteroscedasticity within variables can have an important effect on the results of the analysis, and may increase the chance of a Type I error (Tabachnick & Fidell, 1996). This was also tested by examining the scatterplot of the residual error and standardized predicted error of the variable for both depression and social anxiety. This scatterplot of standardized residuals demonstrated that data met the assumption

of no significant heteroscedasticity in the data set for both depression (Figure 5) and social anxiety (Figure 6).

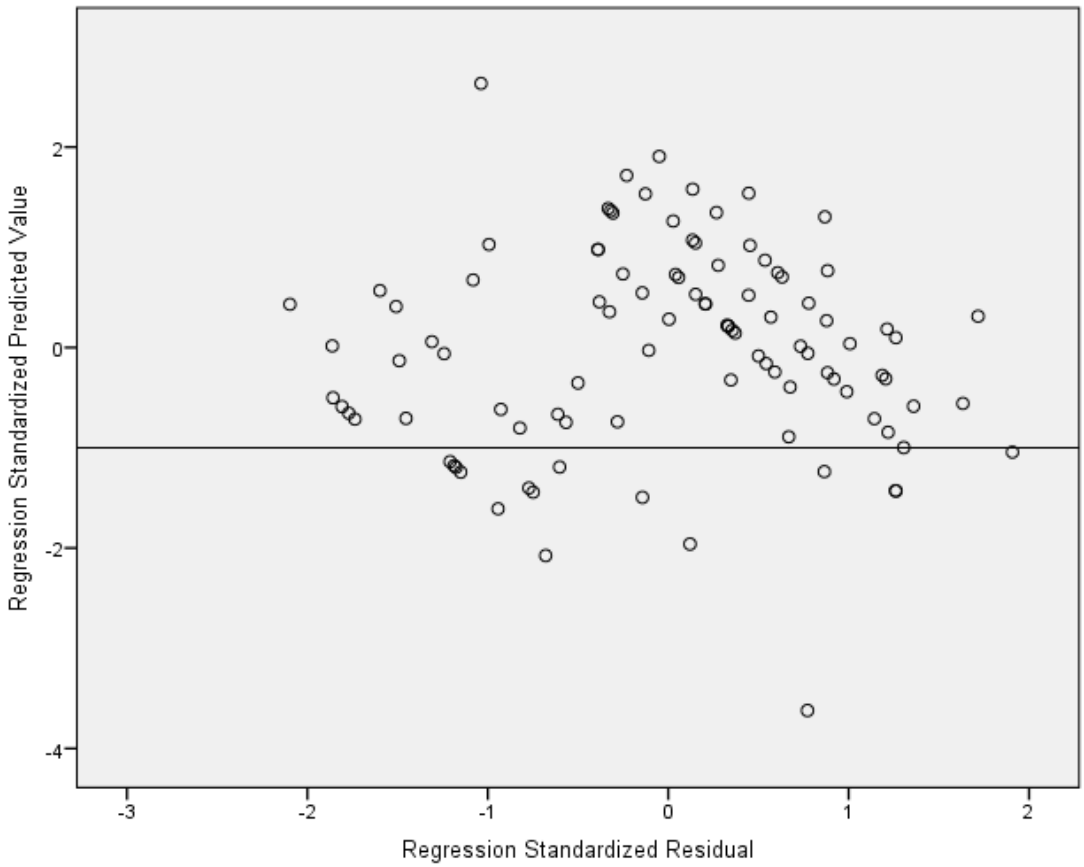


Figure 5. Scatterplot with line of best fit demonstrating regression standardized predicted value as a function of regression standard residual for depression.

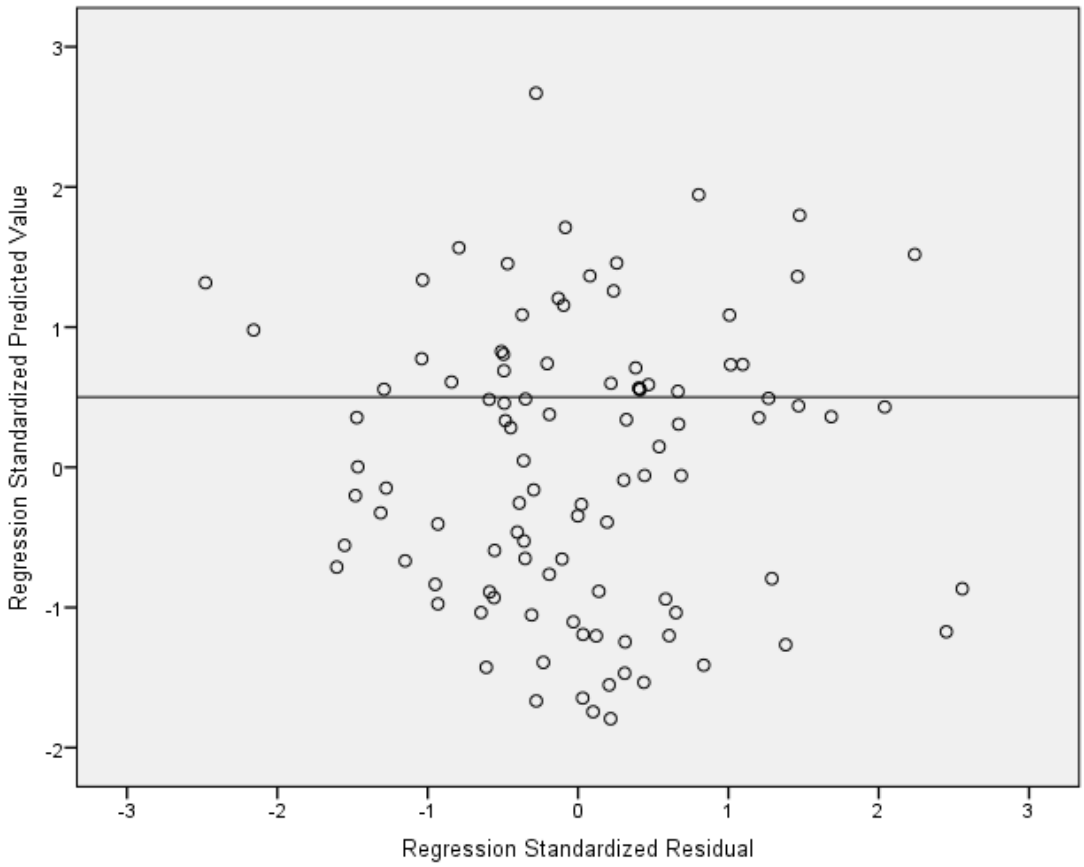


Figure 6. Scatterplot with line of best fit demonstrating regression standardized predicted value as a function of regression standard residual for social anxiety.

Ensuring errors were independent

It is important to ensure that the observations in the data were independent of each other, ensuring there were no problems of autocorrelation (Field, 2013). This was tested with the use of the Durbin-Watson Test. The value from this test is always reported between 0-4. Values closer to 2 represent no autocorrelation, whereas values below 1 or above 3 are felt to represent significant negative and positive autocorrelation respectively (Field, 2013). The results of the Durbin-Watson Test with the present data set revealed that the data met the assumption of independent errors

for both depression (Durbin-Watson value: 1.12) and social anxiety (Durbin-Watson value: 1.98).

Multicollinearity

Multicollinearity is an important consideration when conducting multiple regression analysis with more than one predictor variable. Multicollinearity occurs when there is a relationship between one or more of the predictor variables in the regression (Field, 2013). It was therefore important to ensure there was no correlation between predictors in the present data set. This was examined through the use of collinearity statistics as part of the hierarchical regression analysis. Typically, tolerance values less than .10 and Variance Inflation Factor (VIF) values above 10 are considered indicators of multicollinearity (Marquaridt, 1970). In the present study, tolerance values were all > .30 and VIF values were all <3.40 revealing no issues with multicollinearity in the analysis.

Normality of the residuals

Regression analysis assumes that there is normal distribution of residuals (Field, 2013). Normality of the residuals was assessed through examination of the normal P-P plots of regression standard residuals for both depression and social anxiety.

Depression

Examination of the P-P plot (Figure 7) for depression demonstrated that data points fell within close proximity to the reference line. This was therefore felt to reflect normal distribution of the residuals for depression.

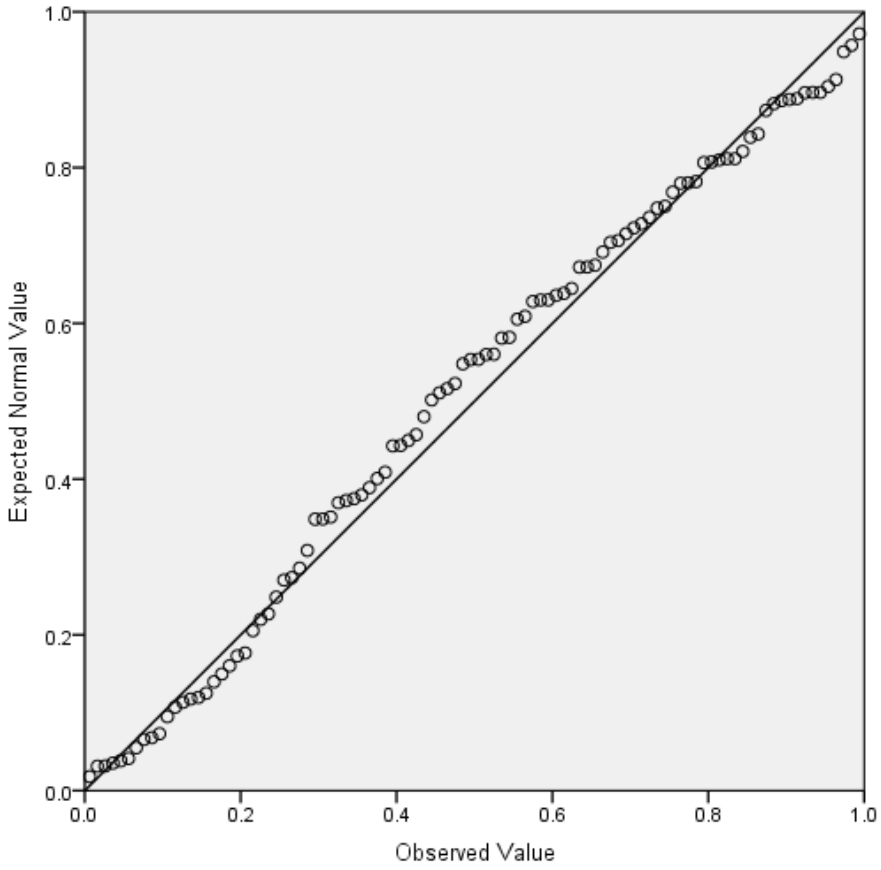


Figure 7. Normal P-P plot of regression standardized residuals with depression as the outcome variable.

Social Anxiety

Examination of the P-P plots of the residuals (Figure 8) showed that the data points fell within close proximity to the reference line. This was also felt to reflect normal distribution of variables for social anxiety.

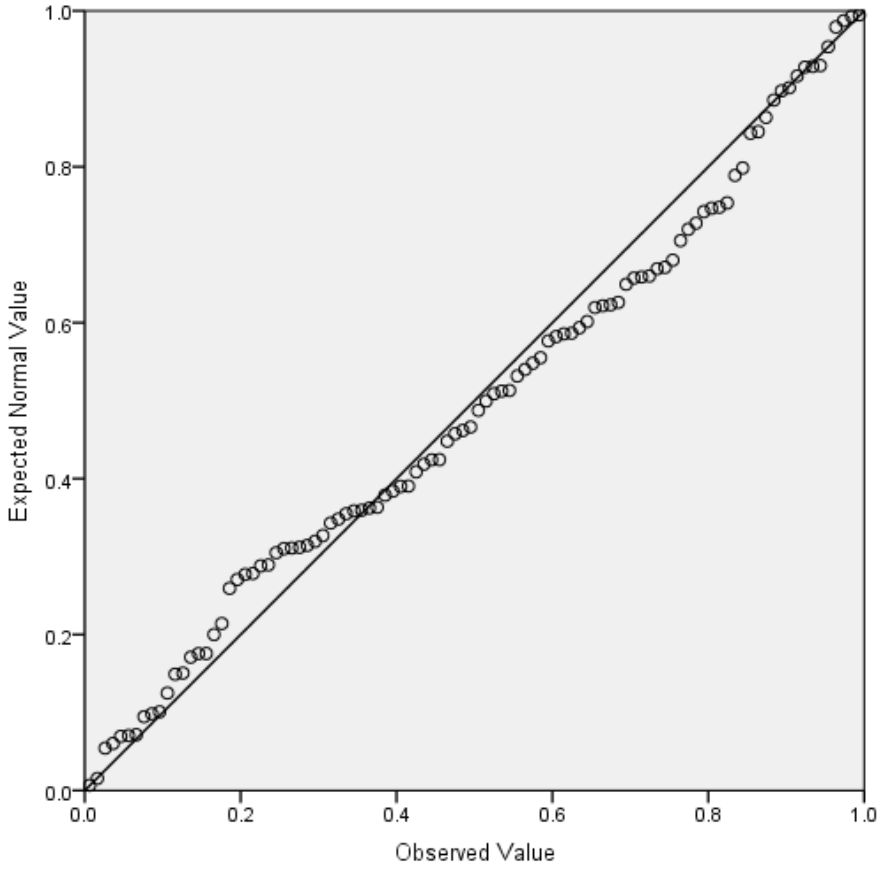


Figure 8. Normal P-P plot of regression standardized residual, with social anxiety as the outcome variable.

Dealing with outliers

Casewise diagnostic analyses revealed that for social anxiety six participants demonstrated scores that were greater than two standard deviations of the mean. Additionally for depression, one participant was shown to demonstrate a score greater than two standard deviations of the mean. This suggested these scores might be possible outliers. It is anticipated that 99% of cases lie within 2.5 standard deviations of the mean, with only 1% falling above this value (Field, 2013). Upon inspection, none of these cases had a standard residual value greater than 2.5. It was therefore decided that these cases would not be removed as outliers in the sample.

Hierarchical regression analyses

Two hierarchical regression analyses were conducted to see if depression and social anxiety scores could be predicted from the predictor variables (sex, age, laterality, attachment and stage of puberty). The first hierarchical regression analysis assessed depression as the outcome variable and the second assessed social anxiety as the outcome variable.

Past research has demonstrated that there are sex differences in the prevalence of emotional disorders. Furthermore, it has been shown that between late childhood and adolescence there is an increase in the prevalence of emotional disorders. Based on this evidence, the predictors of sex and age were entered into Block one of the hierarchical regression. Depression and social anxiety have also often been shown to be co-morbid, therefore either depression or social anxiety (contingent on the outcome variable under review) was also added at Block one of the hierarchical regression.

The three domains assessed for attachment (trust, communication and alienation), stage of puberty and overall laterality quotient were added at Block two of the hierarchical regression. This allowed analysis of whether there was any additional effect of lateralization, attachment and puberty above and beyond age, sex and social anxiety or depression entered at Block one.

To determine if interactions between variables could act as predictors for depression and social anxiety, interactive predictors were entered into Block three of the model.

This involved interactions between laterality and puberty and laterality and each of the three domains of attachment (trust, communication and alienation). Zero-order correlations from the regression analysis can be seen in Table 4.

Table 4. Zero order correlations between continuous measures for depression and social anxiety.

	Depression	*Age*	*Overall laterality*	*Attachment (C)*	*Attachment (T)*	*Attachment (A)*	*Puberty*	*Puberty x Laterality*	*Attachment (C) x Laterality*	*Attachment (T) x Laterality*	*Attachment (A) x Laterality*
Social Anxiety	.28**	.20*	-.13	-.10	-.02	.36***	.03	-.09	-.17*	-.16	.00
Depression		-.06	-.02	.15	.24**	.01	-.17	-.004	-.01	-.02	.004
Age			.04	-.21*	-.22**	.18*	.59***	.15	-.01	.004	.11
Overall laterality				.07	.03	-.10	-.08	.93***	.96***	.97***	.87***
Attachment (C)					.74***	-.66***	-.25**	-.02	.23**	.18*	-.16
Attachment (T)						-.72***	-.37***	-.08	.17*	.19*	-.22**
Attachment (A)							.27**	.02	-.22**	.21*	.19*
Puberty								.13	-.12	-.13	.05
Puberty x Laterality									.86***	.86***	.90***
Attachment (C) x Laterality										.99***	.74***
Attachment (T) x Laterality											.75***

** p = .05, ** p = .01, *** p = .001, Attachment (C) = Attachment, communication subscale; Attachment (T) = Attachment, Trust subscale, Attachment (A) = Attachment, Alienation subscale*

Depression

Results of the hierarchical regression for depression can be seen in Table 5. The analysis revealed that Block one, containing sex, age and social anxiety as predictor variables was significantly better than chance at predicting depression scores ($F(3,96) = 5.12$, $p = .002$), accounting for 11% of the variance. This revealed that both social anxiety scores and sex were significant predictors of depression. The analysis revealed that higher social anxiety scores and female sex were both linked to higher depression, supporting previous findings. There was no effect of age.

In Block two, the addition of attachment, stage of puberty and overall laterality explained a further 7% of the variance. This did not represent a significant change in the amount of variance explained by the variables entered at Block two ($F(5,91) = 1.70$, $p = .143$). With the additional variables entered at Block two, sex remained a significant predictor of depression scores, whereas social anxiety did not. Of the additional predictors added into Block two, only attachment trust emerged as significant predictor of depression. This demonstrated that higher scores of parental attachment trust was linked to higher depression scores. There was no effect of parental attachment communication and alienation, puberty status or overall laterality.

The addition of interactions between laterality and puberty and laterality and attachment entered at Block three explained a further 6% of the variance. This did not represent a significant increase in the amount of variance explained by Block three ($F(4,87) = 1.64$, $p = .170$). Despite the addition of the interacting variables in Block three, sex and parental attachment trust remained as unique predictors. A significant

effect was also found for the interaction between parental attachment trust and laterality. When this interaction was broken down, it was revealed that there was a significant effect between parental attachment trust and depression, but this was mediated by laterality. This showed that it was only when children demonstrated a left or bilateral hemisphere bias for emotional processing that parental attachment trust was related to depression. There were no other significant findings from Block three.

For depression, hypotheses regarding the unique contributions of the social, biological and neuropsychological variables were not supported. It was predicted that lower scores for attachment trust and attachment communication would be linked to higher scores for social anxiety. This was not supported by the analysis, as higher scores for parental attachment trust were found to be associated with higher depression scores, and no relationship was revealed between attachment communication and depression scores. Additionally, the prediction that higher attachment alienation scores would be linked with higher depression scores was also not supported. The hypotheses predicting that higher pubertal status and reduced overall laterality scores would be associated with higher depression scores were also not supported.

The hypotheses regarding interactions between variables were partially supported. The hypothesis of a relationship of interactions between laterality and parental attachment was supported, but only for the interaction of laterality and parental attachment trust. The hypothesis of a relationship of interactions laterality and puberty was not supported.

Table 5. Regression analysis for variables predicting depression.

	B	*t*	*p*
Block One			
Sex	1.84	2.25	.027
Age	-.44	-1.82	.072
Social Anxiety	.06	2.45	.016
Block Two			
Sex	2.01	2.38	.020
Age	-.17	-.57	.570
Social Anxiety	.04	1.40	.164
Attachment trust	2.01	2.20	.031
Attachment communication	-.27	-.37	.716
Attachment alienation	.87	1.13	.261
Puberty status	-.82	-.87	.389
Overall laterality quotient	.58	.41	.680
Block Three			
Sex	1.90	2.25	.027
Age	-.15	-.50	.618
Social Anxiety	.03	1.07	.290
Attachment trust	3.97	3.20	.002
Attachment communication	-.86	-.97	.336
Attachment alienation	1.44	1.69	.096
Puberty status	-.85	-.78	.437
Overall laterality quotient	29.80	1.47	.146
*Overall LQ * Attachment (T)*	-7.70	-2.31	.023
*Overall LQ * Attachment (C)*	2.12	.71	.480
*Overall LQ * Attachment (A)*	-3.23	-1.15	.253
*Overall LQ * Puberty*	1.82	.61	.547

Note. LQ = Laterality quotient. Attachment (T) = Attachment trust domain, Attachment (C) = Attachment communication domain, Attachment (A) = Attachment alienation domain.

Social Anxiety

Results of the hierarchical regression for social anxiety can be seen in Table 6. The analysis revealed that Block one, containing sex, age and depression as predictor variables was significantly better than chance at predicting social anxiety scores ($F(3,96) = 5.98$, $p = .001$), accounting for 16% of the variance. This revealed that depression was the only significant predictor of social anxiety in Block one. Higher depression scores were linked to higher social anxiety scores, similar to findings in previous studies. Neither age nor sex was shown to be significant predictors of social anxiety scores, although sex was trending towards significance.

The addition of attachment, stage of puberty and overall laterality at Block two explained a further 19% of the variance. This represented a significant change in the amount of variance explained by the variables entered at Block 2 ($F(5,91) = 5.37$, $p < .001$). With the additional variables entered at Block two, depression scores no longer represented a significant predictor of social anxiety. However age was now revealed as a significant predictor, with older children reporting higher social anxiety scores. Of the additional predictors added into Block two, both parental attachment trust and parental attachment alienation emerged as significant predictors of social anxiety. This demonstrated that higher scores of parental attachment in both the trust domain and the alienation domain were linked to higher social anxiety scores. Parental attachment communication, puberty status and overall laterality score were not found to be significant predictors.

The addition of interactions between laterality as a function of puberty and laterality as a function of the three attachment domains entered at Block three explained a further 2% of the variance. This did not represent a significant increase in the amount of variance explained by Block three ($F(4,87) = .52$, $p = .722$). Despite the addition of interacting variables entered at Block three, age, parental attachment trust and parental attachment alienation remained as significant unique predictors. There was no effect revealed for the interactive predictors entered into Block three.

For social anxiety, hypotheses regarding the unique contributions of the social variables were partially supported. It was predicted that there would be a relationship between higher parental attachment alienation and higher social anxiety scores. This hypothesis was supported by the analysis. It was also predicted that lower scores for attachment trust and attachment communication would be linked to higher scores for social anxiety. This was not supported by the analysis, as parental attachment trust was found to be positively associated with higher social anxiety scores and there was no relationship revealed between parental attachment communication and social anxiety scores. The hypotheses regarding the unique contributions of biological and neuropsychological factors were not supported. No relationship was revealed between puberty status or laterality scores.

The hypotheses regarding interactions between variables were also not supported. There was no relationship revealed between interactions of laterality and parental attachment or interactions between laterality and puberty.

Table 6. Regression analysis for variables predicting social anxiety.

	B	*t*	*p*
Block One			
Sex	6.01	1.93	.057
Age	1.38	1.49	.139
Depression	.92	2.45	.016
Block Two			
Sex	4.37	1.46	.147
Age	2.06	2.00	.048
Depression	.51	1.40	.164
Attachment trust	8.56	2.73	.008
Attachment communication	-.25	-.10	.923
Attachment alienation	11.19	4.60	< .001
Puberty status	-3.85	-1.17	.245
Overall laterality quotient	-4.76	-.98	.329
Block Three			
Sex	4.13	1.35	.180
Age	2.14	2.03	.045
Depression	.40	1.07	.290
Attachment trust	11.85	2.64	.010
Attachment communication	-1.79	-.57	.572
Attachment Alienation	11.15	3.92	< .001
Puberty status	-3.35	-.87	.389
Overall laterality quotient	8.30	.11	.910
*Overall LQ * Attachment (T)*	-11.26	-.93	.357
*Overall LQ * Attachment (C)*	8.92	.84	.404
*Overall LQ * Attachment (A)*	4.04	.40	.689
*Overall LQ * Puberty*	-4.35	-.41	.685

Note. LQ = Laterality quotient. Attachment (T) = Attachment trust domain, Attachment (C) = Attachment communication domain, Attachment (A) = Attachment alienation domain.

Discussion

The main aim of the present study was to investigate the social, biological and neuropsychological factors that are linked with the emergence of depression and social anxiety in late childhood and adolescence. The study revealed that in the current sample, when controlling for sex, age and co-morbid disorder, only the social factor of parental attachment remained as a significant predictor. Parental attachment was broken down into three domains: trust, communication and alienation. Trust and alienation were the two domains most related to depression and social anxiety. However, the results showed that depression and social anxiety were both related to attachment, but in unique ways. For depression, increased parental attachment trust and parental attachment trust as a function of laterality were predictors. For social anxiety, increased parental attachment trust and increased parental attachment alienation were predictors. Similar to previous research (e.g. La Greca & Harrison, 2005), this suggests depression and social anxiety have overlapping but unique pathways.

When looking at predictors for depression, known predictors of sex, age and social anxiety were entered into Block one. This revealed that both social anxiety and sex were significant predictors of depression, with female sex and higher social anxiety scores linked to higher depression scores. Sex remained a significant predictor in Block two, but the variance previously explained by social anxiety was now explained by parental attachment trust. This demonstrated that higher scores for parental attachment trust were linked with higher depression scores. It had been predicted that

lower parental attachment scores for trust and communication, and higher parental attachment scores for alienation would be predictive of social anxiety. This showed that the hypothesis was not supported, as findings were in the opposite direction predicted. Age and parental trust remained as significant predictors in Block three, but there was now also an effect of parental attachment trust as a function of laterality. This demonstrated that parental attachment trust was linked to depression in participants that were either left or bilateral hemisphere lateralized. This supported the hypothesis that attachment and lateralization would interact. Moreover, it demonstrated that children who did not show the typical lateralization pattern and had higher levels of attachment trust were more likely to report higher depression scores. Overall the model demonstrated a link between attachment and depression, and showed that laterality was also impacted by attachment in the sample.

When looking at predictors for social anxiety, the known predictors of sex, age and depression were again first entered into Block one. This revealed that depression was a significant predictor of social anxiety, with higher depression scores linked to higher social anxiety scores. After the addition of additional variables in Block two, the variability that had previously been explained by depression was now explained by parental attachment in the trust and alienation domains. Age was now also shown to be a significant predictor, with older children reporting higher social anxiety scores. Furthermore, higher parental attachment in both the trust and alienation domains was predictive of higher social anxiety scores. It had been predicted that lower parental attachment scores for trust, and higher parental attachment scores for alienation would be predictive of social anxiety. This hypothesis was partially supported for social anxiety, with higher parental attachment alienation scores being predictive of higher

social anxiety. However, contrary to predictions, higher scores for parental attachment trust were found to be linked to higher scores for both social anxiety and depression. These variables remained as predictors even when interactive variables were added into the model. Furthermore, the interactive predictors entered into Block three did not add significant predictive value to the model. The results therefore demonstrated the important of attachment factors in social anxiety, albeit in a subtly different pattern to those linked with depression.

Social factors: Attachment

The analysis revealed that of the predictive variables entered into Block two, only attachment significantly predicted social anxiety and depression scores. Previous research has shown evidence of a link between attachment and emotional disorders during adolescence. Typically, this research has looked at the link between attachment style, depression and social anxiety. Insecure, ambivalent and anxious attachments have all been implicated in depression and anxiety (Abela et al., 2005; Brumariu & Kerns, 2008; Lee & Hankin, 2009). However, the measure used in the present study (IPPA-R) does not classify children as securely or insecurely attached, but rather measures psychological security (Gullone & Robinson, 2005). Psychological security refers to the role of the primary caregiver in providing comfort and help to the child (Armsden et al., 1990) and allowing the development of cognition and managing affect (Waters & Cummings, 2000). Additionally, previous research looking at attachment has often considered attachment measured in pre-school children, using independent observers to rate attachment security. The present study looked at self-reported parental attachment, obtained from children and adolescents. This allows

insight into how children perceived their own attachments with their parents or caregivers, and how this impacts on their reported depression and social anxiety scores.

In the IPPA-R, the domain of parental attachment trust evaluates mutual understanding and respect between the caregiver and the child (Johnson et al., 2003). The finding that higher scores for parental attachment trust were related to higher depression scores was contrary to the initial hypothesis, as it was expected increased parental understanding and respect would protect against depression. This finding was also in contrast to findings from previous research, which has frequently shown that a poor trusting relationship between children and their parents or caregivers is linked to depression (Green & Goldwyn, 2002). In particular, previous studies have often found the opposite relationship to the present study, with evidence of lower scores for parental trust being linked to depression (e.g. Roelofs, Lee, Ruijten, & Lobbestael, 2011; Ruijten, Roelofs, & Rood, 2011).

One reason that may explain the discrepancy between previous findings and the findings in the present study is the fact that only parental attachment was examined. It has been suggested that parental attachment has more bearing on externalizing behaviours, whereas lower scores for peer attachments have more bearing on internalizing behaviours (Tambelli, Laghi, Odorisio, & Notari, 2012). In addition to this, peer rejection has been linked to lower mood in adolescents (Boivin, Hymel, & Bukowski, 1995; Sebastian, Viding, Williams, & Blakemore, 2010) as well as social anxiety (Sebastian et al., 2010). Previous research has shown that peer rejection can lead to lower self-esteem and feelings of self-worth for adolescents (O'Brien &

Bierman, 1988). In the presence of difficulties with peers, feelings of low mood may increase and adolescents may turn to their parents for support. When looking at adolescent adjustment (comprising depression, aggression and levels of sympathy), it was found that children had more difficulties with adjustment when they had a secure relationship with their parents, but a less secure relationship with their peers (Laible et al., 2000). This suggests that parental relationships remain important during adolescence, but difficulties with peer attachments may present as additional risk factors for depression. Furthermore, peer attachments and parental attachments may interact to have a unique impact on depression that cannot be seen by looking at either attachment relationship alone.

As with depression, the present study revealed higher parental attachment scores for trust were predictive of social anxiety. However, lower parental alienation scores were also linked to higher social anxiety scores. Children in the present study were aged between 9 to 14 years old. It is known that during this time, children's social interactions change dramatically (Blakemore & Mills, 2014). Children have been found to spend less time with their parents and family members in comparison to time spent with peers (Larson et al., 1996). However the finding that parental attachment was predictive of social anxiety scores suggests that parental attachments remain important for children, even when peer attachments increase in importance.

There may be several reasons for the observed relationship between social anxiety and parental attachment trust. A number of studies have examined the effect of parental behaviours on anxiety disorders, including social anxiety. One area that has been examined is that of parent-child interactions in anxious children, particularly in

regards to parental overinvolvement. Parental overinvolvement has been defined as parents demonstrating excessive involvement in their child's activities, including activities related to emotional experiences, which increases dependence (Affrunti & Ginsburg, 2012a; Barber, 1996). Research looking at parental overinvolvement has supported a link between parental overinvolvement and anxiety in children. For example, mothers have been shown to be more involved and intrusive in their interactions with both their own children and other children who have a diagnosis of clinical anxiety than children without such a diagnosis (Hudson, Doyle, & Gar, 2009; Hudson & Rapee, 2002).

As studies looking at the relationship between parental involvement and anxiety have been correlational, it is impossible to determine the direction of the relationship. It has been suggested that parents may become over involved when they sense their child is exhibiting symptoms of anxiety, as a way to help their child and reduce their distress (Hudson & Rapee, 2004). Alternatively, it may be that overinvolved parental behaviour acts as a risk factor for the onset of anxiety disorders in children. In line with this, it has been suggested that parental overinvolvement may lead to feelings of reduced competence and mastery in difficult situations, as children do not gain experience in solving problems autonomously (Affrunti & Ginsburg, 2012b). This demonstrates that the direction of the relationship between social anxiety and parental involvement is presently unclear. Through the use of hierarchical regression analysis, the current study is similarly unable to provide any clues as to whether parental involvement or social anxiety comes first. However, the model does show attachment as a predictive factor of social anxiety. Therefore, the relationship between attachment

and social anxiety warrants further investigation with longitudinal work to help elucidate a direction of effects.

Recent research has begun the process of looking at the direction of effects of attachment on depression and anxiety. In a longitudinal study by Asselmann and colleagues (2015) children aged 14 to 17 were initially assessed for emotional connectedness (disinterested vs. interested, cool vs. warm-hearted and intolerant vs. tolerant) in the mother-child relationship, and for individual autonomy. The children were followed up over the course of ten years and assessed for levels of depression and anxiety (including social anxiety). Children who were assessed as displaying low emotional connectedness were shown to have a greater risk of depression. In contrast, children assessed as having low levels of individual autonomy were shown to have an increased risk of both depression and anxiety. This study did not consider attachment per se. However, it provides important clues regarding mother-child relationships during adolescence and suggests that relationships with parents impact on the emergence of depression and anxiety. It would be important for future work to build on this, specifically considering attachment relationships.

Excessive interactions between parents and their children may account for the finding that higher reported parental trust is linked to social anxiety. However this does not account for the finding that increased parental alienation is also linked to higher social anxiety scores. Previous research has suggested that insecure attachments contribute to the development of social anxiety in children and adolescents (Brumariu & Kerns, 2008). In particular, it has been suggested that when parents are unavailable or intermittently available, children cannot rely on their caregivers, which may results in

increased fear and distress (Bosquet & Egeland, 2006; Brumariu & Kerns, 2008). It has been hypothesised that this fear and distress may then be linked to the emergence of social anxiety. In the present study, parental attachment alienation was evaluated by the IPPA-R. Within this measure, parental attachment alienation evaluates feelings of isolation and alienation between the child and their caregiver (Johnson et al., 2003). It may therefore be the case that children who are attached to their parents and trust them, and yet receive only infrequent or intermittent attention and support from their parents, are more likely to develop social anxiety. This may represent difficulties in the child having the internal concept of a safe base for which to apply to others, making it difficult to successfully interact with peers. It is therefore possible that this intermittent reinforcement from parents therefore plays an important role in social anxiety.

The present study revealed that depression and social anxiety were both linked to attachment, but their relationships to attachment differed. Both depression and social anxiety were linked to stronger parental attachment trust. However it was only in depression that lateralization had a moderating effect on attachment, and it was only in social anxiety that there was also a relationship to increased parental attachment alienation. It has been suggested that depression and social anxiety are related to similar factors, but their pathways differ in subtle ways (e.g. Karevold et al., 2009; La Greca & Harrison, 2005). This assertion seems to be supported by the present study. This has also been evidenced in previous research looking at child and parent interactions. For example, it has been demonstrated that in terms of parental behaviours, control is an important factor for anxiety disorders, whereas depression has been more strongly linked to parental rejection (Rapee, 1997). Furthermore,

depression, but not anxiety, has been linked to parental factors including increased conflict between parents and parents being more hostile towards their child (Yap & Jorm, 2015). The present study adds weight to the argument that depression and social anxiety have unique pathways.

Biological factors: Puberty

The present study found no linear relationship between puberty and depression and social anxiety. However, some previous research has suggested that puberty does not have a linear relationship with depression and social anxiety (Deardorff et al., 2007). This suggests additional factors may have a role in mediating the relationship between puberty and depression and social anxiety. The analysis revealed that there was no evidence of an interaction between puberty and laterality predicting depression and social anxiety in the present sample. This was a surprising finding, as it has been suggested that pubertal hormones have an effect on brain development (Peper et al., 2008; Peper et al., 2011; Perrin et al., 2008). These neural changes have also been thought to have an impact on facial processing (Blakemore & Mills, 2014). In line with this research, hormones have been thought to have an impact on emotional lateralization for faces (Bourne, 2014). However this relationship has only been examined in adult participants, and not for children currently during different stages of puberty. It may be the case that there is a relationship between hormones and laterality, but this develops later, following puberty.

Pubertal status has been linked with depression, above and beyond the effects of age (Angold et al., 1998). However the relationship with between puberty status and

depression has been shown to only be apparent after mid-puberty, and was more apparent for girls than boys (Angold et al., 1998). Neural changes occurring during puberty have been hypothesised to play a role in vulnerability to emotional disorders such as depression and anxiety (Perlman, Webster, Herman, Kleinman, & Weickert, 2007). This suggests the relationship between puberty and emotional disorders may be more complicated than a simple linear relationship. For example, it has been suggested that the onset of depression and social anxiety is related to differences in cognitive coping styles between males and females (Altemus, Sarvaiya, & Neill, 2014). These differences in coping styles tend to emerge during puberty, and may somewhat account for the differences in onset during this time. It may therefore be the case that factors not considered in the present study, such as cognitive style, interacts with puberty to affect depression and social anxiety.

It has been consistently reported that children, particularly girls, who reach earlier pubertal maturation have an increased risk of experiencing both depression (Hamilton, Hamlat, Stange, Abramson, & Alloy, 2014) and social anxiety (Blumenthal et al., 2011). It has been argued that there is increased stress associated with early maturation in girls, which may lead to increased comparison with peers (Hamilton et al., 2014). It is possible that these increased comparisons to others lead to risk of both depression and social anxiety. Whereas early maturation has been found to be an important correlate for the emergence of internalizing disorders in girls, this relationship has not been found with boys. In comparison, late pubertal maturation has been associated with psychopathology in boys, particularly for externalizing disorders such as substance misuse (Graber, Seeley, Brooks-Gunn, &

Lewinsohn, 2004). This may go some way to explaining the differences in the emergence of emotional disorders between girls and boys during puberty.

The links between pubertal hormones, brain development and changes to facial processing during adolescence suggest there would be an interaction between these factors. The finding that there was no effect of puberty on lateralization may suggest that hormonal factors have a greater impact on facial processing prenatally, when the brain is first developing. Previous research has shown that higher levels of prenatal testosterone are associated with stronger right hemisphere lateralization for emotional faces (Bourne, 2014; Bourne & Gray, 2009). However, there was no apparent effect of hormones on lateralization when examining hormonal replacement therapy in later life (Bourne & Gray, 2009). This suggests that the impact of hormones on facial processing may be most apparent prenatally, when the brain is first developing, with little impact of hormones on lateralization later in life. This could suggest a long-term vulnerability for depression and social anxiety, linked to prenatal hormonal exposure and may be an interesting avenue for further study.

Neuropsychological factors: Laterality

The results of the analysis demonstrated no effect of laterality on either social anxiety or depression in this age group. The right hemisphere hypothesis proposes that all emotions are lateralized to the right hemisphere (Borod et al., 1998). There is evidence that as emotional processing becomes more lateralized to the right hemisphere over time, accuracy in recognising emotions has also been shown to increase (Herba & Phillips, 2004). Changes to emotional recognition have been

shown in individuals with both depression (Hall et al., 2014; Schepman et al., 2012) and social anxiety (Battaglia et al., 2012; Blair et al., 2011). There is also evidence of changes to lateralization of emotional recognition in adults with depression (Bourne & Vladeanu, 2013) and social anxiety (Bourne & Vladeanu, 2011). It was therefore hypothesised that changes to lateralization may also be important in the development of social anxiety and depression in adolescents. Unlike attachment, laterality did not uniquely predict the variability in scores for either depression or social anxiety. However, attachment and laterality were shown to interact to predict depression scores. This may suggest that there are additional factors that impact on laterality, which together increase the risk of depression developing. For example, a more trusting parental relationship may only increase the risk of depression when laterality is atypical.

The present study revealed that laterality scores were not uniquely related to depression scores. Previous research has suggested emotional facial recognition may be altered in individuals with depression. For example, adults with depression have been shown to be less accurate at emotional recognition of happy expressions (Surguladze et al., 2005) and need more intensity to recognise happiness on faces (Joormann & Gotlib, 2006). There has also been evidence that lateralization changes in adults with depression (Hecht, 2010; Otto et al., 1987; Reischies et al., 1989; Bourne & Vladeanu, 2013; Grimm et al., 2008). However, this relationship has not been previously examined in children and adolescents. Furthermore, no study has explored social factors concurrent with lateralization, or when controlling for the co-morbidity of depression and social anxiety. The findings of the present study suggest lateralization changes are not behaviourally observable in this age group, although

does not preclude evidence of lateralization changes in neuroimaging studies. However, if emotional facial processing impacts depression in this age group, it does not appear that laterality alone is primarily implicated.

The study revealed another possibility regarding the effect of lateralization on depression. Although there was no unique effect of lateralization on depression, there was a significant interaction between parental attachment trust and lateralization. This demonstrated that parental attachment trust was linked to depression in participants, but only when children were either bi-laterality or left hemisphere lateralized. This demonstrated that children who did not show the typical lateralization pattern and had higher levels of attachment trust were more likely to report higher depression scores. Both children and adults are typically right hemisphere lateralized when recognising facial emotions (Watling et al., 2012). However, it has been shown that lateralization may change in adults with depression (Bourne & Vladeanu, 2013). The present study demonstrated that altered lateralization acted as a mediating factor on parental attachment trust. Children with atypical lateralization and higher scores for parental attachment trust were more likely to report higher depression scores. This finding suggests that altered lateralization may act as a mediator for the effects of attachment on depression. It is interesting that typical lateralization patterns did not demonstrate any effect the relationship between attachment and depression. Only altered lateralization, which has been previously demonstrated in depression, had an effect on attachment. Typically, it has been suggested that lateralization may change as a function of whether an individual is securely or insecurely attached (Fussell et al., 2012). However the present study suggests that changes to lateralization may also have an impact on attachment.

The finding that emotional lateralization for faces was not a significant unique predictor was a particularly surprising finding in social anxiety. In the case of social anxiety it has previously been shown that facial expressions of others have an important role. Previous research has shown that individuals with social anxiety are hypervigilant to facial expressions (Eastwood et al., 2005). Additionally, individuals with social anxiety have been shown to be more likely to attend to negative expressions or facial expressions showing disapproval (Eastwood et al., 2005; Mogg et al., 2004). Importantly, these studies considered adult participants, whereas the present study was looking at this effect in children and adolescents. Previous research that has looked at the link between emotional facial processing and social anxiety in children has also suggested that facial processing is atypical in child and adolescent populations.

However, the present study is one of the first that controlled for the effect of social anxiety when evaluating depression and controlled for the effect of depression when evaluating social anxiety. As individuals with both depression and social anxiety demonstrated changes to emotional processing, there may be an additive effect of considering both depression and social anxiety together. Variability demonstrated in previous studies may therefore not have been present in the current study, as co-morbidity was controlled for. Additionally, the direction of the link between changes in emotional lateralization and emotional disorders has not yet been elucidated. It is therefore possible that laterality effects shift over time in response to depression and social anxiety, rather than as predictive factors when the disorders are developing. Future studies may also want to consider the relationship between peer attachment

and emotional lateralization, to see if there are also unique relationships between laterality and peer attachment for either depression and social anxiety.

Previous studies showing a link between social anxiety and emotional facial processing in children have also looked at other aspects of emotional facial recognition. These have included examining whether children can accurately identify emotions (Simonian et al., 2001) and the time taken to identify facial emotions (Melfsen & Florin, 2002). These studies have revealed that children with social anxiety are significantly less accurate at facial emotion recognition (Simonian et al., 2001) and were both slower at detecting facial emotions and more likely to report an emotion was present when a neutral expression was presented (Melfsen & Florin, 2002). This suggests aspects of facial processing such as reaction time, accuracy of processing and attention biases may be more important for social anxiety in this age group. For example, it may be the case that in childhood and adolescent social anxiety, information is still processed in the right hemisphere, albeit more slowly. It may also be the case that context plays an important role in emotional facial recognition at this time. Previous research has shown that in children aged 8-9 years old, context cues (information describing the experience surrounding a particular emotional expression) led to better expression discrimination than expressive cues alone (images of facial expressions) (Reichenbach & Masters, 1983). The emotional recognition may therefore not be fully developed in this group, and effects on emotional recognition in emotional disorders may therefore emerge at a later age. Only emotional lateralization was examined in the present study, but future research may want to examine the effects of other facets of facial processing on depression to help elucidate the relationship between social anxiety and facial processing.

Additional predictors: Co-morbidity, sex and age

Of note, an interesting finding of the study concerned the predictor variables entered into Block one, which previous research had demonstrated to be associated with depression and social anxiety. Previous research has shown social anxiety and depression to be highly co-morbid disorders (Chavira & Stein, 2005; Thapar et al., 2012). Depression was shown to be predictive of social anxiety scores, and likewise social anxiety was predictive of depression scores in Block one of the hierarchical regression. However in Block two both were shown to no longer be significant predictors. This suggests that the co-morbidity often seen between depression and social anxiety may be explained through the impact of another variable. In the present study, the variance previously attributed to depression and social anxiety scores in Block one was explained by attachment in Block two. However, it is likely that other variables also mediate the co-morbidity between depression and social anxiety. This provides an interesting avenue for future research, in exploring the common factors underling depression and social anxiety.

The study also revealed an interesting finding regarding sex. There was a clear relationship between sex and depression scores, which remained even with the addition of further variables. This demonstrated that girls consistently reported higher levels of depression than boys, in keeping with previous findings (Angold & Costello, 1993; Costello et al., 2006). In contrast, sex was not found to be a significant predictor of social anxiety scores. The finding that only depression reached significance may indicate that there is a larger effect size for the relationship between sex and depression than sex and social anxiety.

It was initially hypothesised that puberty may have an impact independent of age. However, there was no effect of either age or puberty status on depression scores. This may be related to how younger children answer respond to emotion-based tasks. Previous research has shown that younger children (aged 5 to 9 years old) were more likely to choose extreme scores on Likert scales when responding to self-report emotion-based tasks (Chambers & Johnston, 2002). This may suggest that the youngest children were more likely to provide extreme responses for the depression questionnaire, possibly explaining the finding of higher reported depression scores. However, the finding that older children reported higher social anxiety scores may suggest other factors not considered in the present study led to younger children reporting higher depression scores.

There was initially no relationship demonstrated between age and social anxiety in Block one. However with additional factors entered into Block two and Block three, age became a significant predictor. This demonstrated that older children were more likely to report higher social anxiety scores, compared to the two younger age groups. This finding is in line with previous studies that have found that older children are more likely to report higher social anxiety scores. As there was no effect of puberty on social anxiety scores in the present study, age was revealed as a more important predictor of social anxiety than puberty. This again implicates social factors as being more predictive of social anxiety than biological or neuropsychological factors in the present sample.

Additional predictors: Explaining missing variance

Overall, the amount of variance explained by the models was 24% for depression and 37% for social anxiety. This suggests that additional factors that were not considered in the present study must play a role in depression and social anxiety to explain the additional variance. A number of factors may account for this additional variance, such as timing of puberty onset (which has been previously discussed) and cultural factors.

Cultural differences have been noted in both depression (Dunlop, Song, Lyons, Manheim, & Chang, 2003) and social anxiety (Furmark, 2002), with cultural groups showing a different pattern of psychological difficulties (Blumenthal et al., 2011; Hayward, Gotlib, Schraedley, & Litt, 1999). For example, some evidence has suggested that non-White populations have a lower risk of internalizing disorders, including social anxiety and depression (Breslau et al., 2006). African American populations have also been shown to have a lower lifetime prevalence of depression but be more likely to experience dysthymia, a more mild but chronic presentation (Riolo, Nguyen, Greden, & King, 2005). This may have implications for the present study, which did not look at clinical samples of depression. This may also explain the differences in depression scores between the older and younger children. In the present study, higher depression scores were found for younger children compared to older children. This was a surprising finding that was contrary to previous studies (e.g. Kessler et al., 2001), which have reliably shown an increasing effect of depression with age. However, in the present sample the older children were almost

exclusively White British, whereas the younger children were more mixed in terms of ethnicity. This may suggest that cultural factors had an impact on the present results.

Differences in societal rules amongst cultures are also thought to have an important impact on social anxiety (Heinrichs et al., 2006). Moreover, differences between cultures mean that some behaviour may be socially acceptable in one culture but frowned upon in another (Hofmann, Anu Asnaani, & Hinton, 2010). In line with this, social norms are likely to be different in collectivist cultures, where individual gain is seen as less important than group improvement, versus individualistic cultures, where individual success is seen as providing rewards and admiration (Hofmann et al., 2010). Previous research findings have shown that individuals from collectivist cultures report greater levels of social anxiety than individuals from individualistic countries (Heinrichs et al., 2006). Together this suggests that cultural factors are likely to have a large impact on risk for depression and social anxiety, and it would be helpful to explore this further in future research.

Cultural factors have also been examined in terms of laterality. There is some evidence that laterality for processing various stimuli is impacted by reading direction (Heath, Rouhana, & Ghanem, 2005). Whereas Roman script is traditionally read left to right, Arabic script is traditionally read right to left. Using this naturally occurring difference, and an illiterate control group, it has been shown that reading direction can impact laterality. Heath and colleagues (2005) found that right-handed Roman script readers demonstrating the greatest right hemisphere bias for emotional processing. This suggests that cultural factors may impact risk factors, with different patterns emerging depending on cultural influences.

Limitations

The study had several limitations, which may have impacted on the research findings.

Choice of variables

Laterality: The present study assessed laterality for each of the six Ekman emotions, but combined this into a total composite score to reflect overall laterality. This was due to power considerations. Ideally, the study would have looked at the six Ekman emotions separately, but the sample size of the present study did not allow examination of each emotion separately. It is possible that by considering laterality as a single score, important findings regarding the relationship between emotional laterality and particular emotions was lost. Research has shown that individuals with depression show a bias for negative facial expressions (Bourke et al., 2010; Delle-Vigne et al., 2014; Ritchey et al., 2011), whereas individuals with social anxiety seen to be hypersensitive towards threat-related information, such as angry faces (Eastwood et al., 2005). Previous research has also shown that there may be differences in emotional lateralization for different emotions (e.g. Workman et al., 2006, Watling et al., 2012). For example, when looking at individuals with depression, Bourne and Vladeanu (2013) reported evidence of a shift to left hemisphere processing of emotions. This was particularly apparent for anger, disgust and fear. It will be important for future studies to break down laterality into separate emotions, to help shed light on more specific changes to lateralization that may be occurring.

Peer attachment: Only parental attachment was considered in the present study, given the known importance of the child's attachment to parental figures, which continues into adolescence (Ainsworth, 1989; Laible et al., 2000). Previous research has highlighted changes to attachment relationships occurring during adolescence, with peer relationships gaining increased importance (Larson et al., 1996). It would be useful for further research to also consider the effects of peer attachments on depression and social anxiety, due to the importance of these relationships in adolescence. This would also provide important insights into the interplay between parental and peer attachments on depression and social anxiety.

Emotional lateralisation: The present studied considered emotional lateralization as a neuropsychological factor that might be affected in depression and social anxiety. There is strong evidence that there are changes to emotional lateralization in adults with both depression (Bourne & Vladeanu, 2013) and social anxiety (Bourne & Vladeanu, 2011). Previous research has also shown that emotional recognition is affected in depression and social anxiety. The present study did not include an emotional recognition task. It is therefore impossible to provide conclusions of whether altered emotional recognition was related to higher depression and social anxiety scores in the current sample. By including an emotional recognition task, it would have been possible to assess whether higher depression and social anxiety scores were linked to hypersensitivity to particular expressions, reduced accuracy in emotional recognition or slower reaction times. In addition, this would have allowed examination of other factors related to emotional recognition that could not be considered with the use of the chimeric faces test. Future research might consider adding in an emotional recognition task, alongside measures of emotional

lateralization. This would allow investigation of additional neuropsychological factors that may be altered in depression and social anxiety.

Non-clinical samples

The study looked at children reporting higher or lower scores on measures of depression and social anxiety, rather than working with children who had received a clinical diagnosis. It was shown that there was still variability in the sample of children reporting low and high scores for both depression and social anxiety. However, as the children in the present sample had not received a diagnosis of depression and social anxiety, caution needs to be taken if generalizing the results to clinical samples. It is possible that the present results do not accurately represent depression and social anxiety at a clinical level, and different factors may emerge as significant in clinical populations. It would therefore be important for future research to try and replicate the present findings in clinical populations. However the current research may provide some useful insights into children who have subclinical levels of depression and social anxiety. It may also provide useful information to help prevent children with subclinical levels of depression and social anxiety reaching clinical levels.

Self-report

All measures used in the present study were self-report, with all information provided by the child taking part in the study. This gives a picture of how the child perceives the world alongside their opinions of their relationships with their parents and feelings

of social anxiety and depression. However, gaining information from several sources (e.g. teachers, parents) may have provided a more accurate and well-rounded picture. In addition, it is important to consider that the present study used a word-based self-report measure to gain information on puberty status. Previous studies have used other methods to obtain puberty status, including taking saliva samples, having GPs complete the questionnaire on behalf of the children, and using questionnaires that display pictures for children to choose. Obtaining accurate information about puberty status in young children would therefore be an important consideration in future research.

Distribution of participants across puberty

The number of children included in the study who were going through various stages of puberty varied. A high number of children were already in the mid to late stages of puberty, despite the inclusion of younger children in the study. There might not have been sufficient numbers of children in the stages of pre or early puberty to make a meaningful comparison between those in the stages of early and late puberty. Future studies may want to include younger children to ensure that effects across the stages of puberty can be evaluated.

Clinical implications of the study

The study raised some important clinical implications for working with children and adolescents who have depression and social anxiety. The study demonstrated that

social factors were related to depression and social anxiety. Neuropsychological factors were mediated by social factors, and biological factors demonstrated no effect. The social factor under consideration in the present study comprised parental attachment. Psychological interventions may want to consider involving parents in treatment for children and adolescents with depression and social anxiety.

Some studies have looked at the impact of including parents into CBT interventions. There has been evidence of a benefit of CBT for depression and anxiety that involves working with children and parents together, particularly for younger children (Mendlowitz et al., 1999). There has also been evidence of superior effect of treatment when parents are involved for social anxiety in particular (Spence et al., 2000). However, several meta-analyses have found no benefit of including parents in treatment for children and adolescents with a variety of anxiety disorders (Breinholst, Esbjørn, Reinholdt-Dunne, & Stallard, 2012; James, James, Cowdrey, Soler, & Choke, 2013). On the one hand, this finding may relate to the fact that anxiety disorders in general were considered. The present study suggested parental attachment is an important factor in social anxiety, but this does not necessarily mean the same pattern of results would be found for other anxiety disorders. However, in the present study, increased depression and social anxiety was linked to *increased* parental attachment trust. It may therefore be the case that therapy considers working with parents and children, but not concurrently. This would allow children space away from parents to talk about their issues independently. Additionally, treatment with CBT alongside attachment-based family therapy has been shown to be effective in treating symptoms of anxiety, including social anxiety (Siqueland, Rynn, & Diamond,

2005). This outlines the importance of focussing on attachment variables between children and their parents.

The present study revealed that social factors independently predicted the variability in depression and social anxiety scores, whereas biological factors did not. This indicated that social factors, particularly attachment, have clearer links with depression and social anxiety in late childhood and adolescence. This may have implications regarding the use of medications versus psychological therapies as treatment for depression and social anxiety in children and adolescents. It has been shown that, compared to a placebo, the antidepressant Citalopram has a significant effect in treating depression in children and adolescents aged 7 to 17 years old (Wagner, Robb, et al., 2004). However, only 36% of children in the sample saw benefit from the use of medication. Similar findings have been reported for the use of medication with social anxiety. In comparison to a placebo, Paroxetine was shown to be effective at treating social anxiety in children and adolescents aged 8 to 17 (Wagner, Berard, et al., 2004). However, only 48% of children demonstrated an improvement in well-being and reduced severity. Although this shows medications can be effective in treating depression and social anxiety, over half the participants in these studies derived little benefit from medication. Therefore it may be that focussing on social factors such as attachment, or integrating medication use with psychosocial interventions will promote a better treatment response. Parents and children have also been shown to prefer talking therapies over medication (James et al., 2013). This reiterates that it is important not to lose sight of social factors in treatment, even in time-pressured child services.

Future directions

Future studies should aim to build on the present research by considering peer attachments. Peer attachments are known to increase in importance during adolescence (Larson et al., 1996). It would therefore be important to consider whether there is any relationship between peer attachment, depression and social anxiety. Previous research has suggested this may be the case. Research has shown that adolescents who experience peer rejection report increased depression (Boivin et al., 1995) and anxiety (Sebastian et al., 2010). Additionally, peer relationships have also been found to differentially impact on depression and social anxiety. One study has reported that social anxiety was influenced by negative experiences with best friends, whereas depression was influenced by negative qualities in best friends and romantic relationships (La Greca & Harrison, 2005). It would therefore be important to see if peer attachment also impacts on depression and social anxiety. This would also provide insights into any interplay between parent and peer attachment.

Much of the work (including the present study) that has looked at the factors associated depression and social anxiety has been unable to suggest a direction for the relationships uncovered. In the present study, the attachment questionnaire showed that increased parental attachment trust was related to depression and social anxiety. It may be the case that this attachment relationship causes children to experience depression and social anxiety. Alternately, higher scores of depression and social anxiety may drive children closer to their parents. For effective treatments, it will be important to know which factors increase the risk of depression and social anxiety developing, and which act as maintenance factors. Recent work has begun to provide

clues into the direction of this relationship, with a recent longitudinal study suggesting that reduced emotional connectedness with parents and difficulties with autonomy impact on the later development of social anxiety and depression (Asselmann et al., 2015). Future work should therefore aim to continue this work with longitudinal study, particularly concerning the relationship of attachment on depression and social anxiety.

Previous research has examined emotional lateralization for faces in young children (aged 5-11 years old) (Watling & Bourne, 2007; Workman et al., 2006) and in adults (e.g. Bourne, 2010; Bourne & Watling, 2015). However there is little information on how lateralization develops across late childhood and adolescence, and whether this is related to depression and social anxiety. The present study looked at lateralization in this age group, but combined laterality scores across six emotions into one composite score. Future research could shed more light on the development of emotional lateralization during adolescence by examining the six emotions separately. This would also provide information on whether different patterns emerge for different emotions to impact on depression and social anxiety. Moreover, future studies should aim to include tasks of emotional recognition to provide information about other facets of emotional processing related to depression and social anxiety. This may include emotional recognition tasks assessing speed of processing and accuracy in this age group. Finally, it would be helpful to try and replicate the current findings in a clinical sample. This would help to demonstrate whether the current findings are only evident in subclinical populations, thus indicating areas to intervene for prevention, or whether similar factors are evidenced in clinical levels of depression and social anxiety.

Summary

In summary, the results demonstrated that the attachments adolescents have are linked to the levels of depression and social anxiety they may experience. These relationships were shown to be more important than both biological and neuropsychological factors, including sex, puberty and laterality.

Both depression and social anxiety were related to similar predictive factors: attachment. However, subtly different relationships between attachment domains were shown for depression and social anxiety. Previous research has suggested that depression and social anxiety are related to subtly unique pathways. In the present study, depression was primarily linked to higher scores for parental attachment trust. Furthermore, there was evidence of parental attachment trust mediating a relationship between parental attachment trust and laterality. This suggested that laterality might only be related to depression when children have a more trusting relationship with their parents. Social anxiety was similarly related to higher scores for parental attachment trust, but also to higher scores for parental attachment alienation. This might suggest that children that have a strong bond with their parents, but whose parents are often unavailable or intermittently available, have higher social anxiety scores.

The results of the present study showed that depression and social anxiety are more influenced by social factors, such as attachment, rather than biological and neuropsychological factors. As the present study used hierarchical regression, there is no indication of the direction of the relationship between social factors and depression

and social anxiety. It may be the case that attachment factors lead to the emergence of emotion disorders, or that attachments change because of the presence of emotional disorders. It will be important for future research to undertake longitudinal studies to try and elucidate the direction of this relationship, in hopes of aiding prevention and providing better treatment. Furthermore, considering additional attachments (e.g. with peers) will help tease out other social factors that may impact depression and social anxiety in childhood.

References

Abela, J. R. Z., Hankin, B. L., Haigh, E. A. P., Adams, P., Vinokuroff, T., & Trayhern, L. (2005). Interpersonal vulnerability to depression in high-risk children: The role of insecure attachment and reassurance seeking. *Journal of Clinical Child & Adolescent Psychology, 34*(1), 182-192.

Adolphs, R. (1999). Social cognition and the human brain. *Trends in Cognitive Sciences, 3*(12), 469-479.

Adolphs, R., Damasio, H., Tranel, D., & Damasio, A. R. (1996). Cortical systems for the recognition of emotion in facial expressions. *The Journal of Neuroscience, 16*(23), 7678-7687.

Adolphs, R., Gosselin, F., Buchanan, T. W., Tranel, D., Schyns, P., & Damasio, A. R. (2005). A mechanism for impaired fear recognition after amygdala damage. *Nature, 433*(7021), 68-72.

Adolphs, R., Tranel, D., & Damasio, A. R. (1998). The human amygdala in social judgment. *Nature, 393*(6684), 470-474.

Adolphs, R., Tranel, D., Damasio, H., & Damasio, A. (1994). Impaired recognition of emotion in facial expressions following bilateral damage to the human amygdala. *Nature, 372*(6507), 669-672.

Adolphs, R., Tranel, D., Damasio, H., & Damasio, A.R. (1995). Fear and the human amygdala. *The Journal of Neuroscience, 15*(9), 5879-5891.

Affrunti, N. W., & Ginsburg, G. S. (2012a). Exploring parental predictors of child anxiety: The mediating role of child interpretation bias. *Child & Youth Care Forum, 41*(6), 517-527.

Affrunti, N. W., & Ginsburg, G. S. (2012b). Maternal overcontrol and child anxiety: The mediating role of perceived competence. *Child Psychiatry and Human Development, 43*(1), 102-112.

Aftanas, L., Varlamov, A., Pavlov, S., Makhnev, V., & Reva, N. (2001). Event-related synchronization and desynchronization during affective processing: Emergence of valence-telated time-dependent hemispheric asymmetries in theta and upper alpha band. *International Journal of Neuroscience, 110*(3-4), 197-219.

Ainsworth, M. D. (1989). Attachments beyond infancy. *The American Psychologist, 44*(4), 709-716.

Ainsworth, M. D. S., Blehar, M. C., Waters, E., & Wall, S. (1978). *Patterns of attachment: A psychological study of the strange situation*. Hillsdale, NJ: Erlbaum.

Aljuhanay, A., Milne, E., Burt, D. M., & Pascalis, O. (2010). Asymmetry in face processing during childhood measured with chimeric faces. *Laterality, 15*(4), 439-450.

Allen, J. P., & Miga, E. M. (2010). Attachment in adolescence: A move to the level of emotion regulation. *Journal of Social and Personal Relationships, 27*(2), 181-190.

Allen, J. P., Porter, M., McFarland, C., McElhaney, K. B., & Marsh, P. (2007). The relation of attachment security to adolescents' paternal and peer relationships, depression, and externalizing behavior. *Child Development, 78*(4), 1222-1239.

Allgaier, A.-K., Frühe, B., Pietsch, K., Saravo, B., Baethmann, M., & Schulte-Körne, G. (2012). Is the Children's Depression Inventory Short version a valid

screening tool in pediatric care? A comparison to its full-length version. *Journal of Psychosomatic Research, 73*(5), 369-374.

Altemus, M., Sarvaiya, N., & Neill, E. C. (2014). Sex differences in anxiety and depression clinical perspectives. *Frontiers in Neuroendocrinology, 35*(3), 320-330.

Alves, N. T., Fukusima, S. S., & Aznar-Casanova, J. A. (2008). Models of brain asymmetry in emotional processing. *Psychology & Neuroscience, 1*(1), 63-66.

Angold, A., & Costello, E. J. (1993). Depressive comorbidity in children and adolescents: Empirical, theoretical, and methodological issues. *The American Journal of Psychiatry, 150*(12), 1779-1791.

Angold, A., Costello, E. J., Erkanli, A., & Worthman, C. M. (1999). Pubertal changes in hormone levels and depression in girls. *Psychological Medicine, 29*(05), 1043-1053.

Angold, A., Costello, E. J., & Worthman, C. M. (1998). Puberty and depression: The roles of age, pubertal status and pubertal timing. *Psychological Medicine, 28*(1), 51-61.

Angold, A., & Worthman, C. W. (1993). Puberty onset of gender differences in rates of depression: a developmental, epidemiologic and neuroendocrine perspective. *Journal of Affective Disorders, 29*(2-3), 145-158.

Armsden, G. C. , McCauley, E., Greenberg, M. T., Burke, P. M., & Mitchell, J. R. (1990). Parent and peer attachment in early adolescent depression. *Journal of Abnormal Child Psychology, 18*(6), 683-697.

Armsden, G.C., & Greenberg, M.T. (1987). The Inventory of Parent and Peer Attachment: Individual differences and their relationship to psychological well-being in adolescence. *Journal of Youth and Adolescence, 16*(5), 427-454.

Arnett, J. J. (1999). Adolescent storm and stress, reconsidered. *The American Psychologist, 54*(5), 317-326.

Arrais, K. C., Machado-de-Sousa, J. P., Trzesniak, C., Santos Filho, A., Ferrari, M. C., Osorio, F. L., et al. (2010). Social anxiety disorder women easily recognize fearfull, sad and happy faces: The influence of gender. *Journal of Psychiatric Research, 44*(8), 535-540.

Asadi-Pooya, A.A., Sharan, A., Nei, M., & Sperling, M. R. (2008). Corpus callosotomy. *Epilepsy & Behavior, 13*(2), 271-278.

Asselmann, E., Wittchen, H. U., Lieb, R., & Beesdo-Baum, K. (2015). The role of the mother-child relationship for anxiety disorders and depression: Results from a prospective-longitudinal study in adolescents and their mothers. *European Child and Adolescent Psychiatry, 24*(4), 451-461.

Bar-Haim, Y., Dan, O., Eshel, Y., & Sagi-Schwartz, A. (2007). Predicting children's anxiety from early attachment relationships. *Journal of Anxiety Disorders, 21*(8), 1061-1068.

Barber, B. K. (1996). Parental psychological control: Revisiting a neglected construct. *Child Development, 67*(6), 3296-3319.

Bateman, A., Brown, D., & Pedder, J. (2010). *Introduction to psychotherapy: An outline of psychodynamic principles and practice*. Hove, East Sussex: Routledge.

Battaglia, M., Zanoni, A., Taddei, M., Giorda, R., Bertoletti, E., Lampis, V., et al. (2012). Cerebral responses to emotional expressions and the development of social anxiety disorder: A preliminary longitudinal study. *Depression and Anxiety, 29*(1), 54-61.

Batty, M., & Taylor, M. J. (2003). Early processing of the six basic facial emotional expressions. *Cognitive Brain Research, 17*(3), 613-620.

Batty, M., & Taylor, M. J. (2006). The development of emotional face processing during childhood. *Developmental Science, 9*(2), 207-220.

Bava, S., Ballantyne, A. O., May, S. J., & Trauner, D. A. (2005). Perceptual asymmetry for chimeric stimuli in children with early unilateral brain damage. *Brain and Cognition, 59*(1), 1-10.

Beaumont, J. G. (1983). Methods for studying cerebral hemispheric function. In A. W. Young (Ed.), *Functions of the right cerebral hemisphere* (pp. 114-146). London: Academic Press.

Beekman, A. T., de Beurs, E., van Balkom, A. J., Deeg, D. J., van Dyck, R., & van Tilburg, W. (2000). Anxiety and depression in later life: Co-occurrence and communality of risk factors. *The American Journal of Psychiatry, 157*(1), 89-95.

Beesdo, K., Bittner, A., Pine, D. S., Stein, M. B., Hofler, M., Lieb, R., et al. (2007). Incidence of social anxiety disorder and the consistent risk for secondary depression in the first three decades of life. *Archives of General Psychiatry, 64*(8), 903-912.

Beesdo, K., Lau, J. F., Guyer, A. E., McClure-Tone, E. B., Monk, C. S., Nelson, E. E., et al. (2009). Common and distinct amygdala-function perturbations in depressed vs anxious adolescents. *Archives of General Psychiatry, 66*(3), 275-285.

Bistricky, S. L., Ingram, R. E., & Atchley, R. A. (2011). Facial affect processing and depression susceptibility: Cognitive biases and cognitive neuroscience. *Psychological Bulletin, 137*(6), 998.

Blair, K. S., Geraci, M., Korelitz, K., Otero, M., Towbin, K., Ernst, M., et al. (2011). The pathology of social phobia is independent of developmental changes in face processing. *The American Journal of Psychiatry, 168*(11), 1202-1209.

Blakemore, S. J. (2008). The social brain in adolescence. *Nature Reviews Neuroscience, 9*(4), 267-277.

Blakemore, S. J. (2012). Imaging brain development: The adolescent brain. *NeuroImage, 61*(2), 397-406.

Blakemore, S. J., Burnett, S., & Dahl, R. E. (2010). The role of puberty in the developing adolescent brain. *Human Brain Mapping, 31*(6), 926-933.

Blakemore, S. J., & Mills, K. L. (2014). Is adolescence a sensitive period for sociocultural processing? *Annual Review of Psychology, 65*(1), 187-207.

Blehar, M. C., Lieberman, A. F., & Ainsworth, M. D. Salter. (1977). Early face-to-face interaction and its relation to later infant-mother attachment. *Child Development, 48*(1), 182-194.

Blumenthal, H., Leen-Feldner, E. W., Babson, K. A., Gahr, J. L., Trainor, C. D., & Frala, J. L. (2011). Elevated social anxiety among early maturing girls. *Developmental Psychology, 47*(4), 1133-1140.

Blyth, D. A., Hill, J. P., & Thiel, K. S. (1982). Early adolescents' significant others: Grade and gender differences in perceived relationships with familial and nonfamilial adults and young people. *Journal of Youth and Adolescence, 11*(6), 425-450.

Boivin, M., Hymel, S., & Bukowski, W. M. (1995). The roles of social withdrawal, peer rejection, and victimization by peers in predicting loneliness and depressed mood in childhood. *Development and Psychopathology, 7*(04), 765-785.

Boothroyd, L. G., Meins, E., Vukovic, J., & Burt, D. M. (2014). Developmental changes in children's facial preferences. *Evolution and Human Behavior, 35*(5), 376-383.

Bora, E., Fornito, A., Pantelis, C., & Yucel, M. (2012). Gray matter abnormalities in Major Depressive Disorder: A meta-analysis of voxel based morphometry studies. *Journal of Affective Disorders, 138*(1-2), 9-18.

Borod, J. C., Cicero, B. A., Obler, L. K., Welkowitz, J., Erhan, H. M., Santschi, C., et al. (1998). Right hemisphere emotional perception: Evidence across multiple channels. *Neuropsychology, 12*(3), 446-458.

Bosquet, M., & Egeland, B. (2006). The development and maintenance of anxiety symptoms from infancy through adolescence in a longitudinal sample. *Development and Psychopathology, 18*(2), 517-550.

Bouhuys, A. L., Geerts, E., & Gordijn, M. C. M. (1999). Depressed patients' perceptions of facial emotions in depressed and remitted states are associated with relapse: A longitudinal study. *The Journal of Nervous and Mental Disease, 187*(10), 595-602.

Bourke, C., Douglas, K., & Porter, R. (2010). Processing of facial emotion expression in major depression: A review. *The Australian and New Zealand Journal of Psychiatry, 44*(8), 681-696.

Bourne, V. J. (2005). Lateralised processing of positive facial emotion: Sex differences in strength of hemispheric dominance. *Neuropsychologia, 43*(6), 953-956.

Bourne, V. J. (2008a). Chimeric faces, visual field bias, and reaction time bias: Have we been missing a trick? *Laterality, 13*(1), 92-103.

Bourne, V. J. (2008b). Examining the relationship between degree of handedness and degree of cerebral lateralization for processing facial emotion. *Neuropsychology, 22*(3), 350-356.

Bourne, V. J. (2010). How are emotions lateralised in the brain? Contrasting existing hypotheses using the chimeric faces test. *Cognition & Emotion, 24*(5), 903-911.

Bourne, V. J. (2014). Prenatal hormonal exposure (2D:4D ratio) and strength of lateralisation for processing facial emotion. *Personality and Individual Differences, 58*(0), 43-47.

Bourne, V. J. . (2006). The divided visual field paradigm: Methodological considerations. *Laterality, 11*(4), 373-393.

Bourne, V. J., & Gray, D. L. (2009). Hormone exposure and functional lateralisation: Examining the contributions of prenatal and later life hormonal exposure. *Psychoneuroendocrinology, 34*(8), 1214-1221.

Bourne, V. J., & Gray, D. L. (2011). One face or two? Contrasting different versions of the chimeric faces test. *Laterality, 16*(5), 559-564.

Bourne, V. J., & Jonauskaite, D. (2015). Relationship status and sex differences in emotion lateralisation: An examination contrasting the processing of emotional infant and adult faces. *Personality and Individual Differences, 74*(0), 297-302.

Bourne, V. J., & Maxwell, A. M. (2010). Examining the sex difference in lateralisation for processing facial emotion: Does biological sex or psychological gender identity matter? *Neuropsychologia, 48*(5), 1289-1294.

Bourne, V. J., & Todd, B. K. (2004). When left means right: An explanation of the left cradling bias in terms of right hemisphere specializations. *Developmental Science, 7*(1), 19-24.

Bourne, V. J., & Vladeanu, M. (2011). Lateralisation for processing facial emotion and anxiety: Contrasting state, trait and social anxiety. *Neuropsychologia, 49*(5), 1343-1349.

Bourne, V. J., & Vladeanu, M. (2013). Examining the relationship between lateralisation for processing emotional faces, depression, and sex. *Laterality, 18*(6), 748-766.

Bourne, V. J., & Watling, D. (2015). Individual differences in emotion lateralisation and the processing of emotional information arising from social interactions. *Laterality, 20*(1), 95-111.

Bowlby, J. (1969). *Attachment: Attachment and loss, Vol. 1*. London, UK: Hogarth Publishing.

Bramen, J. E., Hranilovich, J. A., Dahl, R. E., Forbes, E. E., Chen, J., Toga, A. W., et al. (2011). Puberty influences medial temporal lobe and cortical gray matter maturation differently in boys than girls matched for sexual maturity. *Cerebral Cortex, 21*(3), 636-646.

Brandon, A. R., Pitts, S., Denton, W. H., Stringer, C. A., & Evans, H. M. (2009). A history of the theory of prenatal attachment. *Journal of Prenatal and Perinatal Psychology and Health, 23*(4), 201-222.

Breinholst, S., Esbjørn, B. H., Reinholdt-Dunne, M. L., & Stallard, P. (2012). CBT for the treatment of child anxiety disorders: A review of why parental involvement has not enhanced outcomes. *Journal of Anxiety Disorders, 26*(3), 416-424.

Breslau, J., Aguilar-Gaxiola, S., Kendler, K. S., Su, M., Williams, D., & Kessler, R. C. (2006). Specifying race-ethnic differences in risk for psychiatric disorder in a USA national sample. *Psychological Medicine, 36*(1), 57-68.

Brooks-Gunn, J., Warren, M. P., Rosso, J., & Gargiulo, J. (1987). Validity of self-report measures of girls' pubertal status. *Child Development, 58*(3), 829-841.

Brown, T. T., Erhart, M., Avesar, D., Dale, A. M., Halgren, E., & Evans, J. L. (2014). Atypical right hemisphere specialization for object representations in an adolescent with specific language impairment. *Frontiers in Human Neuroscience, 8*, 82.

Brumariu, L. E., & Kerns, K. A. (2008). Mother–child attachment and social anxiety symptoms in middle childhood. *Journal of Applied Developmental Psychology, 29*(5), 393-402.

Burt, D. M., & Perrett, D. I. (1997). Perceptual asymmetries in judgements of facial attractiveness, age, gender, speech and expression. *Neuropsychologia, 35*(5), 685-693.

Busch, B., Biederman, J., Cohen, L. G., Sayer, J. M., Monuteaux, M. C., Mick, E., et al. (2002). Correlates of ADHD among children in pediatric and psychiatric clinics. *Psychiatric Services, 53*(9), 1103-1111.

Butler, S. H. , & Harvey, M. (2006). Perceptual biases in chimeric face processing: Eye-movement patterns cannot explain it all. *Brain Research, 1124*(1), 96-99.

Campanella, S. (2013). Why it is time to develop the use of cognitive event-related potentials in the treatment of psychiatric diseases. *Neuropsychiatric Disease and Treatment, 9*, 1835-1845.

Campos, J. J., Thein, S., & Owen, D. (2003). A Darwinian legacy to understanding human infancy: Emotional expressions as behavior regulators. *Annals of the New York Academy of Sciences, 1000*, 110-134.

Canli, T., Desmond, J. E., Zhao, Z., Glover, G., & Gabrieli, J. D.E. (1998). Hemispheric asymmetry for emotional stimuli detected with fMRI. *Neuroreport, 9*(14), 3233-3239.

Carey, M. P., Faulstich, M. E., Gresham, F. M., Ruggiero, L., & Enyart, P. (1987). Children's Depression Inventory: Construct and discriminant validity across clinical and nonreferred (control) populations. *Journal of Consulting and Clinical Psychology, 55*(5), 755-761.

Carey, S., Diamond, R., & Woods, B. (1980). Development of face recognition: A maturational component? *Developmental Psychology, 16*(4), 257.

Carskadon, M. A., & Acebo, C. (1993). A self-administered rating scale for pubertal development. *Journal of Adolescent Health, 14*(3), 190-195.

Cartwright-Hatton, S., McNicol, K., & Doubleday, E. (2006). Anxiety in a neglected population: Prevalence of anxiety disorders in pre-adolescent children. *Clinical Psychology Review, 26*(7), 817-833.

Castiglia, P. T. (2000). Depression in adolescents. *Journal of Pediatric Health Care, 14*(4), 180-182.

Chambers, C. T., & Johnston, C. (2002). Developmental differences in children's use of rating scales. *Journal of Pediatric Psychology, 27*(1), 27-36.

Chavira, D. A., & Stein, M. B. (2005). Childhood social anxiety disorder: From understanding to treatment. *Child and Adolescent Psychiatric Clinics of North America, 14*(4), 797-818.

Chavira, D. A., Stein, M. B., Bailey, K., & Stein, M. T. (2004). Child anxiety in primary care: Prevalent but untreated. *Depression and Anxiety, 20*(4), 155-164.

Chiang, C. H., Ballantyne, A. O., & Trauner, D. A. (2000). Development of perceptual asymmetry for free viewing of chimeric stimuli. *Brain and Cognition, 44*(3), 415-424.

Chiron, C., Jambaque, I., Nabbout, R., Lounes, R., Syrota, A., & Dulac, O. (1997). The right brain hemisphere is dominant in human infants. *Brain, 120*(6), 1057-1065.

Christman, S. D., & Hackworth, M. D. (1993). Equivalent perceptual asymmetries for free viewing of positive and negative emotional expressions in chimeric faces. *Neuropsychologia, 31*(6), 621-624.

Chung, M.-S., & Thomson, D. M. (1995). Development of face recognition. *British Journal of Psychology, 86*(1), 55-87.

Clark, D. M, & Wells, A. (1995). A cognitive model of social phobia. In R. G. Heimberg, M. R. Liebowitz, D. A. Hope & F. R. Schneier (Eds.), *Social phobia: Diagnosis, assessment, and treatment*. New York, NY: Guilford Press.

Cohen Kadosh, K., Johnson, M. H., Dick, F., Cohen Kadosh, R., & Blakemore, S. J. (2013). Effects of age, task performance, and structural brain development on face processing. *Cerebral Cortex, 23*(7), 1630-1642.

Cole, D. A., Martin, J. M., Peeke, L., Henderson, A., & Harwell, J. (1998). Validation of depression and anxiety measures in White and Black youths: Multitrait–multimethod analyses. *Psychological Assessment, 10*(3), 261-276.

Colonnesi, C., Draijer, E. M., Jan JM Stams, G., Van der Bruggen, C. O., Bögels, S. M., & Noom, M. J. (2011). The relation between insecure attachment and child anxiety: A meta-analytic review. *Journal of Clinical Child & Adolescent Psychology, 40*(4), 630-645.

Conway, C. A., Jones, B. C., DeBruine, L. M., Welling, L. L., Law Smith, M. J., Perrett, D. I., et al. (2007). Salience of emotional displays of danger and contagion in faces is enhanced when progesterone levels are raised. *Hormones and Behavior, 51*(2), 202-206.

Cooney, R. E., Atlas, L. Y., Joormann, J., Eugene, F., & Gotlib, I. H. (2006). Amygdala activation in the processing of neutral faces in social anxiety disorder: Is neutral really neutral? *Psychiatry Research, 148*(1), 55-59.

Costello, E. J., Mustillo, S., Erkanli, A., Keeler, G., & Angold, A. (2003). Prevalence and development of psychiatric disorders in childhood and adolescence. *Archives of General Psychiatry, 60*(8), 837-844.

Costello, J. E., Erkanli, A., & Angold, A. (2006). Is there an epidemic of child or adolescent depression? *Journal of Child Psychology and Psychiatry, 47*(12), 1263-1271.

Craighead, W. E., Curry, J. F., & Ilardi, S. S. (1995). Relationship of Children's Depression Inventory factors to major depression among adolescents. *Psychological Assessment, 7*(2), 171-176.

Curry, J., Silva, S., Rohde, P., Ginsburg, G., Kratochvil, C., Simons, A., et al. (2011). Recovery and recurrence following treatment for adolescent major depression. *Archives of General Psychiatry, 68*(3), 263-269.

Davidson, R. J. (1992). Anterior cerebral asymmetry and the nature of emotion. *Brain and Cognition, 20*(1), 125-151.

Davidson, R. J. (1995). Cerebral asymmetry, emotion, and affective style. In R. J. Davidson & K. Hughdahl (Eds.), *Brain asymmetry* (pp. 361-387). Massachusetts: MIT Press.

Davidson, R. J., Ekman, P., Saron, C. D., Senulis, J. A., & Friesen, W. V. (1990). Approach-withdrawal and cerebral asymmetry: Emotional expression and brain physiology. I. *Journal of Personality and Social Psychology, 58*(2), 330-341.

Davidson, R. J., & Irwin, W. (1999). The functional neuroanatomy of emotion and affective style. *Trends in Cognitive Sciences, 3*(1), 11-21.

de Haan, M., & Nelson, C. A. (1997). Recognition of the mother's face by six-month-old infants: A neurobehavioral study. *Child Development, 68*(2), 187-210.

Deardorff, J., Hayward, C., Wilson, K.A., Bryson, S., Hammer, L. D., & Agras, S. (2007). Puberty and gender interact to predict social anxiety symptoms in early adolescence. *Journal of Adolescent Health, 41*(1), 102-104.

Del Giudice, M. (2009). Sex, attachment, and the development of reproductive strategies. *Behavioral and Brain Sciences, 32*(01), 1-21.

Delle-Vigne, D., Wang, W., Kornreich, C., Verbanck, P., & Campanella, S. (2014). Emotional facial expression processing in depression: Data from behavioral and event-related potential studies. *Clinical Neurophysiology, 44*(2), 169-187.

Demenescu, L. R., Kortekaas, R., den Boer, J. A., & Aleman, A. (2010). Impaired attribution of emotion to facial expressions in anxiety and major depression. *PLoS One, 5*(12), e15058.

den Boer, J. A. (2000). Social anxiety disorder/social phobia: Epidemiology, diagnosis, neurobiology, and treatment. *Comprehensive Psychiatry, 41*(6), 405-415.

Derntl, B., Kryspin-Exner, I., Fernbach, E., Moser, E., & Habel, U. (2008). Emotion recognition accuracy in healthy young females is associated with cycle phase. *Hormones and Behavior, 53*(1), 90-95.

Dolcos, F., LaBar, K. S., & Cabeza, R. (2004). Dissociable effects of arousal and valence on prefrontal activity indexing emotional evaluation and subsequent memory: An event-related fMRI study. *Neuroimage, 23*(1), 64-74.

Doty, R. L., Kisat, M., & Tourbier, I. (2008). Estrogen replacement therapy induces functional asymmetry on an odor memory/discrimination test. *Brain Research, 1214*, 35-39.

Douglas, K. M., & Porter, R. J. (2010). Recognition of disgusted facial expressions in severe depression. *The British Journal of Psychiatry, 197*(2), 156-157.

Dunlop, D. D., Song, J., Lyons, J. S., Manheim, L. M., & Chang, R. W. (2003). Racial/ethnic differences in rates of depression among preretirement adults. *American Journal of Public Health, 93*(11), 1945-1952.

Durand, K., Gallay, M., Seigneuric, A., Robichon, F., & Baudouin, J.-Y. (2007). The development of facial emotion recognition: The role of configural information. *Journal of Experimental Child Psychology, 97*(1), 14-27.

Eastwood, J., Smile, D., Oakman, J., Farvolden, P., van Ameringen, M., Mancini, C., et al. (2005). Individuals with social phobia are biased to become aware of negative faces. *Visual Cognition, 12*(1), 159-179.

Egger, H. L., & Angold, A. (2006). Common emotional and behavioral disorders in preschool children: Presentation, nosology, and epidemiology. *Journal of Child Psychology and Psychiatry, 47*(3-4), 313-337.

Ekman, P. (1972). Universals and cultural differences in facial expressions of emotion. In J. Cole (Ed.), *Nebraska symposium on motivation* (Vol. 19, pp. 207-283). Lincoln, NE: University of Nebraska Press.

Engel, K., Bandelow, B., Gruber, O., & Wedekind, D. (2009). Neuroimaging in anxiety disorders. *Journal of Neural Transmission, 116*(6), 703-716.

Erath, S. A., Flanagan, K. S., & Bierman, K. L. (2007). Social anxiety and peer relations in early adolescence: Behavioral and cognitive factors. *Journal of Abnormal Child Psychology, 35*(3), 405-416.

Escobar, M. J., Rivera-Rei, A., Decety, J., Huepe, D., Cardona, J. F., Canales-Johnson, A., et al. (2013). Attachment patterns trigger differential neural signature of emotional processing in adolescents. *PLoS ONE, 8*(8), 2-12.

Ewbank, M. P., Lawrence, A. D., Passamonti, L., Keane, J., Peers, P. V., & Calder, A. J. (2009). Anxiety predicts a differential neural response to attended and unattended facial signals of anger and fear. *Neuroimage, 44*(3), 1144-1151.

Fales, C. L., Barch, D. M., Rundle, M. M., Mintun, M. A., Snyder, A. Z., Cohen, J. D., et al. (2008). Altered emotional interference processing in affective and cognitive-control brain circuitry in major depression. *Biological Psychiatry, 63*(4), 377-384.

Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. London, UK: Sage Publications Ltd.

Finch Jr., A. J., Saylor, C. F., Edwards, G. L., & McIntosh, J. A. (1987). Children's Depression Inventory: Reliability over repeated administrations. *Journal of Clinical Child Psychology, 16*(4), 339-341.

Fogel, A., Toda, S., & Kawai, M. (1988). Mother-infant face-to-face interaction in Japan and the United States: A laboratory comparison using 3-month-old infants. *Developmental Psychology, 24*(3), 398.

Forbes, E E., & Dahl, R. E. (2005). Neural systems of positive affect: Relevance to understanding child and adolescent depression? *Development and Psychopathology, 17*(3), 827-850.

Freitas-Ferrari, M. C., Hallak, J. E., Trzesniak, C., Filho, A. S., Machado-de-Sousa, J. P., Chagas, M. H., et al. (2010). Neuroimaging in social anxiety disorder: A systematic review of the literature. *Progress in Neuro-Psychopharmacology and Biological Psychiatry, 34*(4), 565-580.

Fu, C. H. Y., Mourao-Miranda, J., Costafreda, S. G., Khanna, A., Marquand, A. F., Williams, S. C. R., et al. (2008). Pattern classification of sad facial processing: Toward the development of neurobiological markers in depression. *Biological Psychiatry, 63*(7), 656-662.

Furmark, T. (2002). Social phobia: Overview of community surveys. *Acta Psychiatrica Scandinavica, 105*(2), 84-93.

Fussell, N. J., Rowe, A. C., & Mohr, C. (2012). Hemispheric processing of differently valenced and self-relevant attachment words in middle-aged married and separated individuals. *Laterality, 17*(4), 453-485.

Gamble, S. A., & Roberts, J. E. (2005). Adolescents' perceptions of primary caregivers and cognitive style: The roles of attachment security and gender. *Cognitive Therapy and Research, 29*(2), 123-141.

Gao, X., & Maurer, D. (2009). Influence of intensity on children's sensitivity to happy, sad, and fearful facial expressions. *Journal of Experimental Child Psychology, 102*(4), 503-521.

George, C., Kaplan, N., & Main, M. (1984). *Adult Attachment Interview*. (Unpublished Manuscript). University of California, Berkley.

Giedd, J. N. (2004). Structural magnetic resonance imaging of the adolescent brain. *Annals of the New York Academy of Sciences, 1021*, 77-85.

Giedd, J. N., Blumenthal, J., Jeffries, N. O., Castellanos, F. X., Liu, H., Zijdenbos, A., et al. (1999). Brain development during childhood and adolescence: A longitudinal MRI study. *Nature Neuroscience, 2*(10), 861-863.

Giedd, J. N., Clasen, L. S., Lenroot, R., Greenstein, D., Wallace, G. L., Ordaz, S., et al. (2006). Puberty-related influences on brain development. *Molecular and Cellular Endocrinology, 254-255*, 154-162.

Goddings, A. L., Burnett Heyes, S., Bird, G., Viner, R.M., & Blakemore, S. J. (2012). The relationship between puberty and social emotion processing. *Developmental Science, 15*(6), 801-811.

Goodman, S. H., & Gotlib, I. H. (1999). Risk for psychopathology in the children of depressed mothers: A developmental model for understanding mechanisms of transmission. *Psychological Review, 106*(3), 458.

Gotlib, I. H., Krasnoperova, E., Yue, D. N., & Joormann, J. (2004). Attentional biases for negative interpersonal stimuli in clinical depression. *Journal of Abnormal Psychology, 113*(1), 127.

Graber, J.A., Seeley, J. R., Brooks-Gunn, J., & Lewinsohn, P. M. (2004). Is pubertal timing associated with psychopathology in young adulthood? *Journal of the American Academy of Child & Adolescent Psychiatry, 43*(6), 718-726.

Green, J., & Goldwyn, R. (2002). Annotation: Attachment disorganisation and psychopathology: New findings in attachment research and their potential

implications for developmental psychopathology in childhood. *Journal of Child Psychology and Psychiatry, 43*(7), 835-846.

Grimm, S., Boesiger, P., Beck, J., Schuepbach, D., Bermpohl, F., Walter, M., et al. (2008). Altered negative BOLD tesponses in the default-mode network during emotion processing in depressed subjects. *Neuropsychopharmacology, 34*(4), 932-843.

Gullone, E., & Robinson, K. (2005). The Inventory of Parent and Peer Attachment—Revised (IPPA-R) for children: A psychometric investigation. *Clinical Psychology & Psychotherapy, 12*(1), 67-79.

Hall, J. A. (1978). Gender effects in decoding nonverbal cues. *Psychological Bulletin, 85*(4), 845.

Hall, L. M., Klimes-Dougan, B., Hunt, R. H., Thomas, K. M., Houri, A., Noack, E., et al. (2014). An fMRI study of emotional face processing in adolescent major depression. *Journal of Affective Disorders, 168*, 44-50.

Hamilton, J. L., Hamlat, E. J., Stange, J. P., Abramson, L. Y., & Alloy, L. B. (2014). Pubertal timing and vulnerabilities to depression in early adolescence: Differential pathways to depressive symptoms by sex. *Journal of Adolescence, 37*(2), 165-174.

Hampson, E., van Anders, S. M., & Mullin, L. I. (2006). A female advantage in the recognition of emotional facial expressions: Test of an evolutionary hypothesis. *Evolution and Human Behavior, 27*(6), 401-416.

Hare, T. A., Tottenham, N., Galvan, A., Voss, H. U., Glover, G. H., & Casey, B. J. (2008). Biological substrates of emotional reactivity and regulation in adolescence during an emotional go-nogo task. *Biological Psychiatry, 63*(10), 927-934.

Hausmann, M., & Güntürkün, O. (2000). Steroid fluctuations modify functional cerebral asymmetries: The hypothesis of progesterone-mediated interhemispheric decoupling. *Neuropsychologia, 38*(10), 1362-1374.

Hayward, C., Gotlib, I. H., Schraedley, P. K., & Litt, I. F. (1999). Ethnic differences in the association between pubertal status and symptoms of depression in adolescent girls. *The Journal of Adolescent Health, 25*(2), 143-149.

Hazell, P. (2007). Depression in adolescents. *British Medical Journal, 335*(7611), 106-107.

Heath, R. L., Rouhana, A., & Ghanem, D. A. (2005). Asymmetric bias in perception of facial affect among Roman and Arabic script readers. *Laterality, 10*(1), 51-64.

Hecht, D. (2010). Depression and the hyperactive right-hemisphere. *Neuroscience Research, 68*(2), 77-87.

Heinrichs, N., Rapee, R. M., Alden, L. A., Bogels, S., Hofmann, S. G., Oh, K. J., et al. (2006). Cultural differences in perceived social norms and social anxiety. *Behaviour Research and Therapy, 44*(8), 1187-1197.

Heller, W., & Levy, J. (1981). Perception and expression of emotion in right-handers and left-handers. *Neuropsychologia, 19*(2), 263-272.

Hendriks, A. W., van Rijswijk, M., & Omtzigt, D. (2011). Holding-side influences on infant's view of mother's face. *Laterality, 16*(6), 641-655.

Henje Blom, E., Connolly, C. G., Ho, T. C., LeWinn, K. Z., Mobayed, N., Han, L., et al. (2015). Altered insular activation and increased insular functional connectivity during sad and happy face processing in adolescent major depressive disorder. *Journal of Affective Disorders, 178*, 215-223.

Herba, C., & Phillips, M. (2004). Annotation: Development of facial expression recognition from childhood to adolescence: Behavioural and neurological perspectives. *Journal of Child Psychology and Psychiatry, 45*(7), 1185-1198.

Herting, M. M., Gautam, P., Spielberg, J. M., Dahl, R. E., & Sowell, E. R. (2015). A longitudinal study: Changes in cortical thickness and surface area during pubertal maturation. *PLoS One, 10*(3), e0119774.

Hofmann, S. G., Anu Asnaani, M. A., & Hinton, D. E. (2010). Cultural aspects in social anxiety and social anxiety disorder. *Depression and Anxiety, 27*(12), 1117-1127.

Hofmann, S. G., Asnaani, A., Vonk, I. J. J., Sawyer, A. T., & Fang, A. (2012). The efficacy of cognitive behavioral therapy: A review of meta-analyses. *Cognitive Therapy and Research, 36*(5), 427-440.

Hollon, S. D., Thase, M. E., & Markowitz, J. C. (2002). Treatment and prevention of depression. *Psychological Science in the Public Interest, 3*(2), 39-77.

Horstmann, G. (2003). What do facial expressions convey: Feeling states, behavioral intentions, or action requests? *Emotion, 3*(2), 150-166.

Hudson, J. L., Doyle, A. M., & Gar, N. (2009). Child and maternal influence on parenting behavior in clinically anxious children. *Journal of Clinical Child and Adolescent Psychology, 38*(2), 256-262.

Hudson, J. L., & Rapee, R. M. (2002). Parent-child interactions in clinically anxious children and their siblings. *Journal of Clinical Child and Adolescent Psychology, 31*(4), 548-555.

Hudson, J. L., & Rapee, R. M. (2004). From anxious temprament to disorder: An etiological model. In R. G. Heimberg, C. L. Turk & D. S. Mennin (Eds.),

Generalized anxiety disorder: Advances in research and practice (pp. 51-74). New York, NY: Guildford.

Inderbitzen, H. M., & Hope, D. A. (1995). Relationship among adolescent reports of social anxiety, anxiety, and depressive symptoms. *Journal of Anxiety Disorders, 9*(5), 385-396.

Indersmitten, T., & Gur, R. C. (2003). Emotion processing in chimeric faces: Hemispheric asymmetries in expression and recognition of emotions. *The Journal of Neuroscience, 23*(9), 3820-3825.

Jaffari-Bimmel, N., Juffer, F., van IJzendoorn, M. H., Bakermans-Kranenburg, M. J., & Mooijaart, A. (2006). Social development from infancy to adolescence: Longitudinal and concurrent factors in an adoption sample. *Developmental Psychology, 42*(6), 1143.

James, A. C., James, G., Cowdrey, F. A., Soler, A., & Choke, A. (2013). Cognitive behavioural therapy for anxiety disorders in children and adolescents. *The Cochrane Database of Systematic Reviews, 6*, Cd004690.

Jansari, A., Rodway, P., & Goncalves, S. (2011). Identifying facial emotions: Valence specific effects and an exploration of the effects of viewer gender. *Brain and Cognition, 76*(3), 415-423.

Jansari, A., Tranel, D., & Adolphs, R. (2000). A valence-specific lateral bias for discriminating emotional facial expressions in free field. *Cognition & Emotion, 14*(3), 341-353.

Johnson, L. N, Ketring, S. A, & Abshire, C. (2003). The Revised Inventory of Parent Attachment: Measuring attachment in families. *Contemporary Family Therapy, 25*(3), 333-349.

Joinson, C., Heron, J., Araya, R., Paus, T., Croudace, T., Rubin, C., et al. (2012). Association between pubertal development and depressive symptoms in girls from a UK cohort. *Psychological Medicine, 42*(12), 2579-2589.

Jonauskaite, D., & Bourne, V. J. (2014). *Exploring the neuropsychological processing of emotion and mood in mothers during and after pregnancy: A longitudinal study*. Poster presented at the The British Psychological Society Annual Conference, Birmingham, UK.

Joormann, J., & Gotlib, I. H. (2006). Is this happiness I see? Biases in the identification of emotional facial expressions in depression and social phobia. *Journal of Abnormal Psychology, 115*(4), 705-714.

Joormann, J., Talbot, L., & Gotlib, I. H. (2007). Biased processing of emotional information in girls at risk for depression. *Journal of Abnormal Psychology, 116*(1), 135.

Karevold, E., Roysamb, E., Ystrom, E., & Mathiesen, K. S. (2009). Predictors and pathways from infancy to symptoms of anxiety and depression in early adolescence. *Developmental Psychology, 45*(4), 1051-1060.

Kashdan, T. B., & Herbert, J. D. (2001). Social anxiety disorder in childhood and adolescence: Current status and future directions. *Clinical Child and Family Psychology Review, 4*(1), 37-61.

Katsikitis, M., Pilowsky, I., & Innes, J. M. (1997). Encoding and decoding of facial expression. *The Journal of General Psychology, 124*(4), 357-370.

Kerns, K. A., Klepac, L., & Cole, A. K. (1996). Peer relationships and preadolescents' perceptions of security in the child-mother relationship. *Developmental Psychology, 32*(3), 457.

Kessler, R. C. (2003). Epidemiology of women and depression. *Journal of Affective Disorders, 74*(1), 5-13.

Kessler, R. C., Avenevoli, S., & Ries Merikangas, K. (2001). Mood disorders in children and adolescents: An epidemiologic perspective. *Biological Psychiatry, 49*(12), 1002-1014.

Kessler, R. C., Berglund, P., Demler, O., Jin, R., Merikangas, K. R., & Walters, E. E. (2005). Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry, 62*(6), 593-602.

Killgore, W. D. S., & Yurgelun-Todd, D. A. (2007). The right-hemisphere and valence hypotheses: Could they both be right (and sometimes left)? *Social Cognitive and Affective Neuroscience, 2*(3), 240-250.

Killgore, W. D., & Yurgelun-Todd, D. A. (2005). Social anxiety predicts amygdala activation in adolescents viewing fearful faces. *Neuroreport, 16*(15), 1671-1675.

Kolassa, I. T., & Miltner, W. H. (2006). Psychophysiological correlates of face processing in social phobia. *Brain Research, 1118*(1), 130-141.

Konrad, K., Firk, C., & Uhlhaas, P. J. (2013). Brain development during adolescence: Neuroscientific insights into this developmental period. *Deutsches Arzteblatt International, 110*(25), 425-431.

Kovacs, M. (1985). The Children's Depression Inventory (CDI). *Psychopharmacology Bulletin, 21*(4), 995-998.

Kovács, M. (1983). *The Children's Depression Inventory: A self-rated depression scale for school-aged youngsters*. Unpublished manuscript: University of

Pittsburgh School of Medicine, Department of Psychiatry, Western Psychiatric Institute and Clinic.

Kovács, M. (1992). *Children's Depression Inventory Manual.* North Tonawanda, NY: Multi-Health Systems, Inc.

Kovács, M., & Beck, A. (1977). An empirical-clinical approach toward a definition of childhood depression. In J. Schulterbrandt & A. Raskin (Eds.), *Depression in childhood: Diagnosis, treatment and conceptual models* (Vol. 1-26). Washington, DC: Department of Health, Education and Welfare.

Kristensen, H., & Torgersen, S. (2006). Social anxiety disorder in 11-12-year-old children: The efficacy of screening and issues in parent-child agreement. *European Child & Adolescent Psychiatry, 15*(3), 163-171.

Kucharska-Pietura, K., & David, A. S. (2003). The perception of emotional chimeric faces in patients with depression, mania and unilateral brain damage. *Psychological Medicine, 33*(4), 739-745.

La Greca, A. M., & Stone, W. L. (1993). Social Anxiety Scale for Children-Revised: Factor structure and concurrent validity. *Journal of Clinical Child Psychology, 22*(1), 17-27.

La Greca, A.M., & Harrison, H. M. (2005). Adolescent peer relations, friendships, and romantic relationships: Do they predict social anxiety and depression? *Journal of Clinical Child & Adolescent Psychology, 34*(1), 49-61.

Lack, C. W., & Green, A. L. (2009). Mood disorders in children and adolescents. *Journal of Pediatric Nursing, 24*(1), 13-25.

Ladouceur, C. D. (2012). Neural systems supporting cognitive-affective interactions in adolescence: The role of puberty and implications for affective disorders. *Frontiers in Integrative Neuroscience, 6*, 65.

Laible, D. J., Carlo, G., & Raffaelli, M. (2000). The differential relations of parent and peer attachment to adolescent adjustment. *Journal of Youth and Adolescence, 29*(1), 45-59.

Lappänen, J. M., Milders, M., Bell, J. S., Terriere, E., & Hietanen, J. K. (2004). Depression biases the recognition of emotionally neutral faces. *Psychiatry Research, 128*(2), 123-133.

Larson, R. W., Richards, M. H., Moneta, G., Holmbeck, G., & Duckett, E. (1996). Changes in adolescents' daily interactions with their families from ages 10 to 18: Disengagement and transformation. *Developmental Psychology, 32*(4), 744.

Lavidor, M., Hayes, A., & Bailey, P. (2003). Handedness, measures of hemispheric asymmetry, and lateralised lexical decision. *Laterality, 8*(4), 347-360.

Lawrence, K., Kuntsi, J., Coleman, M., Campbell, R., & Skuse, D. (2003). Face and emotion recognition deficits in Turner syndrome: A possible role for X-linked genes in amygdala development. *Neuropsychology, 17*(1), 39-49.

Lawrence, N. S., Williams, A. M., Surguladze, S., Giampietro, V., Brammer, M. J., Andrew, C., et al. (2004). Subcortical and ventral prefrontal cortical neural responses to facial expressions distinguish patients with bipolar disorder and major depression. *Biological Psychiatry, 55*(6), 578-587.

Lee, A., & Hankin, B. L. (2009). Insecure attachment, dysfunctional attitudes, and low self-esteem predicting prospective symptoms of depression and anxiety during adolescence. *Journal of Clinical Child and Adolescent Psychology, 38*(2), 219-231.

Lee, T. C. , Herbert, M., & Manassis, K. (2014). Do anxious boys and girls differ in emotion recognition accuracy? *Journal of the Canadian Academy of Child and Adolescent Psychiatry, 23*(1), 61-64.

Lee, Y.-S., Krishnan, A., & Park, Y. S. (2012). Psychometric properties of the Children's Depression Inventory: An item response theory analysis across age in a nonclinical, longitudinal, adolescent sample. *Measurement and Evaluation in Counseling and Development, 45*(2), 84-100.

Lemerise, E. A., & Arsenio, W. F. (2000). An integrated model of emotion processes and cognition in social information processing. *Child Development, 71*(1), 107-118.

Lenroot, R. K., & Giedd, J. N. (2006). Brain development in children and adolescents: Insights from anatomical magnetic resonance imaging. *Neuroscience and Biobehavioral Reviews, 30*(6), 718-729.

Levine, S. C., & Levy, J. (1986). Perceptual asymmetry for chimeric faces across the life span. *Brain and Cognition, 5*(3), 291-306.

Levy, J., Trevarthen, C., & Sperry, R. W. (1972). Reception of bilateral chimeric figures following hemispheric deconnexion. *Brain, 95*(1), 61-78.

Lezak, M.D., Howieson, D.B., Bigler, E.D., & Tranel, D. (2012). *Neuropsychological Assessment*. New York, NY: Oxford University Press.

Lieberman, M., Doyle, A. B., & Markiewicz, D. (1999). Developmental patterns in security of attachment to mother and father in late childhood and early adolescence: Associations with peer relations. *Child Development, 70*(1), 202-213.

Little, A. C. (2013). The influence of steroid sex hormones on the cognitive and emotional processing of visual stimuli in humans. *Frontiers in Neuroendocrinology, 34*(4), 315-328.

Little, A. C., Saxton, T. K., Roberts, S. C., Jones, B. C., Debruine, L. M., Vukovic, J., et al. (2010). Women's preferences for masculinity in male faces are highest during reproductive age range and lower around puberty and post-menopause. *Psychoneuroendocrinology, 35*(6), 912-920.

Luh, K. E., Rueckert, L. M., & Levy, J. (1991). Perceptual asymmetries for free viewing of several types of chimeric stimuli. *Brain and Cognition, 16*(1), 83-103.

Malatesta, C. Z, Culver, C., Tesman, J. R., Shepard, B., Fogel, A., Reimers, M., et al. (1989). The development of emotion expression during the first two years of life. *Monographs of the Society for Research in Child Development, 54*(1-2), 105-136.

Manning, J. T., Scutt, D., Wilson, J., & Lewis-Jones, D. I. (1998). The ratio of 2nd to 4th digit length: A predictor of sperm numbers and concentrations of testosterone, luteinizing hormone and oestrogen. *Human reproduction, 13*(11), 3000-3004.

Marquaridt, D. W. (1970). Generalized inverses, ridge regression, biased linear estimation, and nonlinear estimation. *Technometrics, 12*(3), 591-612.

Marshall, W. A., & Tanner, J. M. (1969). Variations in pattern of pubertal changes in girls. *Archives of Disease in Childhood, 44*(235), 291-303.

Marshall, W. A., & Tanner, J. M. (1970). Variations in the pattern of pubertal changes in boys. *Archives of Disease in Childhood, 45*(239), 13-23.

Maughan, B., Collishaw, S., & Stringaris, A. (2013). Depression in childhood and adolescence. *Journal of the Canadian Academy of Child and Adolescent Psychiatry, 22*(1), 35-40.

McClure, E. B. (2000). A meta-analytic review of sex differences in facial expression processing and their development in infants, children, and adolescents. *Psychological Bulletin, 126*(3), 424-453.

McGivern, R. F., Andersen, J., Byrd, D., Mutter, K. L., & Reilly, J. (2002). Cognitive efficiency on a match to sample task decreases at the onset of puberty in children. *Brain and Cognition, 50*(1), 73-89.

Melfsen, S., & Florin, I. (2002). Do socially anxious children show deficits in classifying facial expressions of emotions? *Journal of Nonverbal Behavior, 26*(2), 109-126.

Meltzoff, A. N., & Brooks, R. (2008). Self-experience as a mechanism for learning about others: A Training study in social cognition. *Developmental Psychology, 44*(5), 1257-1265.

Mendlowitz, S. L., Manassis, K., Bradley, S., Scapillato, D., Miezitis, S., & Shaw, B. E. (1999). Cognitive‐behavioral group treatments in childhood anxiety disorders: The role of parental involvement. *Journal of the American Academy of Child & Adolescent Psychiatry, 38*(10), 1223-1229.

Mills, C. K. (1912). The cerebral mechanisms of emotional expression. *Transactions of the College of Physicians of Philadelphia, 34*, 381-390.

Mills, K. L., Lalonde, F., Clasen, L. S., Giedd, J. N., & Blakemore, S. J. (2014). Developmental changes in the structure of the social brain in late childhood and adolescence. *Social Cognitive and Affective Neuroscience, 9*(1), 123-131.

Mizukami, K., Kobayashi, N., Ishii, T., & Iwata, H. (1990). First selective attachment begins in early infancy: A study using telethermography. *Infant Behavior and Development, 13*(3), 257-271.

Mogg, K., & Bradley, B. P. (2002). Selective orienting of attention to masked threat faces in social anxiety. *Behaviour Research and Therapy, 40*(12), 1403-1414.

Mogg, K., Philippot, P., & Bradley, B. P. (2004). Selective attention to angry faces in clinical social phobia. *Journal of Abnormal Psychology, 113*(1), 160.

Mondloch, C. J., Lewis, T. L., Budreau, D. R., Maurer, D., Dannemiller, J. L., Stephens, B. R., et al. (1999). Face perception during early infancy. *Psychological Science, 10*(5), 419-422.

Monk, C. S., McClure, E. B., Nelson, E. E., Zarahn, E., Bilder, R. M., Leibenluft, E., et al. (2003). Adolescent immaturity in attention-related brain engagement to emotional facial expressions. *NeuroImage, 20*(1), 420-428.

Morris, J. S., Friston, K. J., Buchel, C., Frith, C. D., Young, A. W., Calder, A. J., et al. (1998). A neuromodulatory role for the human amygdala in processing emotional facial expressions. *Brain, 121 (Pt. 1)*, 47-57.

Moscovitch, D. A. (2009). What is the core fear in social phobia? A new model to facilitate individualized case conceptualization and treatment. *Cognitive and Behavioral Practice, 16*(2), 123-134.

Nakamura, K., Kawashima, R., Ito, K., Sugiura, M., Kato, T., Nakamura, A., et al. (1999). Activation of the right inferior frontal cortex during assessment of facial emotion. *Journal of Neurophysiology, 82*(3), 1610-1614.

Nakato, E., Otsuka, Y., Kanazawa, S., Yamaguchi, M. K., Honda, Y., & Kakigi, R. (2011). I know this face: Neural activity during mothers' face perception in 7-

to 8-month-old infants as investigated by near-infrared spectroscopy. *Early Human Development, 87*(1), 1-7.

Narumoto, J., Okada, T., Sadato, N., Fukui, K., & Yonekura, Y. (2001). Attention to emotion modulates fMRI activity in human right superior temporal sulcus. *Cognitive Brain Research, 12*(2), 225-231.

National Institute for Health and Care Excellence (2009). *Depression in adults: The treatment and management of depression in adults (CG90)*. London: National Institute for Health and Care Excellence.

National Institute for Health and Care Excellence (2013). *Social anxiety disorder: Recognition, assessment and treatment (CG159)*. London: National Institute for Health and Care Excellence.

National Institute for Health and Care Excellence (2015). *Depression in children and young people: Identification and management in primary, community and secondary care (CG28)*. London: National Institute for Health and Care Excellence.

Neufang, S., Specht, K., Hausmann, M., Gunturkun, O., Herpertz-Dahlmann, B., Fink, G. R., et al. (2009). Sex differences and the impact of steroid hormones on the developing human brain. *Cerebral Cortex, 19*(2), 464-473.

Niedenthal, P. M., & Brauer, M. (2012). Social functionality of human emotion. *Annual Review of Psychology, 63*(1), 259-285.

Niedenthal, P. M., Brauer, M., Robin, L., & Innes-Ker, Å. H. (2002). Adult attachment and the perception of facial expression of emotion. *Journal of Personality and Social Psychology, 82*(3), 419-433.

O'Brien, S. F., & Bierman, K. L. (1988). Conceptions and perceived influence of peer groups: Interviews with preadolescents and adolescents. *Child Development, 59*(5), 1360-1365.

Oldehinkel, A. J., Verhulst, F. C., & Ormel, J. (2011). Mental health problems during puberty: Tanner stage-related differences in specific symptoms. The TRAILS study. *Journal of Adolescence, 34*(1), 73-85.

Osborne, J., & Waters, E. (2002). Four assumptions of multiple regression that researchers should always test. *Practical Assessment, Research & Evaluation, 8*(2), 1-9.

Otto, M. W., Yeo, R. A., & Dougher, M. J. (1987). Right hemisphere involvement in depression: Toward a neuropsychological theory of negative affective experiences. *Biological Psychiatry, 22*(10), 1201-1215.

Pascalis, O., de Schonen, S., Morton, J., Deruelle, C., & Fabre-Grenet, M. (1995). Mother's face recognition by neonates: A replication and an extension. *Infant Behavior and Development, 18*(1), 79-85.

Patton, G. C., Hibbert, M. E., Carlin, J., Shao, Q., Rosier, M., Caust, J., et al. (1996). Menarche and the onset of depression and anxiety in Victoria, Australia. *Journal of Epidemiology and Community Health, 50*(6), 661-666.

Patton, G. C., & Viner, R. (2007). Pubertal transitions in health. *Lancet, 369*(9567), 1130-1139.

Paus, T., Keshavan, M., & Giedd, J. N. (2008). Why do many psychiatric disorders emerge during adolescence? *Nature Reviews Neuroscience, 9*(12), 947-957.

Peper, J. S., Brouwer, R. M., Schnack, H. G., van Baal, G. C., van Leeuwen, M., van den Berg, S. M., et al. (2009). Sex steroids and brain structure in pubertal boys and girls. *Psychoneuroendocrinology, 34*(3), 332-342.

Peper, J. S., Brouwer, R. M., Schnack, H. G., van Baal, G. C., van Leeuwen, M., van den Berg, S. M., et al. (2008). Cerebral white matter in early puberty is associated with luteinizing hormone concentrations. *Psychoneuroendocrinology, 33*(7), 909-915.

Peper, J. S., van den Heuvel, M. P., Mandl, R. C., Hulshoff Pol, H. E., & van Honk, J. (2011). Sex steroids and connectivity in the human brain: A review of neuroimaging studies. *Psychoneuroendocrinology, 36*(8), 1101-1113.

Perlman, W. R., Webster, M. J., Herman, M. M., Kleinman, J. E., & Weickert, C. S. (2007). Age-related differences in glucocorticoid receptor mRNA levels in the human brain. *Neurobiology of Aging, 28*(3), 447-458.

Perrin, J. S., Hervé, P.-Y., Leonard, G., Perron, M., Pike, G. B., Pitiot, A., et al. (2008). Growth of white matter in the adolescent brain: Role of testosterone and androgen receptor. *The Journal of Neuroscience, 28*(38), 9519-9524.

Phan, K. L., Fitzgerald, D. A., Nathan, P. J., & Tancer, M. E. (2006). Association between amygdala hyperactivity to harsh faces and severity of social anxiety in generalized social phobia. *Biological Psychiatry, 59*(5), 424-429.

Pollak, S. D. (2008). Mechanisms linking early experience and the emergence of emotions: Illustrations from the study of maltreated children. *Current Directions in Psychological Science, 17*(6), 370-375.

Pollak, S. D., Cicchetti, D., Hornung, K., & Reed, A. (2000). Recognizing emotion in faces: Developmental effects of child abuse and neglect. *Developmental Psychology, 36*(5), 679-688.

Pollak, S. D., & Sinha, P. (2002). Effects of early experience on children's recognition of facial displays of emotion. *Developmental Psychology, 38*(5), 784-791.

Proverbio, A. M, Brignone, V., Matarazzo, S., Del Zotto, M., & Zani, A. (2006). Gender differences in hemispheric asymmetry for face processing. *BMC Neuroscience, 7*(1), 1-10.

American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders.* Arlington, VA: American Psychiatric Association.

Pujol, J., Deus, J., Losilla, J. M., & Capdevila, A. (1999). Cerebral lateralization of language in normal left-handed people studied by functional MRI. *Neurology, 52*(5), 1038-1043.

Quevedo, K. M., Benning, S. D., Gunnar, M. R., & Dahl, R. E. (2009). The onset of puberty: Effects on the psychophysiology of defensive and appetitive motivation. *Development and Psychopathology, 21*(1), 27-45.

Rahman, Q., Wilson, G. D., & Abrahams, S. (2004). Sex, sexual orientation, and identification of positive and negative facial affect. *Brain and Cognition, 54*(3), 179-185.

Rao, U., & Chen, L.-A. (2009). Characteristics, correlates, and outcomes of childhood and adolescent depressive disorders. *Dialogues in Clinical Neuroscience, 11*(1), 45-62.

Rapee, R. M. (1997). Potential role of childrearing practices in the development of anxiety and depression. *Clinical Psychology Review, 17*(1), 47-67.

Rapee, R. M., & Spence, S. H. (2004). The etiology of social phobia: Empirical evidence and an initial model. *Clinical Psychology Review, 24*(7), 737-767.

Reardon, L. E., Leen-Feldner, E. W., & Hayward, C. (2009). A critical review of the empirical literature on the relation between anxiety and puberty. *Clinical Psychology Review, 29*(1), 1-23.

Reichenbach, L., & Masters, J. C. (1983). Children's use of expressive and contextual cues in judgments of emotion. *Child Development, 54*(4), 993-1004.

Reischies, F. M., Hedde, J. P., & Drochner, R. (1989). Clinical correlates of cerebral blood flow in depression. *Psychiatry Research, 29*(3), 323-326.

Riolo, S. A., Nguyen, T. A., Greden, J. F., & King, C. A. (2005). Prevalence of depression by race/ethnicity: Findings from the National Health and Nutrition Examination Survey III. *American Journal of Public Health, 95*(6), 998-1000.

Ritchey, M., Dolcos, F., Eddington, K. M., Strauman, T. J., & Cabeza, R. (2011). Neural correlates of emotional processing in depression: Changes with cognitive behavioral therapy and predictors of treatment response. *Journal of Psychiatric Research, 45*(5), 577-587.

Robinson, R. G., Kubos, K. L., Starr, L. B., Rao, K., & Price, T. R. (1984). Mood disorders in stroke patients: Importance of location of lesion. *Brain, 107*(1), 81-93.

Rodway, P., Wright, L., & Hardie, S. (2003). The valence-specific laterality effect in free viewing conditions: The influence of sex, handedness, and response bias. *Brain and Cognition, 53*(3), 452-463.

Roelofs, J., Lee, C., Ruijten, T., & Lobbestael, J. (2011). The mediating role of early maladaptive schemas in the relation between quality of attachment relationships and symptoms of depression in adolescents. *Behavioural and Cognitive Psychotherapy, 39*(4), 471-479.

Ruijten, T., Roelofs, J., & Rood, L. (2011). The mediating role of rumination in the relation between quality of attachment relations and depressive symptoms in non-clinical adolescents. *Journal of Child and Family Studies, 20*(4), 452-459.

Salk, L. (1960). The effects of the normal heartbeat sound on the behaviour of the newborn infant: Implications for mental health. *World Mental Health, 12*, 168-175.

Saylor, C. F., Finch, A. J., Jr., Spirito, A., & Bennett, B. (1984). The Children's Depression inventory: A systematic evaluation of psychometric properties. *Journal of Consulting Clinical Psychology, 52*(6), 955-967.

Schepman, K., Taylor, E., Collishaw, S., & Fombonne, E. (2012). Face emotion processing in depressed children and adolescents with and without comorbid conduct disorder. *Journal of Abnormal Child Psychology, 40*(4), 583-593.

Scherf, K. S., Behrmann, M., & Dahl, R. E. (2012). Facing changes and changing faces in adolescence: A new model for investigating adolescent-specific interactions between pubertal, brain and behavioral development. *Developmental Cognitive Neuroscience, 2*(2), 199-219.

Scola, C., Arciszewski, T., Measelle, J., & Vauclair, J. (2013). Infant-holding bias variations in mother–child relationships: A longitudinal study. *European Journal of Developmental Psychology, 10*(6), 707-722.

Sebastian, C., Viding, E., Williams, K. D., & Blakemore, S. J. (2010). Social brain development and the affective consequences of ostracism in adolescence. *Brain and Cognition, 72*(1), 134-145.

Sergerie, K., Chochol, C., & Armony, J. L. (2008). The role of the amygdala in emotional processing: A quantitative meta-analysis of functional neuroimaging studies. *Neuroscience & Biobehavioral Reviews, 32*(4), 811-830.

Shanahan, L., Zucker, N., Copeland, W. E., Bondy, C. L., Egger, H. L., & Costello, E. J. (2014). Childhood somatic complaints predict generalized anxiety and

depressive disorders during young adulthood in a community sample. *Psychological Medicine, 45*(8), 1-10.

Shaw, P., Kabani, N. J., Lerch, J. P., Eckstrand, K., Lenroot, R. K., Gogtay, N., et al. (2008). Neurodevelopmental trajectories of the human cerebral cortex. *The Journal of Neuroscience, 28*(14), 3586-3594.

Sheline, Y. I., Barch, D. M., Donnelly, J. M., Ollinger, J. M., Snyder, A. Z., & Mintun, M. A. (2001). Increased amygdala response to masked emotional faces in depressed subjects resolves with antidepressant treatment: An fMRI study. *Biological Psychiatry, 50*(9), 651-658.

Shirtcliff, E. A., Dahl, R. E., & Pollak, S. D. (2009). Pubertal Development: Correspondence between hormonal and physical development. *Child development, 80*(2), 327-337.

Sieratzki, J. S., & Woll, B. (2002). Neuropsychological and neuropsychiatric perspectives on maternal cradling preferences. *Epidemiologia e Psichiatria Sociale, 11*(3), 170-176.

Silvia, P. J., Allan, W. D., Beauchamp, D. L., Maschauer, E. L., & Workman, J. O. (2006). Biased recognition of happy facial expressions in social anxiety. *Journal of Social and Clinical Psychology, 25*(6), 585-602.

Simonian, S. J., Beidel, D. C., Turner, S. M., Berkes, J. L., & Long, J. H. (2001). Recognition of facial affect by children and adolescents diagnosed with social phobia. *Child Psychiatry and Human Development, 32*(2), 137-145.

Siqueland, L., Rynn, M., & Diamond, G. S. (2005). Cognitive behavioral and attachment based family therapy for anxious adolescents: Phase I and II studies. *Journal of Anxiety Disorders, 19*(4), 361-381.

Sisk, C. L., & Foster, D. L. (2004). The neural basis of puberty and adolescence. *Nature Neuroscience, 7*(10), 1040-1047.

Sisk, C. L., & Zehr, J. L. (2005). Pubertal hormones organize the adolescent brain and behavior. *Frontiers in Neuroendocrinology, 26*(3-4), 163-174.

Smucker, M. R., Craighead, W. E., Craighead, L. W., & Green, B. J. (1986). Normative and reliability data for the Children's Depression Inventory. *Journal of Abnormal Child Psychology, 14*(1), 25-39.

Sowell, E. R., Thompson, P. M., Tessner, K. D., & Toga, A. W. (2001). Mapping continued brain growth and gray matter density reduction in dorsal frontal cortex: Inverse relationships during postadolescent brain maturation. *The Journal of Neuroscience, 21*(22), 8819-8829.

Spence, S. H., Donovan, C., & Brechman-Toussaint, M. (1999). Social skills, social outcomes, and cognitive features of childhood social phobia. *Journal of Abnormal Psychology, 108*(2), 211-221.

Starkstein, S. E., Robinson, R. G., Honig, M. A., Parikh, R. M., Joselyn, J., & Price, T. R. (1989). Mood changes after right-hemisphere lesions. *British Journal of Psychiatry, 155*(1), 79-85.

Starkstein, S. E., Robinson, R. G., & Price, T. R. (1987). Comparison of cortical and subcortical lesions in the production of poststroke mood disorders. *Brain, 110*(4), 1045-1059.

Steele, H., Steele, M., & Croft, C. (2008). Early attachment predicts emotion recognition at 6 and 11 years old. *Attachment & Human Development, 10*(4), 379-393.

Stein, M. B., & Kean, Y. M. (2000). Disability and quality of life in social phobia: Epidemiologic findings. *The American Journal of Psychiatry, 157*(10), 1606-1613.

Stein, M. B., & Stein, D. J. (2008). Social anxiety disorder. *Lancet, 371*(9618), 1115-1125.

Stein, M. B., Torgrud, L. J., & Walker, J. R. (2000). Social phobia symptoms, subtypes, and severity: Findings from a community survey. *Archives of General Psychiatry, 57*(11), 1046-1052.

Storch, E. A., Masia-Warner, C., Crisp, H., & Klein, R. G. (2005). Peer victimization and social anxiety in adolescence: A prospective study. *Aggressive Behavior, 31*(5), 437-452.

Surguladze, S., Brammer, M. J., Keedwell, P., Giampietro, V., Young, A. W., Travis, M. J., et al. (2005). A differential pattern of neural response toward sad versus happy facial expressions in major depressive disorder. *Biological Psychiatry, 57*(3), 201-209.

Suslow, T., Dannlowski, U., Arolt, V., & Ohrmann, P. (2010). Adult attachment avoidance and automatic affective response to sad facial expressions. *Australian Journal of Psychology, 62*(4), 181-187.

Suslow, T., Kugel, H., Rauch, A. V., Dannlowski, U., Bauer, J., Konrad, C., et al. (2009). Attachment avoidance modulates neural response to masked facial emotion. *Human Brain Mapping, 30*(11), 3553-3562.

Tabachnick, B.G., & Fidell, L.S. (1996). *Using multivariate statistics*. New York, NY: Harper Collins.

Tambelli, R., Laghi, F., Odorisio, F., & Notari, V. (2012). Attachment relationships and internalizing and externalizing problems among Italian adolescents. *Children and Youth Services Review, 34*(8), 1465-1471.

Taylor, M. J., McCarthy, G., Saliba, E., & Degiovanni, E. (1999). ERP evidence of developmental changes in processing of faces. *Clinical Neurophysiology, 110*(5), 910-915.

Thapar, A., Collishaw, S., Pine, D. S., & Thapar, A. K. (2012). Depression in adolescence. *Lancet, 379*(9820), 1056-1067.

Thayer, J., & Johnsen, B. H. (2000). Sex differences in judgement of facial affect: A multivariate analysis of recognition errors. *Scandinavian Journal of Psychology, 41*(3), 243-246.

Thomas, K. M., Drevets, W. C., Dahl, R. E., Ryan, N. D., Birmaher, B., Eccard, C. H., et al. (2001). Amygdala response to fearful faces in anxious and depressed children. *Archives of General Psychiatry, 58*(11), 1057-1063.

Thomas, L. A., De Bellis, M. D., Graham, R., & LaBar, K. S. (2007). Development of emotional facial recognition in late childhood and adolescence. *Developmental Science, 10*(5), 547-558.

Trinkl, M., Greimel, E., Bartling, J., Grunewald, B., Schulte-Korne, G., & Grossheinrich, N. (2015). Right-lateralization of N2-amplitudes in depressive adolescents: An emotional go/no-go study. *Journal of Child Psychology and Psychiatry, 56*(1), 76-86.

van Strien, J. W., & van Beek, S. (2000). Ratings of emotion in laterally presented faces: Sex and handedness effects. *Brain and Cognition, 44*(3), 645-652.

van Wingen, G. A., Ossewaarde, L., Backstrom, T., Hermans, E. J., & Fernandez, G. (2011). Gonadal hormone regulation of the emotion circuitry in humans. *Neuroscience, 191*, 38-45.

Vauclair, J., & Donnot, J. (2005). Infant holding biases and their relations to hemispheric specializations for perceiving facial emotions. *Neuropsychologia, 43*(4), 564-571.

Vervloed, M. P., Hendriks, A. W., & van den Eijnde, E. (2011). The effects of mothers' past infant-holding preferences on their adult children's face processing lateralisation. *Brain and Cognition, 75*(3), 248-254.

Wade, T. J., Cairney, J., & Pevalin, D. J. (2002). Emergence of gender differences in depression during adolescence: National panel results from three countries. *Journal of the American Academy of Child and Adolescent Psychiatry, 41*(2), 190-198.

Wagner, K. D., Berard, R., Stein, M. B., Wetherhold, E., Carpenter, D. J., Perera, P., et al. (2004). A multicenter, randomized, double-blind, placebo-controlled trial of paroxetine in children and adolescents with social anxiety disorder. *Archives of General Psychiatry, 61*(11), 1153-1162.

Wagner, K. D., Robb, A. S., Findling, R. L., Jin, J., Gutierrez, M. M., & Heydorn, W. E. (2004). A randomized, placebo-controlled trial of Citalopram for the treatment of major depression in children and adolescents. *The American Journal of Psychiatry, 161*(6), 1079-1083.

Waters, E., & Cummings, E. M. (2000). A secure base from which to explore close relationships. *Child Development, 71*(1), 164-172.

Watling, D., & Bourne, V. J. (2007). Linking children's neuropsychological processing of emotion with their knowledge of emotion expression regulation. *Laterality, 12*(5), 381-396.

Watling, D., & Bourne, V. J. (2013). Sex differences in the relationship between children's emotional expression discrimination and their developing hemispheric lateralization. *Developmental Neuropsychology, 38*(7), 496-506.

Watling, D., Workman, L., & Bourne, V. J. (2012). Emotion lateralisation: Developments throughout the lifespan. *Laterality, 17*(4), 389-411.

Weatherill, R. P., Almerigi, J. B., Levendosky, A. A., Bogat, G. A., Von Eye, A., & Harris, L. J. (2004). Is maternal depression related to side of infant holding? *International Journal of Behavioral Development, 28*(5), 421-427.

Weir, J. M., Zakama, A., & Rao, U. (2012). Developmental risk I: Depression and the developing brain. *Child and Adolescent Psychiatric Clinics of North America, 21*(2), 237-259.

Weissman, M. M., Bland, R. C., Canino, G. J., Faravelli, C., Greenwald, S., Hwu, H. G., et al. (1996). Cross-national epidemiology of major depression and bipolar disorder. *Journal of the American Medical Association, 276*(4), 293-299.

Wheeler, R. E., Davidson, R. J., & Tomarken, A. J. (1993). Frontal brain asymmetry and emotional reactivity: A biological substrate of affective style. *Psychophysiology, 30*(1), 82-89.

Winton, E. C., Clark, D. M., & Edelmann, R. J. (1995). Social anxiety, fear of negative evaluation and the detection of negative emotion in others. *Behaviour Research and Therapy, 33*(2), 193-196.

Wittchen, H.-U., Stein, M. B., & Kessler, R. C. (1999). Social fears and social phobia in a community sample of adolescents and young adults: Prevalence, risk factors and co-morbidity. *Psychological Medicine, 29*(02), 309-323.

Workman, L., Chilvers, L., Yeomans, H., & Taylor, S. (2006). Development of cerebral lateralisation for recognition of emotions in chimeric faces in children aged 5 to 11. *Laterality, 11*(6), 493-507.

Yap, M. B. H., & Jorm, A. F. (2015). Parental factors associated with childhood anxiety, depression, and internalizing problems: A systematic review and meta-analysis. *Journal of Affective Disorders, 175*(0), 424-440.

Yecker, S., Borod, J. C., Brozgold, A., Martin, C., Murray, A., & Welkowitz, J. (1999). Lateralization of facial emotional expression in schizophrenic and depressed patients. *The Journal of Neuropsychiatry and Clinical Neurosciences, 11*(3), 370-379.

Appendices

Appendix 1 – School opt-out consent form for parents.

Social Development Lab
Department of Psychology
Address

Dr Dawn Watling
Contact Details

Dear Parent/Guardian,

My name is Christine Longinotti, and I am Trainee Clinical Psychologist at Royal Holloway, University of London. I am carrying out research for my doctorate in clinical psychology, exploring how social, hormonal, and brain-related factors impact might predict children's feelings. Dr. Dawn Watling and Dr. Victoria Bourne are supervising the project. I have arranged to visit [SCHOOL NAME] on [DATE], and would greatly appreciate the participation of your child in this valuable research project during this time. This project not only forms a major part of the Clinical Psychology doctorate, but will also provide important insights into how we might help children with anxiety and depression.

This research involves approximately 30 minutes of your child's time. Your child will be asked to complete a short computer-based task. This will present two faces of people showing an emotional expression on one side of their face (e.g. happiness), and a neutral expression on the other. Your child will be asked to decide which face looks more emotional. In addition, your child will be asked to complete four questionnaires to allow us to estimate stage of puberty, their relationships with others, and their mood. All information is anonymous (in no place will your child write their name) and will be used for research purposes only. Your child's individual responses will be used for research purposes only, and will not be seen by anyone besides my supervisors and myself. Your child's responses will not be shown to teachers or other parents/guardian. However, [SCHOOL NAME] will be provided with a summary of the research findings after the research is complete. It is important to stress that the focus is on overall scores of the year group as a whole, not of individual children.

This study has been reviewed and approved by the Psychology Department internal ethical procedure at Royal Holloway, and [NAME OF HEADTEACHER], the Head teacher, has also given permission for this study to be carried out at [SCHOOL NAME]. I have had a recent Disclosure Barring Service check (formerly a Criminal Records Bureau check), a copy of which will be left with reception at [SCHOOL NAME]. Children invited to take part will be advised that they do not have to answer any questions they feel uncomfortable answering, and can withdraw from a session at any time if they do not wish to continue. If your child decides not to participate, this will not affect their education.

If you would like to discuss any aspect of the research with Dr. Watling, you can contact her by email or by phone the details of which are provided above. You can also contact me by email: [email address].

If you do NOT wish for your child to take part, please complete and detach the information below, and return it to your child's class teacher before [DATE]. Please retain the top portion of this letter for information on our study and our contact details. Your child's right to privacy and confidentiality will be respected at all times. Note that you may withdraw your son or daughter from the study at any point during the schedule of research. Importantly, as noted above, if your son or daughter indicates that he or she does not want to take part in the session, at any point before or during the session, their wishes will be respected.

Yours faithfully,
Christine Longinotti (Trainee Clinical Psychologist)

Appendix 2 – Opt-out reply slip.

✂_ _

Research project: Effect of puberty on children's feelings

I wish for my son/daughter to be excluded from taking part in the research project being conducted by Christine Longinotti.

Signature of parent / guardian ....

Name of parent/guardian (please print) ....

Name of child ....

Name of class teacher ....

Date ....

Appendix 3 – School contact letter.

Social Development Lab
Department of Psychology
Address

Dr Dawn Watling

Contact Details

[School address]

[Date]

Dear [name of head teacher],

My name is Christine Longinotti and I am a Trainee Clinical Psychologist at Royal Holloway, University of London. I am writing about visiting children aged [AGE] as part of research exploring the effects of puberty on children's feelings. We know that puberty can be a difficult time for some children, and it is during this time when feelings can fluctuate a great deal. However we do not yet fully understand why this occurs. We are therefore hoping that you would be interested in taking part in the research that we are conducting. The project investigates how children's understanding of emotion and their relationships with others relate to their feelings during puberty. It is hoped, in the future, this study will also provide important insights into how we might help children with anxiety and depression. Dr. Dawn Watling and Dr. Victoria Bourne based at Royal Holloway, University of London, will be supervising the project. This study has been reviewed and approved by the Psychology Department internal ethical procedure at Royal Holloway.

I would like to visit children in year(s) [NUMBER] on one occasion. The research should last approximately 30 minutes. Please note that I have had a recent Disclosure Barring Service check (formerly Criminal Records Bureau check), and will be happy to leave a copy of this with you when I visit. I am hoping that I could visit [SCHOOL NAME] in October, but I can be flexible in arranging a time that is convenient to you. I would do my utmost to ensure this research is not disruptive. Children that participate will complete a computer-based task, showing two faces with different expressions (e.g., happy, sad, angry). Each child will be asked to state what the emotion is and to judge which face they believe looks more emotional (e.g., happier). Children will also be asked to complete four short questionnaires allowing us to evaluate their feelings and stage of puberty.

It is important you know that all of the responses will be anonymous, with the child being identified only by a number, and their information will be used for research purposes only. It is also important to stress that the focus is on overall scores of the year group as a whole, not of individual children. The research team (e.g., my supervisors and myself) will be the only people to see individual responses. However, we would be happy to provide you with a summary of the findings after the research had been completed. Children invited to take part in the study do not have to answer questions they do not want to answer and will be allowed to withdraw from a session at any time if they do not wish to continue.

I will be contacting you in the next week to see if you have any questions, would like more information, and if you would be happy for us to visit your school. However, if before then you have any queries or would like to discuss any aspect of the research with Dr Watling you can contact her by email: **[ADDRESS]** or by phone at the above number. Alternatively, if you would like to contact me you can do so via mobile telephone: **[NUMBER]** or email: **[ADDRESS].**

We would greatly appreciate your school's participation in this research.

Yours sincerely,

Christine Longinotti
Trainee Clinical Psychologist

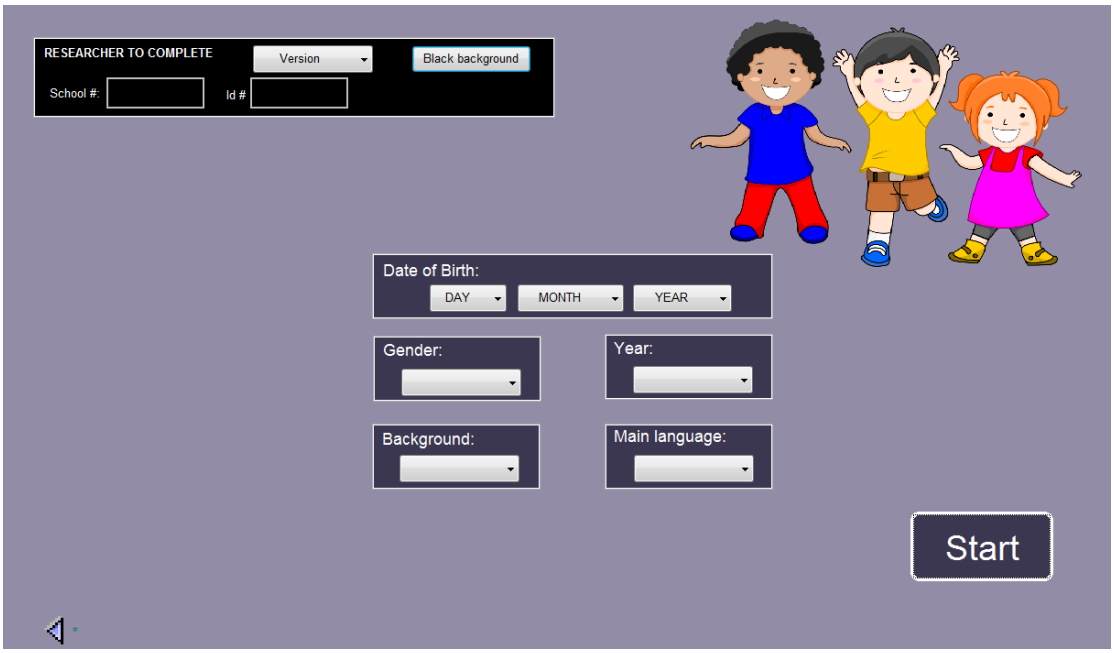
Appendix 4 – Ethical approval from Royal Holloway, University of London.

From: Psychology-Webmaster@rhul.ac.uk
Sent: 06 August 2014 14:40
To: Watling, Dawn; Watling, Dawn
Cc: PSY - Ethics Admin
Subject: Ref: 2014/079 Ethics Form Approved

Applicant Name: **Dawn Watling**

Application title: **Anxiety and depression in adolescents: Exploring social, neuropsychological, and hormonal influences.**

Appendix 5 – Demographic questions, and an example screenshot of these presented via computer screen.



Date of Birth (Day/Month/Year): ____/____/_____

Gender: _____

School Year (Year 5/Year 7/Year 9): _____

Background: _____

Main Language (the language you speak at home): _____

Which hand do you use when you throw a ball?

Which hand do you use when you brush your teeth?

Which hand do you use when you write your name?

Appendix 6 – Social Anxiety Scale for Children – Revised (SASC-R).

Instructions

In this section you will see a number of different sentences. For each sentence you should click the button to show how much you feel the sentence is true for you.

You can choose between:

□ Not at all
□ Hardly ever
□ Sometimes
□ Most of the time
□ All of the time

This is not a test and there are no right or wrong answers. Please answer as honestly as you can.

1. **I worry about doing something new in front of other children.**
   □ Not at all
   □ Hardly ever
   □ Sometimes
   □ Most of the time
   □ All of the time

2. **I like to play with other children.**
   □ Not at all
   □ Hardly ever
   □ Sometimes
   □ Most of the time
   □ All of the time

3. **I worry about being teased.**
   □ Not at all
   □ Hardly ever
   □ Sometimes
   □ Most of the time
   □ All of the time

4. **I feel shy around children I don't know.**
   □ Not at all
   □ Hardly ever
   □ Sometimes
   □ Most of the time
   □ All of the time

5. **I only talk to children that I know really well.**
   - □ Not at all
   - □ Hardly ever
   - □ Sometimes
   - □ Most of the time
   - □ All of the time

6. **I feel that other children talk about me behind my back.**
   - □ Not at all
   - □ Hardly ever
   - □ Sometimes
   - □ Most of the time
   - □ All of the time

7. **I like to read.**
   - □ Not at all
   - □ Hardly ever
   - □ Sometimes
   - □ Most of the time
   - □ All of the time

8. **I worry about what other children think of me.**
   - □ Not at all
   - □ Hardly ever
   - □ Sometimes
   - □ Most of the time
   - □ All of the time

9. **I'm afraid that others will not like me.**
   - □ Not at all
   - □ Hardly ever
   - □ Sometimes
   - □ Most of the time
   - □ All of the time

10. **I get nervous when I talk to children I don't know very well.**
    - □ Not at all
    - □ Hardly ever
    - □ Sometimes
    - □ Most of the time
    - □ All of the time

11. **I like to play sports.**
    - □ Not at all
    - □ Hardly ever
    - □ Sometimes
    - □ Most of the time
    - □ All of the time

12. I worry about what others say about me.

□ Not at all
□ Hardly ever
□ Sometimes
□ Most of the time
□ All of the time

13. I get nervous when I meet new children.

□ Not at all
□ Hardly ever
□ Sometimes
□ Most of the time
□ All of the time

14. I worry that other children don't like me.

□ Not at all
□ Hardly ever
□ Sometimes
□ Most of the time
□ All of the time

15. I'm quiet when I'm with a group of children.

□ Not at all
□ Hardly ever
□ Sometimes
□ Most of the time
□ All of the time

16. I like to do things by myself.

□ Not at all
□ Hardly ever
□ Sometimes
□ Most of the time
□ All of the time

17. I feel that other children make fun of me.

□ Not at all
□ Hardly ever
□ Sometimes
□ Most of the time
□ All of the time

18. If I get into an argument with another child, I worry that he or she will not like me.

□ Not at all
□ Hardly ever
□ Sometimes
□ Most of the time
□ All of the time

19. I'm afraid to invite other children to do things with me because they might say no.

□ Not at all
□ Hardly ever
□ Sometimes
□ Most of the time
□ All of the time

20. I feel nervous when I'm around certain children.

□ Not at all
□ Hardly ever
□ Sometimes
□ Most of the time
□ All of the time

21. I feel shy even with children I know well.

□ Not at all
□ Hardly ever
□ Sometimes
□ Most of the time
□ All of the time

22. It's hard for me to ask other children to do things with me.

□ Not at all
□ Hardly ever
□ Sometimes
□ Most of the time
□ All of the time

Appendix 7 – Child Depression Inventory: Short Form (CDI:S).

Measure not included due to copyright restrictions

Appendix 8 – Inventory of Parent and Peer Attachment- Revised (IPPA-R) - Parent subscale.

Instructions

In this section you will be shown a number of different sentences. For each sentence, you have to click a button to show HOW OFTEN the sentence is true for you.

You can choose between:

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

This is not a test and there are no right or wrong answers.

Please answer as truthfully as you can.

1. My parents respect my feelings.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

2. My parents are good parents.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

3. I wish I had different parents.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

4. My parents accept me as I am.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

5. I can't depend on my parents to help me solve a problem.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

6. I like to get my parents' view on things I am worried about.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

7. It does not help to show my feelings when I am upset.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

8. My parents can tell when I'm upset about something.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

9. I feel silly or ashamed when I talk about my problems with my parents.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

10. My parents expect too much from me.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

11. I easily get upset at home.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

12. I get upset a lot more than my parents know about.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

13. When I talk about things with my parents, they listen to what I think.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

14. My parents listen to my opinions.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

15. My parents have their own problems, so I don't bother them with mine.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

16. My parents help me to understand myself better.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

17. I tell my parents about my problems and troubles.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

18. I feel angry with my parents.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

19. I don't get much attention at home.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

20. My parents support me to talk about my worries.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

21. My parents understand me.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

22. I don't know who I can depend on.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

23. When I am angry about something, my parents try to understand me.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

24. I trust my parents.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

25. My parents don't understand my problems.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

26. I can count on my parents when I need to talk about a problem.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

27. No one understands me.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

28. If my parents know that I am upset about something, they ask me about it.

□ Always true
□ Almost always true
□ Sometimes true
□ Almost never
□ Never true

Appendix 9 - The Self-Administered Rating Scale for Pubertal Development – Girl's version.

Instructions:

The next questions are about changes that may be happening to your body. These changes normally happen to different young people at different ages.

You will be asked to click on the answer that applies best to you.

There are no right or wrong answers, so please answer the questions as truthfully as possible. All answers will be kept private.

If you do not understand a question or do not know the answer, just mark 'I don't know.'

1. Would you say that your growth in height:

□ Has not yet begun to spurt
□ Has barely started
□ Is definitely underway
□ Seems completed
□ I don't know

2. Would you say that your body hair growth:

("Body hair" means hair any place other than your head, such as under your arms.)

□ Has not yet begun to grow
□ Has barely started to grow
□ Is definitely underway
□ Seems completed
□ I don't know

3. Have you noticed any skin changes, especially pimples?

□ Skin has not yet started changing
□ Skin has barely started changing
□ Skin changes are definitely underway
□ Skin changes seem complete
□ I don't know

4. Have you noticed that your breasts have begun to grow?

□ Have not yet started growing
□ Have barely started growing
□ Breast growth is definitely underway
□ Breast growth seems complete
□ I don't know

5a. Have you begun to menstruate (started to have your period)?

□ Yes
□ No

5b. If yes, how old were you when you started to menstruate?

_____ (age in years)

Appendix 10 – The Self-Administered Rating Scale for Pubertal Development – Boy's version.

Instructions:
The next questions are about changes that may be happening to your body. These changes normally happen to different young people at different ages.

You will be asked to click on the answer that applies best to you.

There are no right or wrong answers, so please answer the questions as truthfully as possible. All answers will be kept private.

If you do not understand a question or do not know the answer, just mark 'I don't know.'

1. Would you say that your growth in height:

□ Has not yet begun to spurt
□ Has barely started
□ Is definitely underway
□ Seems completed
□ I don't know

2. Would you say that your body hair growth:
("Body hair" means hair any place other than your head, such as under your arms.)

□ Has not yet begun to grow
□ Has barely started to grow
□ Is definitely underway
□ Seems completed
□ I don't know

3. Have you noticed any skin changes, especially pimples?

□ Skin has not yet started changing
□ Skin has barely started changing
□ Skin changes are definitely underway
□ Skin changes seem complete
□ I don't know

4. Have you noticed a deepening of your voice?

□ Voice has not yet started changing
□ Voice has barely started changing
□ Voice changes are definitely underway
□ Voice changes seem complete
□ I don't know

5. Have you begun to grow hair on your face?

□ Facial hair has not yet started growing
□ Facial hair has barely started growing
□ Facial hair growth has definitely started
□ Facial hair growth seems complete
□ I don't know

Appendix 11 – Parental questionnaire evaluating appropriateness of materials.

Information Sheet

Thank you for agreeing to help with this research! Your help is crucial to this research being successful, and I am very grateful for your help.

I would like to undertake a research study with children, and use the enclosed sheets during the study. I would like to get feedback from parents and children on the sheets, and if they can be improved.

What you will be asked to do:

- Read through the enclosed sheets for parents
- Answer the attached Parental Questionnaire
- Ask your child to read the enclosed sheet for children
- Ask you child answer the attached Child Questionnaire
- Return the forms

Your participations should take no more than 10 minutes.

Outline of the proposed study

Social anxiety and depression are uncommon during childhood, but increase substantially during adolescence. We are not sure why there is a large increase during adolescence. The proposed study will look at several factors we think are related to social anxiety and depression during adolescence.

Young children and adults who do **not** have depression or anxiety are generally very good at recognising emotions from facial expressions. The right side of the brain is known to recognise emotional facial expressions. Adults with anxiety and depression have weaker right-sided brain processing, and find it harder to recognise emotions facial expressions. Unfortunately we do not know if this is the same in adolescents. Adolescence is an important time for brain development, as children go through puberty. Hormonal changes during puberty change the brain's structure. Hormones may therefore change the brain, affecting right sided processing and may explain one reason why anxiety and depression occur at this time. We also want to look at whether children who get on well with their parents experience more social anxiety and depression, and if this affects facial processing.

What participation in the proposed study will involve

Children aged 9-14 will take part. They will complete a computer task that asks them to look at some faces showing emotions. They will also be asked to complete 4 questionnaires asking about their stage of puberty, their relationship with their parents, and if they experience social anxiety or depression.

Aims of the study

The study aims to look at whether hormones affect right-sided brain processing and the ability to recognise facial emotions. If this is found to be the case, it can provide important insights to help treatment of social anxiety and depression.

Parental Questionnaire

My child is _____ years old

My child is currently attending **PRIMARY** **SECONDARY** school

PLEASE TAKE A MOMENT TO READ THE 2 SHEETS MARKED "PARENTAL CONSENT FORMS"

Which consent form do you prefer? (please circle)

Opt-in Opt-out

Were the consent forms easy to understand? (please circle)

YES NO

If you selected NO, what could be change or improved?

After reading the consent forms, did you understand why I would be doing the study? (please circle)

YES NO

After reading the consent forms, did you understand what your child would be asked to do? (please circle)

YES NO

Would you give permission for your son or daughter to take part in this research? (please circle)

YES NO

If you selected NO, what concerns do you have?

Do you have any additional comments or suggestions to improve the consent forms?

Appendix 12 – Child questionnaire evaluating appropriateness of materials.

Child Questionnaire

PLEASE READ THE "DEBRIEF FORM"

Did the form make sense?

YES NO

If the form did not make sense, how can we make them better?

Can you write a few words into the box to say what the study is about?

Was the form:

TOO LONG JUST RIGHT TOO SHORT

Did you like the pictures used on the form?

YES NO

What can we do to make the form better?

Would you say yes if asked to do the study?

YES NO

Children who do the study get to pick a prize. Which prize is better?

PENCIL TOPPER STICKER

Do you have anything else you would like to say ?

Appendix 13 – Verbal debrief for younger children.

Debrief outline.

The debriefing included statements similar to the following:

> "Thank you for helping out in our research project. You did really well. Remember all of you answers will be private and we will not be showing them to any of your classmates, teachers, or parents.
>
> It's important I tell you a little bit about why I asked you to do the tasks. We know that sometimes people feel sad or scared around other people, and this changes as we get older. Something else that changes as we get older, is how well we can recognise what someone is feeling from looking at his or her face. We wanted to see if the way someone recognises an emotion in a face is different depending on if they feel sad or scared, and how this changes with age.
>
> We asked you to look at some faces and about whether you feel sad or scared some times and asked you some questions to know more about your age. We will now put all this information together and this will help to answer our research questions.
>
> Do you have any questions you would like to ask me about our project? Thank you again for helping out."

Appendix 14 - Debrief sheet for older children.

Participant Debrief Sheet

You might be wondering why I asked you to do those tasks. We know that sometimes people feel sad, or scared of other people. Everyone feels like this sometimes, but some people feel like this more than others. When people get very sad or very scared they might need to talk to someone for help. We know that people can feel more sad or scared as they get older, but we do not know why. You are helping us to find out! By doing this we hope to help people who feel very sad or scared.

Our brain is inside our heads. It helps to control everything we do. When we look at other people's faces, our brains help us to see who is it and how they might be feeling. We know that when we grow up, our brain changes like our body changes. Our brain gets better at seeing other people until we are 10 years old, but we do not know what happens after that until we get to 18 years old. Finding it harder to know what a person is feeling may make people sadder or more scared, but we do not know. That is what we are trying to find out. We were also trying to find out if people who get on very well with their mum and dad feel sad and scared too.

We know that as we get older our brain changes, but we do not know what makes our brain change. We asked you to complete a questionnaire that tells us about your age and your development. This will help us to see if there are factors other than age that might make our brain change.

Thank you for helping with this research!

You have worked very hard today and I am very thankful that you were able to help