Exploring Correlates of Threat Related Attention Bias in Community Sample Children and Adolescents

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A thesis submitted for the degree of Doctor of Philosophy

To

School of Health in Social Science
University of Edinburgh

August 2020

Dedicated to the legacy of Dr Jonas Salk,

which he left to all children of this world.

Acknowledgements

I would first like to thank all the awesome parents and brilliant children and adolescents who took part in my project. Without your precious collaboration and effort, this thesis would not have been possible.

I would also like to express my profound gratitude to my supervisors, Prof Matthias Schwannauer, Dr Stella Chan, and Dr Nicolas Chevalier, for their moral support and academic guidance throughout the completion of this thesis. Thank you for setting me an example of how to be a teacher, a researcher, and a mentor. It has been a great pleasure to learn from you.

Thanks to Rebecca, Emily, Stephanie, and Katie for assisting me during data collection. Your incredible time management skills, sense of responsibility, and being available in the lab whenever I had a family coming whilst preparing for your exams always amazed me.

Also a huge thanks to my family; my mother, father, and brother. Endless thank you for surrounding me with love, compassion, joy, understanding, and support. I love you all immensely.

A special thank you also goes to my fiancé, Hasan. Your unique sense of humour, never ending emotional support, patience, and trust in me throughout my PhD is invaluable. Thank you, my light.

Finally, I am grateful to have met Erifili, Aliki, Zoi, Jo, Claire Ann, and Eilidh on this journey. Thank you for all the support and advice whenever I needed and for all the great memories.

This work was funded by a PhD scholarship from Republic of Turkey Ministry of National Education.

Abstract

Attention bias for threatening information is an acknowledged factor that plays a causal or maintaining role in childhood anxiety with small to medium effect sizes. Both clinically anxious and trait anxious children and adolescents show greater AB for threat compared to neutral information and compared to their non-anxious counterparts. However, attention bias is a complex construct with several components. This leads to heterogeneity in the way it is manifested as vigilance towards threat, difficulty in disengaging attention away from threat, or avoidance from threat, which in turn affects efficiency of the techniques that aim to eliminate attention bias and reduce anxiety. So, emerging research have started to explore developmental mechanisms that could modulate and potentially contribute to the heterogeneity in attention bias for threat in children and adolescent populations.

Following a systematic database search, three potential correlates of threat related attention bias were identified to be examined further in this thesis based on scarcity of the studies and disputes related to the measurement tools. So, the aim of this thesis was to explore the role of parental transmission (Study 1), attentional control ability (Study 2), and emotion regulation strategy use (Study 3) on children's attention biases for threat within the context of trait anxiety.

Data informing each empirical study came from the same community sample of 112 children and adolescents aged between 8 and 16, in addition to their parents for Study 1, youth participants completed 2000 milliseconds dot-probe task while their eye movements were recorded to measure attention bias, Simon task to measure attentional control ability, and Emotion Regulation Questionnaire-Children (ERQ – CA; Gullone & Taffe, 2011) to measure emotion regulation strategy use.

The results suggest that parental attention bias is not a significant correlate of their children's attention bias in community sample of families. However, children and adolescents' low attentional control ability, especially executive switching, predicted greater difficulty in disengaging attention from angry faces. Finally, children and adolescents with low cognitive reappraising skills showed greater vigilance and disengagement difficulty for angry faces compared to their high reappraiser counterparts.

While the key limitation of the project is that neither parental nor youth sample were representative of high trait anxious individuals, our set of studies provide preliminary results regarding associates of threat related attention bias in youth with low trait anxiety. Accordingly, our results highlight that individual differences in attentional control and emotion regulation abilities could increase vulnerability for threat related attention biases independent of anxiety in normative developmental populations. This has potential implications for psychoeducation programmes for community sample youth, such that aiming to improve control over attention and reappraisal skills as an element of emotion regulation could prevent them from developing or maintaining cognitive biases and the associated emotional difficulties.

Lay Summary

Research shows that both clinically anxious youth and youth with high trait anxiety (a tendency to have a high level of anxiety that is pervasive across a wide range of situations) give priority to threat signalling information (consciously or unconsciously) among other types of information to look at, to interpret, to remember, to make decisions, and to react. Selectively looking at threatening information such as angry faces is called attention bias for threat and research also shows that anxious children look at threatening information more than neutral information or more than their non anxious peers. So, attention bias for threat is thought to be a maintaining or causal factor for anxiety in children.

Attention bias is complex and can be displayed in various ways. It can be shown as immediate detection of threat among other types of information (vigilance), difficulties in disengaging attention away from threat (disengagement difficulty) or avoiding looking at threat (avoidance). So, recent theories of attention bias have focused on developmental factors that might explain the variety in the way attention bias is manifested in children and adolescents.

In order to understand developmental contributors of attention bias, hence, to offer suggestions regarding how to handle attention bias in trait anxious children and adolescents, this thesis explored three factors that might be associated with attention bias for threat in children/adolescents and their parents from community.

Parental environment, which is a rich source of interaction through conversation and observation, is one of the key risk factors that contribute to development of anxiety in children. Therefore, the first factor explored was parents' own attention biases. We specifically examined whether attention bias for threat was transferred from parents to children. Our results revealed no association between parents' own attention biases and their children's attention biases. This suggests that parental attention bias on its own is not a medium that impacts children's attention bias.

The second factor was children's ability to control their attention. Specifically, we examined the association between children's ability to control their attention and their attention biases. The results revealed that especially the ability to switch back and forth between tasks is related to looking at threatening faces longer. This suggests that poor ability in switching between tasks also operates on attentional level and prevents attention to be flexibly allocated on the stimuli other than threatening ones.

Third, we examined whether children's habitual use of strategies to regulate emotions were associated with their attention biases. The results revealed that children who practice reappraisal (rethinking about a situation and developing a more constructive perspective) more often showed reduced vigilance for threat faces and took less time to disengage from threatening faces.

Overall, our results on attentional control and emotion regulation suggest that good attentional control ability and reappraisal ability are key factors that can increase resilience against attention biases for threat in children and adolescents. This has important implications for practice. Accordingly, psychoeducation programmes to improve attentional control and emotion regulation skills can be useful as a preventative approach against cognitive biases, associated with emotional difficulties, in children with varying levels of trait anxiety.

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1. CHAPTER ONE: GENERAL LITERATURE REVIEW ON CHILDHOOD ANXIETY AND ATTENTION BIAS FOR THREAT

1.1. Childhood Anxiety in a Nutshell

1.1.1. From Normal to Pathological Anxiety: Definition and Classification

From early childhood to late adolescence, human development witnesses substantial changes in physical, cognitive, emotional, social, and behavioural domains. This is an exquisite period of life where our brain becomes enriched with billions of neurons (Harvard University, Center of Developing Child), we start thinking, learn to keep track of our thoughts and may even notice that our thoughts are strong enough to influence the way we feel and act (Birney & Sternberg, 2011), we leave behind needing an external body and physical sensation to be soothed and learn how to control and regulate our emotions on our own (Thompson, 1991), and we transform into individuals capable of having social relationships which have their own sophisticated dynamics (Eccles & Roeser, 2011). These elements of expected developmental stages contribute to the way we function in various areas of life such as acquisition of new skills, discovery of novel things, and making and sustaining new relationships.

But sometimes development of one or some of these areas can take a different path than developmental expectations (Huberty, 2012c), which leads to poor wellbeing and functioning in childhood. Unfortunately, childhood is not exempt from psychological disorders and oftentimes it lays the foundations of our wellbeing in adulthood. The most common and perhaps the earliest form of psychological disorder during childhood and adolescence is anxiety disorders (Beesdo, Knappe, & Pine, 2009; Polanczyk, Salum, Sugaya, Caye, & Rohde, 2015). It causes distress and functional impairments such as low educational achievement, poor relationships with peers and teachers, low self-competence (Essau, Conradt, & Petermann, 2000; Ezpeleta, Keeler, Erkanli, Costello, & Angold, 2001), suicidal behaviour, substance abuse, and early parenthood (Woodward & Fergusson, 2001). Henceforth, it creates significant economic and social burden (Bandelow & Michaelis, 2015; Bodden, Dirksen, & Bögels, 2008).

In essence, anxiety is characterised as a defensive response to a perceived threat underlined by concerns about anticipatory (imaginary) threats to self and fear is characterised as a defensive response to real threats (to very specific stimuli) (Castro-Fonseca & Perrin, 2014; Huberty, 2012a; Pine, Helfinstein, Bar-Haim, Nelson, & Fox, 2009). Although most of the time anxiety is referred to be something negative, it is actually an intriguing type of emotion with its function to adapt ourselves against the demands of our environment, and ultimately to alert us for dangers and keep us alive (Al-Biltagi & Sarhan, 2016; Beesdo-Baum & Knappe, 2012). Each one of us stand at some point on a continuum from the necessity to the psychopathology of anxiety experience.

As far as young people are concerned, manifestation of anxiety at certain ages and in specific contexts is even considered to be a marker of typical development (Al-Biltagi & Sarhan, 2016; Beesdo et al., 2009; Huberty, 2012a). For example, stranger anxiety, separation anxiety, and night-time anxiety during infancy and toddlerhood; fear of specific objects/situations, and school anxiety during childhood; and anxiety regarding rejection from peers during adolescence are thought to be age appropriate expressions of anxiety (Beesdo et al., 2009). Therefore, identifying what constitutes normative, subclinical, or pathological anxiety and whether a young person is standing on the pathological side of the anxiety experience appears to be especially challenging in childhood and requires a thorough assessment (Beesdo et al., 2009).

Nevertheless, the consensus is that anxiety becomes pathological in children when it is persistent and not transient, not developmentally appropriate for the child's age, the reaction is disproportioned to the source of threat and irrational, and it interferes with and impairs everyday functioning as well as psychosocial development of the child (Al-Biltagi & Sarhan, 2016; Beesdo et al., 2009; Castro-Fonseca & Perrin, 2014; Huberty, 2012a; Nauta, 2005).

Pathological anxiety can take several different forms, and anxiety disorders is an umbrella term that refers to a cluster of several different but interrelated disorders, which are commonly underlined by extreme anxious apprehension and behavioural disturbances. This structure of anxiety is reflected in Diagnostic and Statistical Manual of Mental Disorders (DSM: American Psychiatric Association [APA], 1952, 1968, 1980, 1987, 1994, 2000, 2013) and the International Classification of Diseases (ICD: World Health Organization [WHO], 1992).

In DSM-4-TR, seven main anxiety disorders are classified: (1) Separation Anxiety Disorder (i.e., excessive anxiety about separation from home or attachment figures, the only anxiety disorder that is considered to be specific to childhood in the manual); (2) Generalized Anxiety Disorder (i.e., excessive and uncontrollable worry in various and not specific contexts); (3) Specific Phobias (i.e., persistent and marked fear evoked by anticipation or presence of certain objects or situations); (4) Social Phobia or Social Anxiety Disorder (i.e., the fear of performing or being embarrassed/humiliated in unfamiliar social situations); (5) Panic Disorder with or without agoraphobia (i.e., having panic attacks and also having persistent worry regarding the possibility of having panic attacks, can be accompanied by agoraphobia, which is the fear of open or crowded places); (6) Post Traumatic Stress Disorder (i.e., reexperiencing and avoidance of certain events with heightened arousal after being exposed to a certain traumatic event); (7) Obsessive Compulsive Disorder (i.e., presence of obsessions, recurrent intrusive thoughts marked by anxiety and presence of compulsions, repetitive behavioural rituals or mental acts to reduce of stress caused by obsessions) (APA, 2000 as cited in Arnold et al., 2003).

The organization and grouping of anxiety disorders have changed considerably in the latest DSM (DSM-5; APA, 2013). Distinctive than its predecessor DSM-4-TR, two anxiety disorder subcategories are now separate categories in DSM-5. Obsessive Compulsive Disorders is a separate chapter on its own called Obsessive Compulsive and Related Disorders, Post Traumatic Stress Disorder has also become a separate category called

Trauma- and Stressor-Related Disorders (APA, 2013 cited in Kupfer, 2015); and agoraphobia is a diagnosis of its own independent from the presence of panic disorder (Creswell, Waite, & Cooper, 2014).

Release of DSM-5 (APA, 2013) has been relatively recent and substantial amount of childhood anxiety research is published based on the classification, assessments, and diagnosis criteria led by DSM-4-TR (APA, 2004). Therefore, it is imperative to establish links between current research and DSM-4-TR for meaningful literature continuity. So, the broad term of anxiety disorders refers to all the disorders organized under anxiety disorders in DSM-4-TR including OCD and PTSD within the boundaries of this thesis.

1.1.2. Distribution of Childhood Anxiety: Prevalence Rates

According to British National Mental Health Survey of 5 to 15-year-olds (Meltzer, Gatward, Goodman, & Ford, 2003), the proportion of community children having any type of anxiety disorder at any point in their lives is 3.8%. Given that the same survey noted that the lifetime prevalence of children having any type of emotional disorder is 4.3% (Meltzer et al., 2003), the anxiety prevalence rate appears to be quite high in British developmental population. Similarly, the data from The Great Smoky Mountains Study of Youth in the US suggests that the most prevalent disorder among children is anxiety disorder with a prevalence rate of 5.7% (Costello et al., 1996).

However, there are ups and downs with large ranges in the estimates of anxiety prevalence across studies due to varieties in the sample populations, countries, informants, anxiety measurements, definition of anxiety disorders, the diagnostic systems used, and the length of retrospective prevalence rate period (Al-Biltagi & Sarhan, 2016; Beesdo et al., 2009; Costello, Mustillo, Erkanli, Keeler, & Angold, 2003; Pine, 1997, Kessler, Petukhova, Sampson, Zaslavsky, & Wittchen, 2012). Especially more recent reviews have reported higher lifetime prevalence rates in children and adolescents that vary between 4.7 - 9. 1% (Polanczyk et al., 2015), 15 - 20% (Beesdo et al., 2009), 2 - 24% (Merikangas, Nakamura, & Kessler, 2009), and 9 - 32% (Creswell et al., 2014).

In addition, interestingly, not only the prevalence of diagnosis but also subclinical anxiety symptoms in community sample of non-referred children (i.e., trait anxiety) seems to be considerably high with a range of 9.8 - 30.6% (Bernstein, Borchart, & Perwien, 1996) and 70% of school children indicate that “they worry every now and then” (Al-Biltagi & Sarhan, 2016, p.19).

The prevalence distribution of anxiety is affected by sex. According to the study by McLean and colleagues (McLean, Asnaani, Litz, & Hofmann, 2011), the lifetime male: female prevalence ratio of having any anxiety disorder is 1: 1.7 in adults. Although this ratio in developmental populations is yet to be clarified due to limited reports on this issue (Costello et al., 2011), researchers agree that, similar to women, girls have a greater preponderance to have an anxiety disorder than boys for almost all the anxiety disorder types (Beesdo et al., 2009; Bernstein et al., 1996; Costello et al., 1996; Costello et al., 2003; Huberty, 2012a; Lewinsohn et al., 1998). The prevalence shows a consistent and sharper increase in girls starting from the age of five with a peak in adolescence in comparison to boys (Merikangas et al., 2009) and the ratio gets more divergent with development, reaching to 1: 2– 3 in adolescence (Beesdo-Baum & Knappe, 2012; Wehry et al., 2015).

Anxiety disorders appear to be prevalent in all age groups. Although the mean age of onset for any anxiety disorder by the age of 21 is reported to be eight (Costello et al., 2011), it is possible to spot both qualitative and quantitative trends in the prevalence rates of subcategories across different age groups. Accordingly, the prevalence of having any anxiety disorder in youth aged between (a) 2 to 8 ranges between 6.1 – 14.8% (specific phobia and SAD are the most prevalent ones), (b) 6 to 12 is 12.3% (specific phobia and SAD are at the top), and (c) 13 to 18 is 11% (specific phobia and social phobia are the most common ones) (Costello et al., 2011).

1.1.3. Anxiety Prognosis from Childhood Onward

How anxiety manifests during childhood and adolescence vary according to subtypes of anxiety disorders, age of onset, and the criteria that differentiate psychopathological anxiety from age appropriate anxiety expressions. Hence, the following section outlines age of onset of anxiety subtypes within stages of childhood and adolescence including behavioural manifestations. Also, the developmental trajectory of anxiety disorders such as stability or change in diagnosis, comorbidity, and response to treatment are addressed.

During early childhood (age between 2 to 8), temperamental characteristics such as behavioural inhibition is an acknowledged risk factor in developing an anxiety disorder. Development of separation anxiety and specific phobias are common in this age group (Costello et al., 2011). Some primary symptoms of separation anxiety are refusal to leave home or go to school, reluctance to develop friendships, and somatic complaints (Huberty, 2012a). Age of onset for specific phobias, on the other hand, are dependent on the type of stimulus/situation. Behavioural manifestations of them involve increased physiological symptoms, attempts to escape or avoid the situation accompanied by crying, tantrums, hiding, and flight (Huberty, 2012a).

Middle childhood (age between 8 to 12) is the age period in which most types of the anxiety disorders start to develop (Huberty, 2012a). Nevertheless, the most prevalent types of anxiety disorders in this age group are specific phobia, separation anxiety, social phobia, and generalized anxiety disorder (Costello et al., 2011). While social phobia during mid childhood is usually predicted by shyness and behavioural inhibition early on and the diagnosis first made in early adolescence, the primary symptoms involve extreme social discomfort and self-consciousness, preferring to spend time with adults rather than peers, and physiological reactions in social settings (Huberty, 2012a). Generalized anxiety disorder, on the other hand, is not limited to social situations and is manifested as uncontrollable worry about daily functioning and future, doubts in efficacy, and competence in various social situations including school, and perfectionism (Huberty, 2012a).

Although not common, the age of onset of obsessive-compulsive disorder as a subtype of anxiety disorder is also reported to be in middle childhood, between the ages of 10 to 12 (Huberty 2012a). The primary symptoms should be differentiated from non-symptomatic childhood rituals that involve repetition of the same behaviour in specific contexts, which dissipates at the age of around 9 (Huberty, 2012a). Behavioural manifestations of it in children are similar to the ones that occur in adults and involve intrusive thoughts about specific objects/situations such as germs and illness, time consuming repetition of behaviour such as hand washing, and the degree of distress if the ritual is prevented or interrupted (Huberty 2012a).

Post traumatic stress disorder can occur at any age in children and adolescents based on idiosyncratic life experiences; and can develop either soon after the traumatic event or later due to chronic exposure and gradual stress (Huberty, 2012a) and cognitive maturity, which determines formation of meaning around the traumatic event (Nader, 2011). The behavioural manifestations during childhood are similar to that of adults and include concentration problems, trouble in sleeping, hypervigilance, numbing of responsiveness, and cognitive re-enactment of the traumatic event (Huberty, 2012a).

During adolescence (age between 12 and 18), the formerly developed anxiety disorders, especially generalized anxiety disorder, social phobia, and specific phobia, appear to persist (Costello et al. 2011; Huberty, 2012a). In addition, age of onset of panic disorder is specific to adolescence period; reported to be during late adolescence years and occurs less frequently during childhood (Huberty, 2012a). The behavioural manifestations include heart palpitations, sweating, shaking, fears of dying, loss of control, and the fear of having panic attack (Huberty, 2012a).

Even though anxiety symptoms are known to wax and wane, researchers point out that anxiety is carried over from childhood to adolescence (Costello, Copeland, & Angold, 2011) and especially from adolescence to adulthood by getting stronger (Craske & Waters, 2005; Gregory et al., 2007; Costello et al., 2011).

This temporal persistence could be in the form of stability in diagnosis or symptoms. For example, social phobia was found to have the strongest persistent continuity from late childhood to early adolescence (Ferdinand, Dieleman, Ormel, & Verhulst, 2007). This is in accordance with Pine and colleagues' (Pine, Cohen, & Brook, 2001) results on social anxiety continuity from adolescence to adulthood.

Also, the presence of clinical anxiety during childhood is deemed as a precursor of forthcoming disorders later in life (Wehry, Beesdo-Baum, Hennelly, Connolly, & Strawn, 2015). Consequently, it becomes a predicting factor for the occurrence of other disorders and problems such as depression and substance abuse (Beesdo et al., 2009; Woodward & Fergusson, 2001). Former anxiety diagnosis leading to another diagnosis was supported by a longitudinal study (Last, Perrin, Hersen, & Kazdin, 1996) such that children in the anxiety group had gained new anxiety or other disorders during the two-year follow up. The same study also showed that prior anxiety linked disorder persisted in the anxious children since one in third of them still had a disorder at the end of the follow up (Last et al., 1996). Likewise, a more recent study also supported that anxiety predicts prospective occurrence of other disorders by showing longitudinal links between anxiety and consecutive depression (Copeland, Shanahan, Costello, & Angold, 2009).

Comorbidities are also very common in paediatric anxiety. Oftentimes other anxiety subtypes accompany a principal anxiety disorder (Kendall et al., 2010). But anxiety has the highest comorbidity rate with depression in youth (Brady & Kendall, 1992; Cummings, Caporino, & Kendall, 2014), which ranges from 28 – 53.7% (O'Neil, Podell, Benjamin, & Kendall, 2010) and results in greater impairment than primary anxiety diagnosis (Cummings et al., 2014).

How anxious youth respond to treatment is also a marker of anxiety prognosis. Remission rates appear to fluctuate among studies. However, low remission rates in the long term are not uncommon. For example, 73% of childhood and adolescents had an anxiety disorder or depression after 10-year follow up despite their initial improved anxiety (Beesdo-Baum & Knappe, 2012), which suggests that anxiety is recurrent over time.

1.2. Anxious Children's Cognition: Information Processing Biases

Given that anxiety is one of the most prevalent and debilitating disorders in childhood, qualifying anxious children's neurological response style, cognitive profiles, how they cope with anxiogenic emotions, and how all these are manifested in their behaviour have been a longstanding interest for developmental psychopathology researchers. With the rise of cognitive-behavioural approaches, childhood models of anxiety have shown great acknowledgement of how anxious children's cognition operates.

1.2.1. Anxious Children's Minds: Threat Schemas, Dysfunctional Reasoning Patterns, and Biased Threat Processing

According to Beck and Clark's (1988; 1997; 2010) influential schema-based cognitive theory of anxiety and depression, cognitive processes are necessary for emotion generation as well as generation and maintenance of maladaptive emotions, which lead to emotional disorders. The theory states that the representations of our prior knowledge and experiences are called schemas. We process information by screening, encoding, organizing, storing, and retrieving in the light of our preexisting schemas (Beck & Clark, 1988; 1997). These schemas are activated in the presence of appropriate environmental stimuli. Correspondingly, Beck and Clark (1988) characterize anxiety with heightened appreciation of environmental cues, selectivity in detecting danger, and underestimation of personal capability in dealing with them.

Schemas are assumed to have a role in children's anxious cognition as well. Building upon Beck's work, Kendall and colleagues (Ingram & Kendall, 1987) have proposed a general cognitive theory of childhood anxiety. Accordingly, cognitive distortions are underlined by over-active danger related schemas, which consistently lead the individual to detect threat and finally result in dysfunctional behavioural circuits (Kendall, 1985; Kendall & Chansky, 1991). In line with this, empirical studies have shown that cognitive profiles of anxious children can be broadly characterised with abnormal threat perception (Dalgleish et al., 2003) underlined by sensitivity to threat (Ehrenreich & Gross, 2002).

Maladaptive thoughts and beliefs that result from dysfunctional thinking processes (Kendall, 1985) exemplify the frequency of anxious children's extraction of threat cues in the ordinary. Studies employing Children's Negative Error Cognitive Questionnaire (CNECQ, Leitenberg, Yost, & Carroll-Wilson, 1986) have reported that both trait anxious (Maric, Heyne, van Widenfelt, & Westenberg, 2011; Schwartz & Maric, 2015; Watts & Weems, 2006; Weems, Costa, Watts, Taylor, & Cannon, 2007) and clinically anxious (Weems, Berman, Silverman, & Saavedra, 2001) children typically have reasoning distortions in favour of danger exaggeration such as catastrophising, overgeneralizing the results of one single negative event, take responsibility for negative events and indulge in self accusation, and focus on only a negative aspect of a situation.

The literature remains inconclusive as to whether this distorted thinking is specific to anxiety or some of them are also shared by children with depression (Schwartz & Maric, 2015). However, working on and modifying these dysfunctional thinking patterns (i.e., cognitive restructuring) are an important part of the cognitive – behavioural treatments of anxiety (Alfano, Beidel, & Turner, 2002; Kendall, 1985, Clark & Beck, 2010; Manassis, 2013).

1.2.2. Crick and Dodge's (1994) Social Information Processing Model

In addition to the reasoning distortions above, extensive empirical research also highlight the role of prioritized processing of threatening information in the aetiology or maintenance of anxiety in youth (Field & Lester, 2010; Hadwin, Garner, & Perez-Olivas, 2006; de Jong, 2014; Manassis, 2013; Mathews, 1990; Muris & Field, 2008; Weems & Watts, 2005).

What underlies production or maintenance of threat-related dysfunctional belief systems and biases in threat processing require co-operation of several different cognitive processes such as attention, learning, memory, and decision making (Beck & Clark, 1997, Crick & Dodge, 1994; Dodge, 1991). Therefore, information processing models are valuable as they offer description of how cognitive processes with emotional input are associated with each other and how they shape behaviour. Correspondingly, cognitive theories of anxiety consistently highlights the role of information processing in explaining the aetiology of both childhood and adult anxiety (Alfano et al., 2002; Muris & Field, 2008).

Characterizing and describing how information processing unfolds in children and which processing biases nest in the corresponding information processing stages is crucial for developing appropriate assessment methods and targeting these distortions during treatment (Bijttebier, 2003; Ehrenreich & Gross, 2002; Daleiden & Vasey, 1997; Muris & Field, 2008). Also, examining age related changes and the factors related to the emergence of information processing biases during development are important to get a better grasp of child psychopathology (Hadwin et al., 2006).

In that regard, Crick and Dodge's (1991, 1994) Social Information Processing Theory outlines a step-wise prescription of how cognition operates during information processing. It has been recognized by many (Bijttebier, 2003) since the likely distortions in the processing stages provide explanations of what underpins occurrence of disruptive behaviour in children such as externalizing behaviours, (Lansford et al., 2006); depression, (Luebbe, Bell, Allwood, Swenson, & Early, 2010); autism spectrum disorders, (Mazza et al., 2017); and social competence and school readiness (Ziv, 2013).

According to the model, children process information through 6 steps: (1) encoding; (2) interpretation; (3) goal construction; (4) response access; (5) response decision; and (6) enactment. In the encoding stage, children select the information to focus on and start the processing. The interpretation stage involves attaching a meaning to the information by referring to the previous schema database in the long-term memory. In the goal clarification stage, the tendency to behave in a certain way based on arousal occurs. During the response access, children examine their previous experiences to find the most approprite reaction to the situation. Finally, they decide on a response and the enactment based on the choice occurs (Crick & Dodge, 1994).

1.2.3. Formulation of Anxious Children's Information Processing Biases for Threat

Although Crick and Dodge's (1994) model has received substantial recognition, a framework specific to how threatening information is processed by children with anxiety was much needed. By extending their work, Daleiden and Vasey (1997) proposed a model to explain how threat-related schemas and biases may manifest itself through information processing stages by combining Kendall's (Kendall & Chansky, 1991) cognitive theory of childhood anxiety with Crick and Dodge's (1994) model. By examining the results of the converging empirical research with anxious children, they outlined how anxiety typically occurs on different stages of the process.

In the original model (Crick & Dodge,1994; Dodge, 1991); the processing starts with encoding, which involves reception of internal or external stimuli and entry of the most relevant/salient stimuli to the processing system. Accordingly, Daleiden and Vasey (1997) postulated that the encoding stage entails selective attention to threat cues. This bias that takes place on the attentional level and *attention bias* for threat occurs (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & IJzendoorn, 2007). Numerous research have shown that anxious children process threatening information differentially, either compared to their non anxious counterparts (Dalgleish, Moradi, Taghavi, Neshat-Doost, & Yule, 2001; Reid, Salmon, & Lovibond, 2006; Roy et al., 2008) or compared to neutral information (Hunt, Keogh, & French, 2007; Waters & Lipp, 2008a; Waters & Lipp, 2008b). Literature also confirms that anxious children are vigilant to threat (Hadwin et al., 2003) and spend relatively little time to decide that something is threatening (Waters, Wharton, Zimmer-Gembeck, & Craske, 2008).

Interpretation stage involves assessment of the situation and making inferences about it based on prior experiences stored in the long-term memory (Crick & Dodge, 1994; Dodge, 1991). At this stage (Daleiden & Vasey, 1997), anxiety manifest itself by interpreting ambiguous situations as threatening and so *interpretation bias* takes place (Bögels, Snieder, & Kindt, 2003; Creswell & O'Connor, 2006; Muris, Kindt et al., 2000; Muris, Merckelbach, & Damsma, 2000). Accordingly, empirical research revealed that anxious children prefer to use threatening meaning of homograph words (e.g., arms) rather than neutral meaning in sentences (Taghavi, Moradi, Neshat-Doost, Yule, & Dalgleish, 2000); and they better match physical symptoms of anxiety with anxious emotion (Muris, Mayer, Freher, Duncan, & van den Hout, 2010).

Because prior experience is an important factor that shapes the way we interpret a situation, danger interpretation is intrinsically linked with pre-existing danger schemas. Therefore, memory is inevitably at play at the interpretation stage (Muris & Field, 2008; Weems & Watts, 2005). The propensity of remembering more negative information rather than positive information in congruence with negative emotional state is called *memory bias* (Muris & Field, 2008). In support of this, literature has shown that anxious children recall more negative words or fewer positive words after being presented a mixture of words (Dalgleish et al., 2003; Moradi, Taghavi, Neshat-Doost, Yule, & Dalgleish, 2000; Vassilopoulos, 2012; Watts & Weems, 2006; Reid et al., 2006), and interestingly show superior recognition of faces with negative expressions (Foa, Gilboa-Schechtman, Amir, & Freshman, 2000).

Goal clarification involves psycho-physiological arousal that the meaning of the situation brings and requires determination of what to do within the corresponding situation (Crick & Dodge, 1994). As for anxiety, it is typically motivated by escape from danger and behavioural avoidance to reduce anxious arousal (Daleiden & Vasey, 1997). During response construction, anxious children refer to their previous experiences regarding how they had coped with similar stimuli/situations before, which usually consist of avoidant behaviours (Daleiden & Vasey, 1997). Following these, response selection and enactment comprising of avoidant strategies take place. There is no bias type that is thought to occur specifically within these final three stages. However, considering that danger schemas need to be accessed to determine what to do and how to do in threatening situations, long term memory should be at play (Crick & Dodge, 1994). Therefore, it is safe to assume that memory bias for threat is in operation also during these stages.

The processing stages and different biases observed within these stages allow examining the potential contingency between these biases. Weems and Watts (2005) have posited that there may be a temporal mediational association between these biases. A similar integration approach was also embraced by Muris and Field (2008). Accordingly, cognitive distortions leading to anxiety starts with attention bias with selective encoding of threat into the system. This in turn awakens memories related to danger and results in increased stream of negative memories. Information recalled from these memories lead biases in interpretation. The interaction between memory bias and interpretation bias can also result in newly created danger schemas.

So, as part of a bigger system, attention bias appears to have a pivotal role among other cognitive biases as it determines what information will be entered to the system for further processing. Furthermore, if indeed there is a contingency between the biases, attention bias has the potential to modulate the following processing stages, which would ultimately impact the efficiency of response style to the threatening information. Therefore, among all cognitive biases in childhood anxiety, the focus of this thesis is on attention bias for threat.

1.3. Significance of Attention Bias for Threat in Anxious Children

1.3.1. The Association Between Attention Bias and Anxiety

Attention by nature is selection of some information over other information (Weierich, Treat, & Hollingworth, 2008) that is relevant to the goal of the individual (Chica, Bartolomeo, Lupiáñez, 2013) since limited cognitive capacity requires selection of information for further processing (Desimone & Duncan, 1995). Therefore, the stimuli in the environment are in competition to draw attention to be taken into the processing system. Yet, according to the biased competition model (Desimone & Duncan, 1995), ultimate stimulus selection is biased in favour of the stimulus that is relevant to the one's concurrent goal. In contrast, attention bias (AB) occurs as persistent and prioritized processing of a specific stimulus, that may not necessarily be aligned with one's goal at hand.

It has been observed for disorder-related types of stimuli in various problematic behaviours (e.g., substance addiction, Wetherill et al., 2014; Noël et al., 2006; obesity, Castellanos et al., 2009; sexual violence, Smith & Waterman, 2004; smoking, Hogarth, Mogg, Bradley, Duka, & Dickinson, 2003).

Within the context of anxiety, the most salient stimulus type is threatening/danger signalling stimulus for anxious people, and anxious people have long been known with their hypervigilance and selective attention towards threat. Three decades of empirical research have shown that AB for threat is a robust phenomenon in both anxious adults (Bar-Haim et al., 2007; Cisler, Bacon, & Williams, 2009; Cisler & Koster, 2010; Richards, Benson, Donnelly, & Hadwin, 2014) and youth populations (Bar-Haim et al., 2007;

Dudeney, Sharpe, & Hunt, 2015; Ehrenreich & Gross, 2002; Puliafico & Kendall, 2006).

For example, AB for threat has been evidenced in children with various anxiety disorders such as spider phobia (Kindt & Brosschot, 1998; Kindt, van den Hout, de Jong, & Hoekzema, 2000; Klein, Becker, & Rinck, 2011), social anxiety (Pergamin-Hight, Bitton, Pine, Fox, & Bar-Haim, 2016; Fitzgerald, Rawdon, & Dooley, 2016; Seefeldt, Kramer, Tuschen-Caffier, & Heinrichs, 2014; Stirling, Eley, & Clark, 2006), post-traumatic stress disorder (Bertó et al., 2017; Dalgleish et al., 2001; Ribchester, Yule, & Duncan, 2010), generalized anxiety disorder (Monk et al., 2006, Monk et al., 2008; Taghavi, Dalgleish, Moradi, Neshat-Doost, & Yule, 2003), and separation anxiety (Perez-Olivas, Stevenson & Hadwin, 2008; Price et al., 2014).

In addition, it is well documented that not only children with anxiety disorders but also high trait anxious children manifest AB for threat (Broeren, Muris, Bouwmeester, Field, & Voermann, 2011; Hadwin et al., 2003; Hadwin, Donnelly, Richards, French, & Patel, 2009; Helzer, Connor-Smith, & Reed, 2009; Reinholdt-Dunne, Mogg, Esbjørn, & Bradley, 2012; Richards, Richards, & McGeeney, 2000; Waters, Kokkoris, Mogg, Bradley, & Pine, 2010).

Meta-analytic examinations with respect to the discussions around whether AB for threat is a real phenomenon in anxiety reported significant medium to large effect sizes. Bar-Haim and colleagues' (2007) seminal meta-analysis reported that effect size of AB for threat in anxious adults is d = 0.45 and in anxious youth is d = 0.50. In addition, Dudeney and colleagues' (2015) recent meta-analysis also supported significance of AB in anxious children and adolescents with similar effect size rate (*d* = 0.54).

AB can be defined in two different contexts. It could be one's differential processing of neutral information compared to threatening information (Dagleish et al., 2003; Hankin, Gibb, Abela, & Flory, 2010; Legerstee et al., 2009; Reinholdt-Dunne et al., 2012; Susa, Pitică, & Benga, 2008, Waters, Bradley, & Mogg, 2014) as well as differential threat processing of anxious individuals compared to non-anxious individuals (Hankin et al., 2010; Martin & Jones, 1995; Monk et al., 2006; Richards et al., 2000; Richards, French, Nash, Hadwin, & Donnelly, 2007). Bar-Haim and colleagues' meta-analysis study (2007) reported that the effect sizes of both within-subjects bias and between-groups bias are significant with medium strength (*d* = .45 and *d* = .41 respectively), which suggests that both can be markers of anxiety.

In alignment with the reported medium to large strength, AB for threat has been seen as a key concept in understanding anxiety. It is assumed to play a role in at least maintenance and enhancement of anxiety (Van Bockstaele et al., 2014). Interestingly, there are also studies which reported that inducing AB for threat increases anxiety vulnerability, in which case AB may also have a causal role on anxiety (Cret, 2013; Eldar, Ricon, & Bar-Haim, 2008; MacLeod, Rutherford, Campbell, Ebsworthy, & Lin, 2002; Van Bockstaele et al., 2014).

1.3.2. Targeting Attention Bias in Anxiety Treatment

Since AB is recognized as a maintaining or a causal factor in anxiety development, altering biased attentional processing or eliminating it have been implicated in anxiety treatment (Mogg & Bradley, 1998, Mobini & Grant, 2007). But the treatment approaches towards AB depend on understanding how attention captures threatening information.

If threat capture is effortful and conscious, then addressing anxious individuals' distorted threat appraisals during verbal therapy is suggested to work (Beck & Clark, 1997; McNally, 1995; Mobini & Grant, 2007). However, if the threat capture is automatic, unconscious, and effortless, then the effectivity in eliminating this pattern in verbally mediated therapies appears to be questionable since their controllability is limited (McNally, 1995; Mogg & Bradley, 1998).

A novel treatment technique called attention bias modification technique (ABMT) have the potential to fill this gap, such that it can target automatic threat related ABs in a cost-effective manner in developmental cohorts (Bar-Haim, Morag, & Glickman, 2011; Eldar et al., 2012; Waters, Pittaway, Mogg, Bradley, & Pine, 2013) as well as adults (Amir, Beard, Burns, & Bomyea, 2009; Brosan, Hoppitt, Shelfer, Sillence, & Mackintosh, 2011; Koster, Baert, Bockstaele, & De Raedt, 2010). Since anxious people are typically characterised as being sensitive to threatening information and vigilant to threat cues in the environment, the ABMT technique is typically based on the expectation that training individuals to shift their attention away from threat would reduce anxiety symptoms since the first chain of maladaptive threat appraisal gets broken.

Meta-analyses of ABMT randomized controlled trials suggest that application of this technique is a fruitful endeavour to reduce pre-treatment anxiety symptoms ($0.36 < d < 1.00$) as well as pre-treatment AB for threat ($0.85 < d < 1.16$) (Hakamata et al., 2010; Linetzky, Pergamin-Hight, Pine, & Bar-Haim, 2015).

However, extant body of ABMT research is not far from inconsistencies as there are studies which suggest that ABMT is not significantly effective on reduction of anxiety symptoms (De Voogd, Wiers, Prins, & Salemink, 2014; Fitzgerald et al., 2016; Pergamin-Hight, Pine, Fox, & Bar-Haim, 2016).

The reason behind this inconsistency could be the heterogenous structure of AB. As will be discussed in detail in the previous sections, AB is not a simple construct and the directionality of AB (i.e., towards, away from, persistent maintenance on threat) is highly influenced by the way its formulated and measured. Therefore, AB as a generic concept will be referred as AB *for* threat or only AB within the scope of this thesis, unless the directionality of AB is addressed specifically.

1.4. Theories of Attention Bias

Plenty of theories have been postulated regarding how evaluation of threatening stimuli in anxious individuals lead to differential attentional allocation compared to non-anxious individuals by proposing various cognitive mechanisms. The most influential ones that have guided empirical research were selected for review below and the diagrams in Figure 1.1. display other theories as well.

1.4.1. Early Models of Attention Bias

Williams and colleagues (1988, 1997)

In Williams and colleagues' model (Williams, Watts, MacLeod, & Mathews, 1988, 1997 as cited in Yiend, 2010), two structures underlie attentional processing of emotional information. Affective decision mechanism determines the emotional value of stimulus while resource allocation mechanism determines how attentional resources would be allocated on stimuli. The model predicts that automatic vigilance for threatening stimuli is characteristic to trait anxiety while elongated elaboration for emotional value of stimuli is related to depression. Accordingly, the model predicts that increased threat value of a stimulus or increased anxiety levels is related to greater vigilance for threat; however, low trait anxious individuals can suppress their AB for threat through increased effort for processing task relevant stimuli and display avoidance away from threat (Williams et al., 1998, 1997 as cited in Mogg & Bradley, 2016).

Cognitive – Motivational Model (Mogg & Bradley, 1998)

Similarly, Mogg and Bradley's (1998) cognitive – motivational model also postulates two structures responsible for stimuli evaluation and consequent responding. Accordingly, the valence evaluation system, which is underlined by neurological structures involved in anxiety, is responsible from the initial threat appraisal. If the information is determined to be highly threatening, goal engagement system allocates resources on threat for further processing (Mogg & Bradley, 1998). The difference between William and colleagues' model is the detailed emphasis on the reappraisal process. As such, Mogg and Bradley (1998) argue that even mildly threatening stimulus may be found subjectively more threatening by high anxious individuals and they may be more vigilant towards them as a sign of anxiety vulnerability. On the other hand, in the presence of high threat, low trait anxious individuals can also show vigilance because of adaptive processing.

Critically, the model also offers explanation on the role of directionality of AB in experiencing and sustaining anxious emotion. So, high anxious individuals' vigilance may be followed by avoidance away from threat to reduce discomfort caused by anxiety with repeated shifts towards and away from threat. In the long term, this pattern may increase anxiety sensitivity since thorough appraisal of threat value during the vigilance stage is interrupted by the following avoidance (Mogg & Bradley, 1998). In contrast, when low anxious individuals evaluate the threat value of the stimuli as minor during the initial appraisal stage, they may show avoidance away from threat to allocate their attentional resources on more relevant stimuli.

Future Detection Model (Öhman & Wiens, 2004)

On the other hand, Öhman and Wiens' feature detection model (Öhman & Wiens, 2004) views automatic selective attention to threat as an adaptive outcome of evolution process. Selective attention to biological threats (e.g., snakes, spiders, angry faces) serves to keep individuals alive, therefore everyone shows AB to these types of danger signalling stimuli (Öhman, 1996, cited in Cisler & Koster, 2010; Mogg & Bradley, 2016). However, anxious individual's irrational threat appraisal underlined by their more sensitive fear module (i.e., a fear evaluation system formulated to have neurological, mental, behavioural elements in the model) lead to greater AB towards threat compared to non-anxious individuals.

Matthews and Mackintosh (1998)

Matthews and Mackintosh's model (1998) have postulated that threat stimulus is a distractor against target stimulus and they both compete for attention. Ultimately, one's anxiety level determines what will be focused. So, the model agrees with the other accounts above on the grounds that it is anxiety that magnifies threat value of stimulus and vigilance towards threat occurs. Notably, like Williams and colleagues' (1988, 1997), the authors also pinpoint the role of effort to suppress AB.

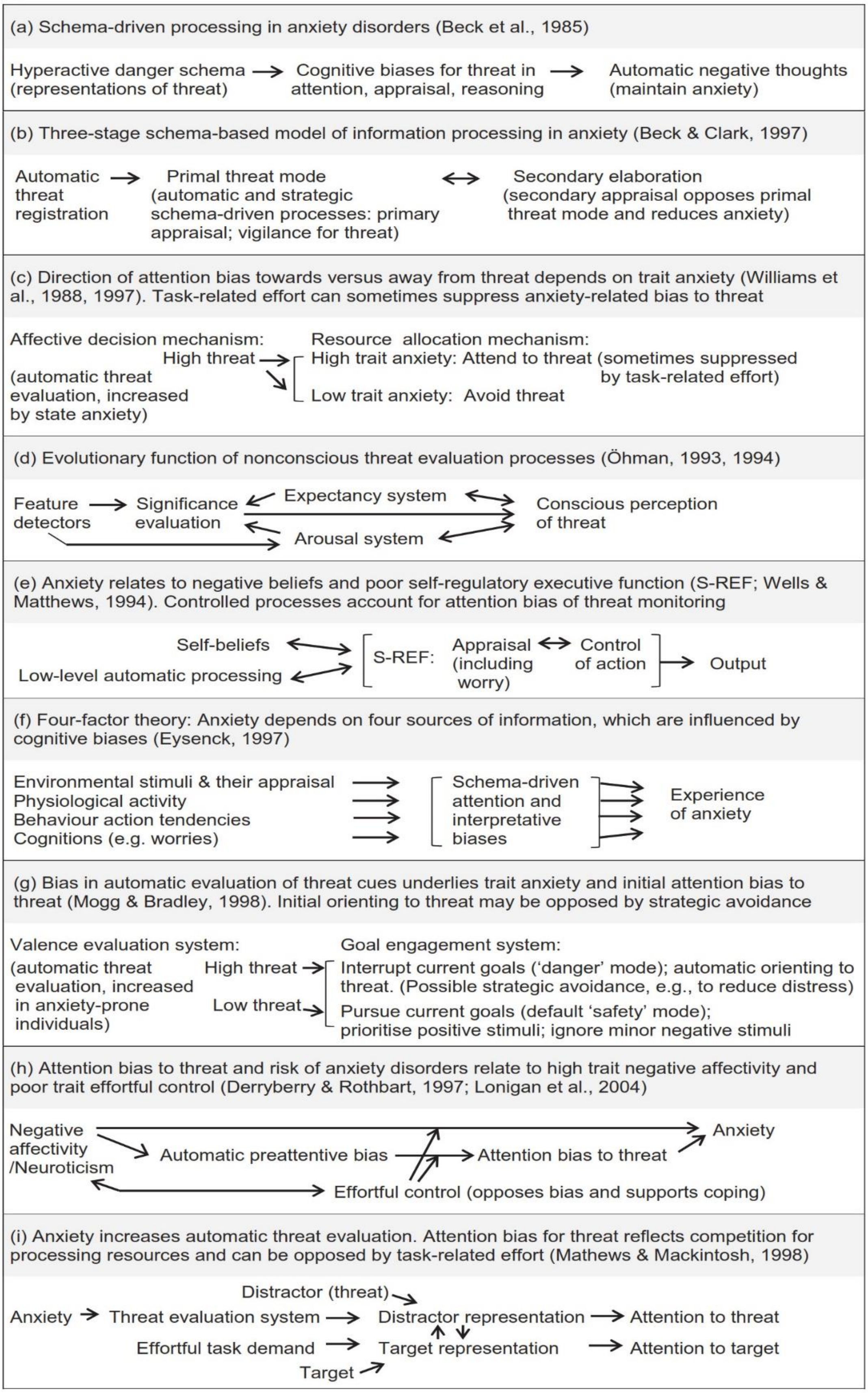
As such, the model predicts that anxious people can exert voluntary control over threat through activation of target representation when task is highly demanding. Therefore, they may inhibit threat interference and put voluntary effort on the direction of attention to increase attention on the stimulus related to task demand (Field & Lester, 2010; Matthews & Mackintosh, 1998; Mogg & Bradley, 2016).

Wells and Matthews (1994)

In contrast to the views that argue that anxiety magnifies threat value of stimulus and anxious individuals display vigilance towards threat, Wells and

Matthews (1994) suggested that AB may be an outcome of strategic processing rather than automatic processing. In their Self-Regulatory Executive Function (S-REF) Model, S-REF mechanism stands in the core; and the initial automatic processing and the beliefs around threat activates S-REF. S-REF, which is guided by self-beliefs in relation to features of the encountered stimulus, determines direction of attention as a form of coping strategy (Matthews & Wells, 2000). Accordingly, this is reflected as conscious and voluntary monitoring of environment against threat in anxious people as a maladaptive attentional control strategy (Cisler & Koster, 2010).

Although the model acknowledges the role of automatic processing; this initial system only serves to feed information into S-REF. Therefore, it stands out from the other models such that AB for threat is formulated as impaired strategic processing underlined by attentional control rather than automatic threat capture (Cisler & Koster, 2010).


(a) Schema-driven processing in anxiety disorders (Beck et al., 1985)
Hyperactive danger schema (representations of threat)
Cognitive biases for threat in attention, appraisal, reasoning
Automatic negative thoughts (maintain anxiety)
(b) Three-stage schema-based model of information processing in anxiety (Beck & Clark, 1997)
Automatic threat registration
Primal threat mode (automatic and strategic schema-driven processes: primary appraisal; vigilance for threat)
Secondary elaboration (secondary appraisal opposes primal threat mode and reduces anxiety)
(c) Direction of attention bias towards versus away from threat depends on trait anxiety (Williams et al., 1988, 1997). Task-related effort can sometimes suppress anxiety-related bias to threat
Affective decision mechanism:
High threat
(automatic threat evaluation, increased by state anxiety)
Resource allocation mechanism:
High trait anxiety: Attend to threat (sometimes suppressed by task-related effort)
Low trait anxiety: Avoid threat
(d) Evolutionary function of nonconscious threat evaluation processes (Öhman, 1993, 1994)
Feature detectors
Significance evaluation
Expectancy system
Arousal system
Conscious perception of threat
(e) Anxiety relates to negative beliefs and poor self-regulatory executive function (S-REF; Wells & Matthews, 1994). Controlled processes account for attention bias of threat monitoring
Self-beliefs
Low-level automatic processing
S-REF:
Appraisal (including worry)
Control of action
Output
(f) Four-factor theory: Anxiety depends on four sources of information, which are influenced by cognitive biases (Eysenck, 1997)
Environmental stimuli & their appraisal
Physiological activity
Behaviour action tendencies
Cognitions (e.g. worries)
Schema-driven attention and interpretative biases
Experience of anxiety
(g) Bias in automatic evaluation of threat cues underlies trait anxiety and initial attention bias to threat (Mogg & Bradley, 1998). Initial orienting to threat may be opposed by strategic avoidance
Valence evaluation system:
(automatic threat evaluation, increased in anxiety-prone individuals)
High threat
Low threat
Goal engagement system:
Interrupt current goals ('danger' mode); automatic orienting to threat. (Possible strategic avoidance, e.g., to reduce distress)
Pursue current goals (default 'safety' mode); prioritise positive stimuli; ignore minor negative stimuli
(h) Attention bias to threat and risk of anxiety disorders relate to high trait negative affectivity and poor trait effortful control (Derryberry & Rothbart, 1997; Lonigan et al., 2004)
Negative affectivity /Neuroticism
Automatic preattentive bias
Attention bias to threat
Anxiety
Effortful control (opposes bias and supports coping)
(i) Anxiety increases automatic threat evaluation. Attention bias for threat reflects competition for processing resources and can be opposed by task-related effort (Mathews & Mackintosh, 1998)
Distractor (threat)
Anxiety
Threat evaluation system
Distractor representation
Attention to threat
Effortful task demand
Target representation
Attention to target
Target

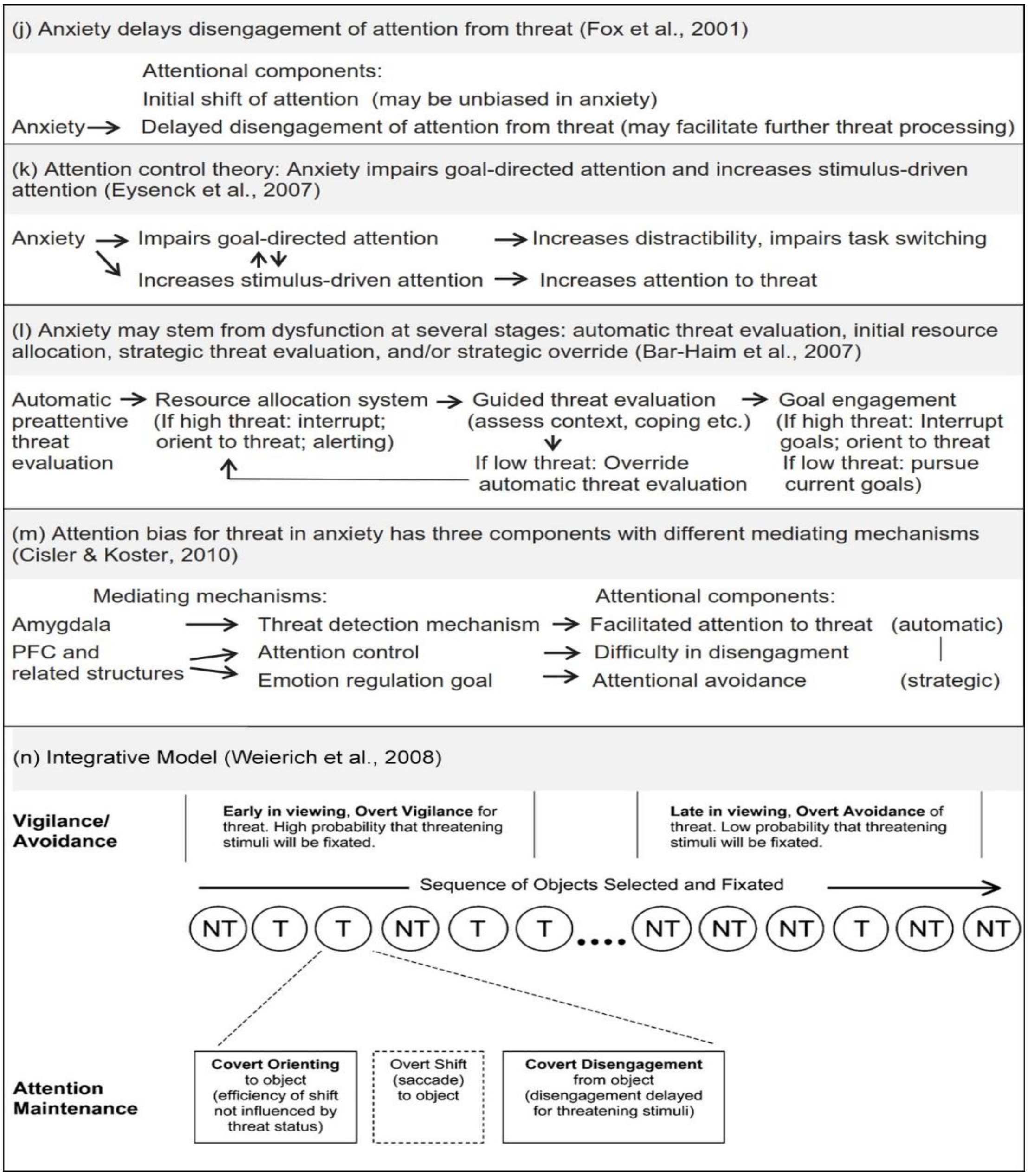


Figure 1.1. Models of Attention Bias in Anxiety (adapted from Mogg & Bradley, 2016 and Weierich et al., 2008).

Attentional Maintenance Model (Fox, Russo, Bowles, & Dutton, 2001)

According to Fox and colleagues' Attentional Maintenance Model (2001), what differentiates anxious individuals from non-anxious individuals is not rapid detection of threat, but their difficulty in disengaging attention from threat (Fox et al., 2001). In support of this, they argue that initial detection of threat depends on threat value of stimulus; however, personal anxiety levels determine the length of attentional maintenance on threat stimulus (Fox, 2004). The way Fox and colleagues (2001) view AB poses a strong contrast to the other models. However, they have provided an effective perspective to understand the diversity in AB with respect to components of attention.

1.4.2. New Age Models

Attentional Control Theory (Eysenck, Derakshan, Santos, & Calvo, 2007)

The fundamental assumption of Eysenck and colleagues' Attentional Control Theory (2007) is that anxiety impairs cognitive performance through attentional processes. The model embraces the difference between goal-driven, controlled attentional system and stimulus-driven, automatic attentional system (Corbetta & Shulman, 2002). It states that anxiety impairs attentional control and thus stimulus-driven attentional system overrides goal-driven attentional system, resulting in allocation of attentional resources on threat stimulus rather than the task related stimuli at hand (Eysenck et al., 2007). Remarkably, based on Miyake's (2000) influential work, Eysenck and colleagues (2007) have also proposed that inhibition and shifting executive functions are involved in attentional control operations. Accordingly, impaired inhibition cannot interfere with overactive stimulus-driven system and anxious people become more distracted by threat (Eysenck et al., 2007). In addition, impaired shifting does not allow attention to be allocated on the most relevant stimulus flexibly and effectively; and this may result in difficulty in disengaging attention from threat.

Bar-Haim and Colleagues (2007)

Bar-Haim and colleagues (2007) formulated a model which integrates the proposals of the previous theories to close the gap between empirical research and existing theories of AB based on the results of their seminal meta-analysis. Their model consists of mechanisms that operate during the timeline of automatic to strategic attentional processing stages.

Critically, Bar-Haim and colleagues (2007) postulated that AB can be result of a deficit in any of these mechanisms, which is distinct from especially the early automatic attentional threat capture models. Accordingly, initial capture of even mildly threat could be one form of AB, but allocating resources on threat for further evaluation, and perseverance of heightened threat value even at the conscious level of processing can lead to biased attention (Bar-Haim et al., 2007).

Weierich and colleagues (2008)

As discussed in the previous section, there is discrepancy between Mogg and Bradley's (1998) cognitive-motivational hypothesis and Fox and colleagues' (2001) attentional maintenance model. Indeed, some empirical evidence showed that anxious individuals, especially anxious adults, show vigilance towards threat followed by later avoidance (Cooper & Langton, 2006; Mogg & Bradley, Miles, & Dixon, 2004; Koster, Crombez, Verschuere, Van Damme, & Viersema, 2006). On the other hand, some other studies evidenced disengagement difficulty (e.g., Amir, Elias, Klumpp, & Przeworski, 2003; Compton, 2000; Koster, Crombez, Verschuere, & De Houwer, 2004; Salemink, van den Hout, & Kindt, 2007).

With respect to this discrepancy, Weierich and colleagues (2008) have argued that this divergence stems from methodological differences across studies such that they capture a different component of attention. Consequently, they have synthesized two competitive hypotheses as each theory represents a different component of attention. Therefore, the theories can be reconciled within one single episode of threat stimulus viewing on a voluntary vigilance-attentional maintenance-attentional avoidance continuum. According to the model (Weierich et al., 2008), initial threat detection is a result of voluntary/conscious scanning of the environment. Once threat is detected, anxious people would have longer dwell times on threat which means difficulty in disengaging from threat. Attentional avoidance follows successful disengagement from threat.

Cisler and Koster (2010)

Cisler and Koster (2010) argue that the heterogeneity in the components of AB for threat may stem from the underlying mediating mechanisms. According to their model, attentional processes operate in parallel to the suggested mediating mechanisms. The result is three types of AB mentioned above over the course of automatic and strategic processes. Facilitated attention for threat is mediated by amygdala activation and considered to take place during automatic processing. Disengagement difficulty, on the other hand, is thought to be linked with attentional control, yet whether it is underlined by automatic or strategic processing or both is not clearly known. Finally, attentional avoidance is formulated to be a strategic process which is linked with emotion regulation strategy use (Cisler & Koster, 2010).

1.4.3. Discussion

Attempts to obtain a thorough explanation of AB have been highly influenced by the mainstream attention literature. Consequently, the knowledge on mechanisms of attention orientation and what controls attention orienting have been translated into the field of AB for threat.

According to Posner and colleagues' highly influential Attentional Systems Theory (Posner, Inhoff, Friedrich, & Cohen,1987), attention orienting has three components: a) shifting (i.e., spatial relocation of the attention); b) engaging with new target (i.e., selection and processing of a stimulus); c) disengagement from the target attended (i.e., selection or processing of the stimulus has finished or inhibited) (Posner et al., 1987; Yiend, 2010).

By this standard, anxious people should show AB during one or more of these attentional components while they are in operation. However, what constitutes anxious people's attentional focus, how long they look at threat, and where they shift their attention to in the presence of threatening information has been a longstanding debate for AB researchers. Notably, especially theories framed before 2000 do not account for all the components of attention. Given that attention is a dynamic process spanning from automatic selective attention to more effortful and controlled focuses or shifts, early models of AB appear to have a restricted perspective for mapping the dynamicity in the direction and focus of attention into AB for emotional stimuli.

Each model highlighted a different attentional component in a piece meal fashion such as automatic vigilance (Öhman & Wiens, 2004; Matthews & Mackintosh, 1998; Mogg & Bradley 1998; Williams et al., 1988), strategic vigilance for monitoring (Wells and Matthews, 1994), greater attentional maintenance on threat underlined by disengagement difficulty (Fox et al., 2001), or avoidance away from threat in anxious individuals following vigilance (Mogg & Bradley,1998).

Abundance of empirical work indeed evidenced vigilance towards threat in both anxious youth and adults (Calamaras, Tone, & Anderson, 2012; Eldar et al., 2012; Hommer et al., 2014; Lindstrom et al., 2011; Montagner et al., 2016; Reinholdt-Dunne et al., 2012; Zvielli, Bernstein, & Koster, 2014). However, a similar voluminous body of work evidenced that they may have difficulties in disengaging attention away from threat (Amir et al., 2003; Fox et al., 2001; Fulcher, Mathews, & Hammerl, 2008; Pollak & Tolley-Schell, 2003; Zhang, Ni, Xie, Xu, & Liu, 2017) or they may avoid from threat (Carmona et al., 2015; Cooper & Langton, 2006; Pine et al., 2005; Salum et al., 2013; Schoorl, Putman, Van Der Verff, & Van Der Does, 2014; Waters et al., 2014; Zvielli et al., 2014). Therefore, the main shortcoming of the early models is not recognizing that AB for threat has components reflecting elements of attentional flow and that there might be heterogeneity among anxious individuals in the way it is manifested.

Exploring what controls attention orientation has the potential to explain how dynamic AB unfolds. According to attention literature, orienting attention to a stimulus can be realized through two different, but interlinked processes called stimulus-driven control of attention (i.e., selection of a stimulus based on its perceptual features such as emotionality, uniqueness, spatial location, or sudden appearance) and goal-driven control of attention (i.e., selection of stimulus which is relevant to our current behaviour and based on prior knowledge and expectations) (Corbetta & Shulman, 2002). Goal-driven/top-down attention is postulated to be effortful and conscious (Chica et al., 2013) since it involves operation of higher control systems (Yiend, 2010). Stimulus-driven attention, on the other hand, is postulated to be rather involuntary (Chica et al., 2013) since it operates as a reaction to salient features of stimuli. The interaction between these two systems is postulated to be responsible from where attention will be oriented to since top-down control of attentional selection it is not necessarily efficient on its own without attending to the salient features of stimuli (Desimone & Duncan, 1995; Yiend, 2010). Chica and colleagues (2013) have stated that these two attention systems may differ in the timeline of their operation, in that stimuli-driven attention is relatively rapid and does not sustain over time while goal-driven attention can be in operation for longer periods of time.

Consequently, more recent AB models guided by growing empirical research are more flexible in the way they conceptualize threat processing in relation to the course of automatic and strategic processing. While majority of the previous models somewhat rigidly limit biased attention to initial automatic threat detection and evaluation, new models encompass all the attentional components by linking how they might be related to the span of attention.

Especially, Bar-Haim and colleagues' (2007) and Cisler and Koster's (2010) models show recognition of the continuity between AB components based on the processing timeline from automaticity and strategy. Consequently, vigilance towards threat is tentatively believed to be underlined by stimuli-driven attention since what captures attention is the threatening property of stimulus. Therefore, vigilance is assumed to occur automatically (Armstrong & Olatunji, 2012; Cisler & Koster, 2010). On the other hand, maintained attention on and avoidance away from threat stimulus is hypothesised to be underlined by goal-driven attention since they require appraisal of threat after detection. Therefore, disengagement difficulty and avoidance are cautiously concluded to occur strategically during later stages of processing (Armstrong & Olatunji, 2012; Derryberry & Reed, 2002).

More importantly, the focus of new models is not restricted to the directionality of AB. To offer an understanding of the divergent AB patterns, their emphasis is on what modulates AB for threat in anxious individuals beyond anxiety (Cisler & Koster, 2010; Eysenck et al., 2007). Individuals can be grouped based on their different AB patterns within the same sample (e.g., Calamaras et al., 2012; Ho, Yeung, & Mak, 2017; Salum et al., 2013), which provides a generic support to the new AB models regarding the person-specific structure of AB. Accordingly, there could indeed be individual differences that lead to specific AB components to become more dominant. If this is the case, identifying modulating mechanisms has the potential to explain those individual differences and how they impact AB, which may ultimately lead to development of better anxiety treatment techniques including AB modification techniques.

1.4.4. AB Models Formulated for Youth Population

In addition to the anxiety related AB models formulated for adult populations above, there has been a number of AB models produced specifically for children and adolescent populations based on the calls (Ehrenreich & Gross, 2002; Puliafico & Kendall, 2006) for consideration of the impact of developmental variables on anxiety related AB for threat such as variations in cognitive abilities and temperament.

Hindered development of inhibition ability in anxious children: Kindt and Colleagues' (1997)

Kindt and colleagues' set of Stroop task studies (Kindt & Brosschot, 1998; Kindt & Brosschot, 1999; Kindt, Brosschot, & Everaerd, 1997; Kindt, Bögels, & Morren, 2003; Kindt et al., 2000; Kindt, Bierman, & Brosschot, 1997) with children reported quite interesting results by showing how cognitive development is involved in children's AB for threat. In their studies, they administered Stroop task with threatening and neutral stimuli, which requires naming the print colour of the word as quickly as possible while ignoring the semantic meaning. They found that all children under the age of roughly 10 showed Stroop interference (i.e., longer time to name the print colour of threat words) for threat regardless of anxiety levels (reading ability measured: Kindt, Bierman, et al., 1997; Kindt, Brosschot, et al.,1997; no report on test of reading ability: Kindt et al., 2000). However, this pattern diverged as children gets older such that only high anxious children showed Stroop interference (Kindt, Brosschot, et al.,1997; Kindt et al., 2000; Kindt, Bierman, et al., 1997).

The authors suggested that bias for threat is a common feature in early childhood. From middle to late childhood all children acquire executive inhibition ability and so they become better able to exert control over their selective attention by inhibiting attention to threat. However, anxiety hinders development of inhibition ability in anxious children. Therefore, the differences in biases for threat between anxious and non-anxious children gets greater as children gets older (Nightingale, Field, & Kindt, 2010).

Temperamental factors are involved in attention bias: Lonigan and colleagues' Temperamental Model (Lonigan, Vasey, Phillips, & Hazen, 2004)

Lonigan and colleagues (2004) have highlighted the role of temperamental factors in accounting for AB in children. They embraced Rothbart and colleagues' (Rothbart, Ahadi, & Evans, 2000) temperament model in their account and outlined interactions between reactive (i.e., negative and positive affectivity) and regulatory (i.e., effortful control) temperamental traits in producing AB for threat.

According to the model, having the propensity to feel negative affect is not enough to develop psychopathology on its own if effortful control ability is efficient (Lonigan et al., 2004). So, low effortful control ability is the key to develop anxiety. In line with this, the authors evidenced that high effortful control functions to shift attention away from threat stimulus despite negative affectivity; however, if both effortful control ability is poor and negative affectivity is high, AB occurs because reactive control overrides effortful control (Lonigan & Vasey, 2009).

A Cognitive – Learning Formulation of Youth Anxiety (Waters & Craske, 2016)

Waters and Craske (2016) recently proposed a stage-wise account of information processing model for youth anxiety by considering various factors such as cognitive learning processes, underlying neurological mechanisms, and their anxiogenic behavioural expressions. The model also accounts for how attention regulative processes, especially biased attention for threatening stimuli, are influenced by these mechanisms.

Accordingly, the *Stimulus Complex* stage involves exposure to numerous types of stimuli with varying emotional loads within a given situation. The following stage is the *Acquisition Processes*, where conditioning to highly threatening stimuli and generalization of what is threatening to similar types of stimuli are formed. These learning experiences have a reciprocal influence on the initial evaluation of threat value of a stimulus and biased attention for that stimulus during the initial stages of attentional processing. Initial attention bias at this stage involves activation of amygdala and ventral prefrontal cortex (Waters & Craske, 2016). Acquisition Processes is followed by *Internal Representation of Generalized Threat Salience*. At this stage, threatening values of stimuli within varying ranges become mental representations. The saliency strength of the threatening stimuli either activates spotlight of attention (i.e., highly salient threat) or margin of attention (i.e., mildly salient threat). In the following *Maintenance Processes*, the previously internalized knowledge on threatening stimuli is maintained through elaborative evaluation biases (i.e., interpretation biases) and strategic attention biases, which underpin regulation of attention either as threat avoidance (i.e., underlined by greater activation of ventrolateral prefrontal cortex) or threat monitoring (i.e., characterized with less activation of ventrolateral prefrontal cortex and greater activation of anterior cingulate cortex and medial prefrontal cortex). Notably, both ways of attention regulation are responsible for maintaining anxiety in anxious youth. The next stage called *Symptom Expression* accounts for how threat avoidance and monitoring is reflected on the symptoms of anxious youth. Accordingly, threat avoidance is associated with fear related anxiety disorders such as phobias, where behavioural avoidance and post-event cognitive distress and rumination are observed. Threat monitoring, on the other hand, is associated with sustained cognitive distress, rumination, and varied behavioural responses such as hesitant approach towards or avoidance of situations. The final stage called *Intra-Individual and Environmental Risk Factors* involves the factors (e.g., temperamental characteristics or sustained exposure to abuse) that contribute to previous threat related cognitive-learning pathways become persistent, which lead to pathological anxiety in turn (Waters & Craske, 2016).

1.4.5. Discussion

Kindt and colleagues' (Kindt, Brosschot, et al.,1997; Kindt et al., 2000; Kindt, Bierman, et al., 1997) cognitive inhibition hypothesis has encouraged AB researchers to consider age related effects underlined by ongoing cognitive development in developmental populations. However, empirical evidence is far from being conclusive as to whether all young children typically show AB for threat or anxious ones show greater bias towards threat from middle childhood onward.

For example, Brown and colleagues have shown that anxious 8-year-olds display avoidance from threat (Brown et al., 2013) while this pattern was also found in anxious older children in another study (Carmona et al., 2015). Interestingly, some other researchers could not find any age-related difference (Broeren et al., 2011) or effect of age at all (Roy et al., 2008; White et al., 2017) in their samples, which involved young children as well.

Likewise, given that temperament is one of the fundamental factors that impact various aspects of child development and adolescence (Morales, Pérez-Edgar, & Buss, 2015; Pérez-Edgar, Taber-Thomas, Auday, & Morales, 2014; Wang, Eisenberg, Valiente, & Spinrad, 2016), Lonigan and colleagues' (2004) temperamental model has also been highly influential. However, although the model takes into consideration of negative affectivity in producing AB, it does not provide a detailed account of the role of anxiety on AB or vice versa.

Given that anxiety impacts executive functions involved in the actualization of effortful control children (Affrunti & Woodroff-Borden, 2015; DePrince, Weinzierl, & Combs, 2009; Ng & Lee, 2016; Micco et al., 2009; Visu-Petra, Cheie, & Mocan, 2013), the model lacks sufficient detail in explaining why some children with high negative affectivity have intact effortful control while some others have impaired effortful control, which is the key mechanism in modulating AB. Nevertheless, their valuable emphasis on effortful control has led researchers to further examine the role of children's attentional control ability and their AB for threat.

Overall, like childhood anxiety, childhood AB is also difficult to locate within adult models. Formulation of childhood models require consideration of other developmental factors that might explain varieties in childhood AB (Puliafico & Kendall, 2006). In addition, children's capacity or speed of information processing continue to enhance during development (Crick & Dodge, 1994; Field & Lester, 2010) and this might change the way AB is manifested in children.

Consequently, in parallel to the emphasis on the modulators of AB in recent AB models for adults, childhood AB models also highlight the role of especially cognitive factors in addition to anxiety, and have informed the researchers examine other developmental variables in relation to AB.

1.5. Measuring Attention Bias

The AB models outlined above have been partially supported by empirical work; hence, none of them have been entirely rejected or fully accepted. In addition to the challenges in theoretical operationalizations of AB, its empirical operationalizations in experimental settings are also discrepant. The tasks designed to measure AB, the length of time that participants are exposed to stimuli, and the properties of the stimuli contribute to this discrepancy.

1.5.1. The Role of Task Type

AB is typically measured with reaction-time based tasks and the most commonly used AB tasks are emotional Stroop task, dot-probe task, emotional spatial cueing task, and visual search task (Bar-Haim et al., 2007; Dudeney et al., 2015).

Bar-Haim and colleagues' (2007) meta-analysis study revealed that the effect sizes of the AB tasks are significant to elicit AB for threat. They range from small to medium; d = 0.49 for emotional Stroop; d = 0.37 for dot-probe; and d = 0.43 for emotional spatial cueing. Similar effect sizes for emotional Stroop and dot-probe were also reported by Dudeney and colleagues' (2015) meta-analysis on children's data; with limited number of visual search task, emotional spatial cueing task, and eye tracking studies that did not go into the analysis.

Empirical attempts towards finding links between these tasks point out that the AB scores obtained from the tasks do not show significant associations with each other. In other words, although the tasks reveal some meaningful trend for differential attentional processing of threatening stimuli in anxious individuals, weak associations between them indicate that their convergent validity is poor in both developmental (Brown et al., 2014; Dalgleish et al., 2003; De Voogd et al., 2016; Klein, de Voogd, Wiers, & Salemink, 2018; Morales, Taber-Thomas, & Pérez-Edgar, 2017; Reinholdt-Dunne et al., 2012; Sylvester, Hudziak, Gaffrey, Barch, & Luby, 2016) and adult populations (Mogg et al., 2000; Van Bockstaele et al., 2014; Waechter & Stolz, 2015).

This suggests that they may tap into different aspects of attention (Cisler et al., 2009; Van Bockstaele et al., 2014; Yiend, 2010). Therefore, each of these tasks appear to have their own merits and limitations, which raised some serious criticisms among researchers regarding their validity and reliability (Clarke, MacLeod, & Guastella, 2013; Van Bockstaele et al, 2014; Weierich et al., 2008; Yiend, 2010).

Emotional Stroop Task

Emotional Stroop paradigm is one of the earliest and seminal tasks utilized to measure AB for threat (Williams, Mathews, MacLeod, 1996). It is developed from the classic Stroop paradigm (Stroop, 1935). In the classic Stroop paradigm, colour name words are printed in coloured ink. In some trials, the ink colour matches with the colour name (e.g., colour name red is printed in red colour) whereas it does not match in other trials (e.g., colour name red is printed in blue colour). Participant’s task is to indicate the colour of the print as quickly as possible either verbally or by key press. The relative difficulty in naming the print colour of the words in non-matching trials compared to matching trials is called *Stroop effect*. The underlying process of Stroop effect is response inhibition (Diamond, 2013) with longer response times to name the print colour in non-matching trials indicate greater difficulty in inhibiting predominant response.

Mathews and MacLeod (1985) adapted Emotional Stroop Paradigm to measure selective attention to threat words in anxious individuals. In Emotional Stroop, the words are still printed in coloured ink and participant's task is to name the ink colour. However, the semantic aspect of the words is threat related such as "injury", "foolish" or neutral such as "playful", "optimistic" (Mathews & MacLeod, 1985). Therefore, participants are required to ignore the meaning of the words to name its colour as fast as possible. Stroop interference occurs when participants take longer time to indicate the colour of the threat words compared to neutral words. This is taken as indicator of biased attention to threat, since threat meaning of the word draws attention first by leaving little cognitive resource to inhibit this tendency (Van Bockstaele et al., 2014).

Dot-probe Task

A typical dot-probe trial (Fig. 1.2) starts with a fixation cross in the centre of the screen, to which participants are asked to fixate on for sometime to avoid overlap of gaze location with the following stimuli. Then, a threatening and a neutral stimulus are presented side by side for typically 500 milliseconds (msec). After stimuli offset, an emotionally neutral target (i.e., the probe/asterisk) occurs in the location of one of the previous stimuli. In threat congruent trials, the probe occurs in the location of threat cue whereas in threat incongruent trials it occurs in the location of the neutral cue after stimulus offset. Participant's task is to indicate the location of the probe as quickly and accurately as possible by keypress. AB for threat score is obtained by subtracting the average reaction times (RTs) on threat congruent trials from the average RTs on threat incongruent trials. The sign of the outcome value is believed to reflect different components of attention.

Correspondingly, positive scores stem from the idea that average RTs on threat congruent trials are shorter than average RTs in threat incongruent trials. This is thought to occur due to attention being drawn by particularly threat stimulus compared to neutral stimulus during stimuli presentation phase of the task. Thus, participants' attention do not need to be reallocated on threat congruent trials since it has already been at the cued spatial position, which results in faster reaction times. This pattern of AB is called vigilance towards threat.

Negative scores, on the other hand, is believed to occur due to average RTs on threat incongruent trials are shorter than threat congruent trials. The logic behind this assumption is that participant's attention would be allocated to neutral stimulus rather than threat and therefore the time to indicate the location of the probe that replaces neutral stimulus would be shorter. This type of AB is called avoidance from threat stimulus.

Threat Congruent Trial	Duration	Task	Threat Incongruent Trial
	Varies	Fixating on the cross	
	Varies Usually 500 msec	Stimuli Observation	
	Varies Usually until response	Keypress to indicate the probe location	

***Figure 1.2*.** Example congruent and incongruent trials in dot-probe task

Emotional Spatial Cueing Task

It is adapted from classical Posner cueing task (Posner, 1980). In the classic version, following the fixation cross, a cue stimulus appears in either left or right. Following the offset of the cue, target stimulus appears. Participant's task is to indicate the location of the target stimulus as quickly and accurately as possible by keypress. If the location of the target is aligned with the preceding cue (e.g., cue is on the left, target is on the left), it is a congruent trial. If the location of the target is on the opposite side of the target location (e.g., cue is on the left, target is on the right), it is an incongruent trial. Because there is only one cue before presentation of target stimulus, attention is assumed to be captured by the cue stimulus (MacNamara, Kappenman, Black, Bress, & Hajcak, 2013). Thus, the relative ease in indicating target location in cued trials (i.e., congruent) compared to non-cued trials (i.e., incongruent) qualifies this assumption; such that attention that has previously been captured by the cue do not need to be diverted to detect the target location in congruent trials, which result in faster response times.

In the emotional version of the task (Fig. 1.3), either a threatening or neutral stimulus is presented per trial instead of concurrently presented two stimuli. Faster response times to threat congruent targets compared to neutral congruent targets indicate attentional orienting to emotional content of the cue, which means attentional vigilance towards threat. On the other hand, slower response times to threat incongruent targets compared to neutral incongruent targets evidence that threat cue holds attention away from the location of target stimuli, which indicates disengagement difficulty.

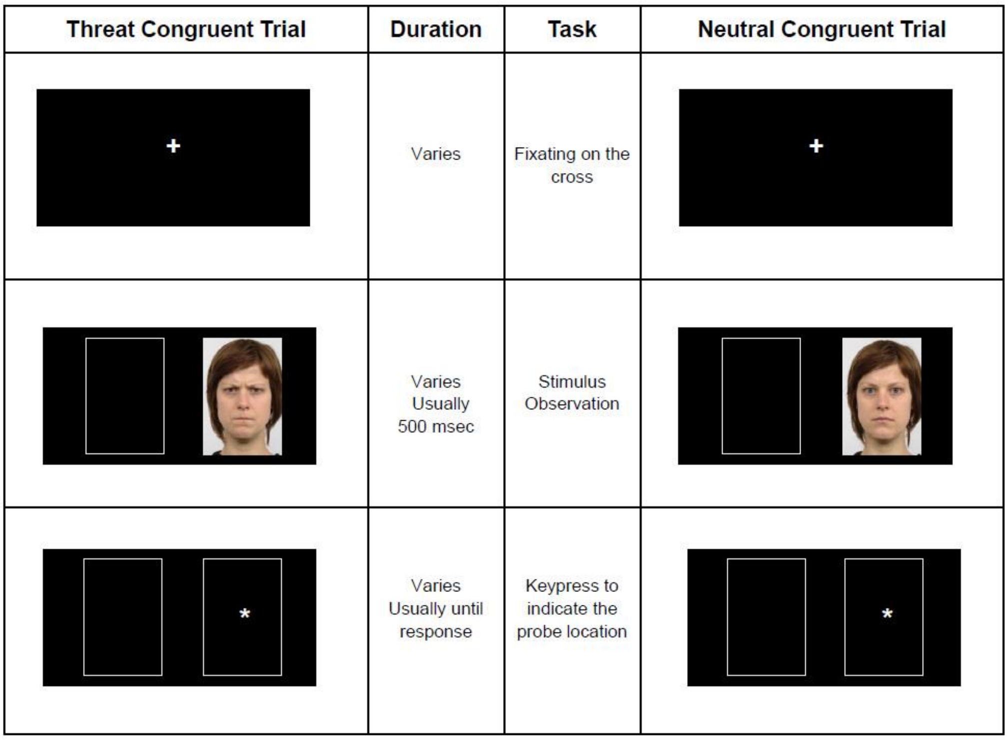


Figure 1.3. Example congruent and incongruent trials in emotional spatial cueing task

Visual Search Task

Visual search tasks (Fig. 1.4) are based on the idea of “odd one out”, where participants search for a target stimulus in an array of distracter stimuli. With respect to threat detection, the task involves a threat target stimulus in a matrix of neutral stimuli (Hansen & Hansen, 1988; Öhman, Flykt, & Esteves, 2001). Faster reaction times for threat targets embedded among neutral stimuli compared to neutral targets embedded in neutral stimuli is taken as indicator of vigilance for threat. Another way of evaluating vigilance is manipulating the matrix size with increasing the number of distracter stimuli. Accordingly, if the reaction time to finding threat stimuli is not affected by the complexity of the matrix, this is taken as indicator of intact vigilance for threat (Hadwin et al., 2003; Weierich et al., 2008).

Also, embedding a neutral target stimulus in an array of threat stimuli facilitates exploration of disengagement difficulty in visual search tasks. Accordingly, slower reaction times for finding the neutral target embedded in threat stimuli compared to the neutral targets embedded in neutral stimuli is thought to reflect difficulty in disengaging away from threat (e.g., Rinck, Becker, Kellermann, & Roth, 2003; Waters & Lipp, 2008b).

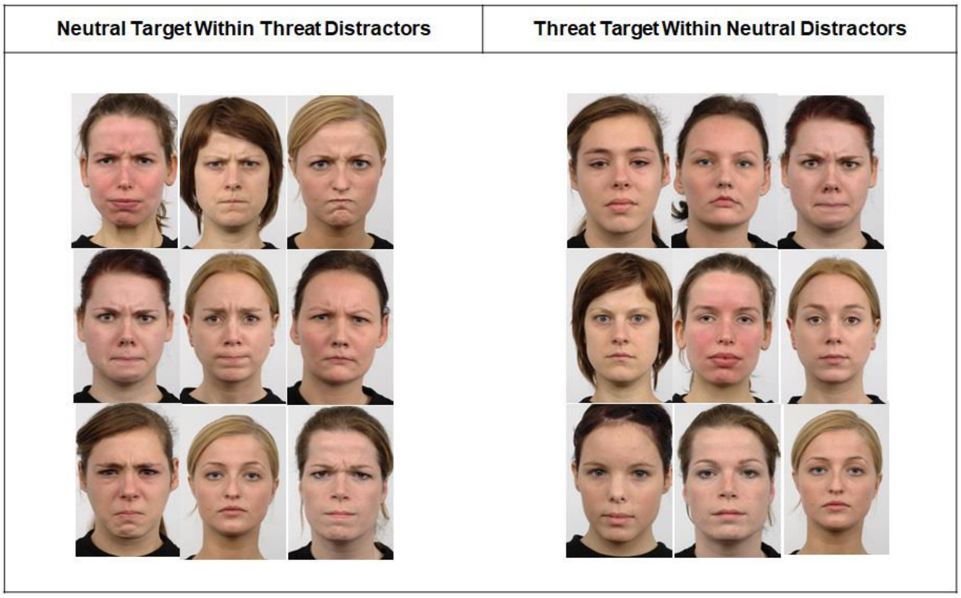


Figure 1.4. Example trials in visual search task

<u>Other tasks</u>

Other paradigms have also been developed by modifying some mainstream attention tasks with emotional stimuli such as dichotic listening (Burgess, Jones, Robertson, Radcliffe, & Emerson, 1981), attentional blink (Mathewson, Arnell, & Mansfield, 2008; Van Bockstaele et al., 2014), gaze contingent masking (Yiend, 2010), and startled eye blink (Waters, Lipp, & Cobham, 2000) to name a few. However, since studies utilizing these paradigms are scarce, evaluating their efficacy based on cumulative research is not feasible.

1.5.2. Critical Evaluation of the Tasks

Regarding emotional Stroop task, empirical evidence supports existence of Stroop interference on threat words in both community sample children with trait anxiety (Richards et al., 2000; Richards et al., 2007; Hadwin et al., 2009; Heim-Dreger, Kohlmann, Eschenbeck, & Burkhardt, 2006), with spider phobia (Kindt, Bierman, et al., 1997; Kindt & Brosschot 1997, Kindt & Brosschot, 1998; Kindt et al., 2000; Klein et al., 2011, 2018; Martin et al.,1995; Martin, Horder, & Jones, 1992), and clinical sample children with GAD (Taghavi et al., 2003). However, emotional Stroop has been subject to criticisms regarding its construct validity.

The first issue relates to how well the nature of the task is qualified to elicit the spatial components of AB. As mentioned previously, it is now well known that AB has visuo-spatial components as vigilance towards threat, difficulty in disengaging from threat, and avoidance away from threat. While emotional spatial cueing task, dot-probe task and visual search task allow investigation of these components, it is clear that emotional Stroop does not have such property. Although many emotional Stroop studies found debilitating interference of threatening meaning on attending to critical aspect of stimulus, it is impossible to interpret what longer reaction times to threat compared to neutral information means when underlying attentional processes are considered (Clarke et al., 2013).

Therefore, as many authors claimed (Fox, 2004; Weierich et al., 2008), whether long reaction times are result of initial attentional orienting towards threat or the following difficulty in disengaging attention away from threat cannot be decomposed. Consequently, emotional Stroop is at best the measure of the extent of difficulty in inhibiting response towards emotional distractors to maintain attention on the goal-relevant information (Platt, Waters, Schulte-Koerne, Engelmann, & Salemink, 2017).

Another problematic aspect of the emotional Stroop stems from a phenomenon called response bias (Yiend, 2010). Response bias is defined as the impact of non-attentional processes on responding such as general slowing in reaction times when encountered with threat stimuli in anxious individuals (Clarke et al., 2013; Puliafico & Kendall, 2006). This bias is thought to be particularly present when both the target and distractor are the characteristics of the same stimulus (Weierich et al., 2008), and they are presented at the same time (Yiend, 2010). Accordingly, Weierich and colleagues (2008) have argued that it is difficult to differentiate whether the delayed response in emotional Stroop is due to pure distractor interference of threat or it is coupled with the general slowing due to response bias. Yiend (2010) suggests that ruling out the potential contribution of response bias on reaction times requires target stimulus to be presented in the absence of emotional stimulus.

Due to the claims that Stroop task is ineffective to reveal how attention is distributed over threatening stimuli in anxious individuals, MacLeod and colleagues (MacLeod, Mathews, & Tata, 1986) also developed dot-probe paradigm. However, the capacity of dot-probe to reveal AB components is influenced by stimuli presentation time to a considerable degree. As such, since participants respond to the target stimuli after some stimuli observation period, what is captured as vigilance may actually reflect maintained attention on threat in the form of disengagement difficulty (Yiend, 2010).

Another issue as raised by Weierich and colleagues (2008) is the way vigilance and avoidance scores are obtained. As mentioned above, positive values indicate vigilance while negative values indicate avoidance after subtracting the average RTs on threat congruent trials from the average RTs on threat incongruent trials. However, Weierich and colleagues (2008) have argued that vigilance and avoidance could occur at different time points; therefore, making inferences about the existence of one in the absence of the other within a restricted time period may not provide an accurate representation.

Because vigilance for threat scores in dot-probe task are not unequivocal as to whether it reflects true initial engagement with threat or difficulty in disengaging from threat, Fox and colleagues (2001) used emotional spatial cueing task to differentiate initial vigilance towards threat from disengagement difficulty. Fox and colleagues (2001) indeed found that anxious individuals were slower to indicate the location of the probes that replace neutral cue in their set of experiments, which means they had difficulty in shifting their attention from the location of threat cue to the opposite location.

However, albeit disengagement difficulty is an acknowledged form of AB, limited data from children is contradictory. One study showed slower disengagement from threat in children (Zhang et al., 2017), but it is limited to boys only. In contrast to the attentional maintenance model (Fox et al., 2001), Pergamin-Hight and colleagues (Pergamin, Bitton, et al., 2016) found only vigilance towards threat in anxious kids whereas the significant vigilance was not qualified by anxiety in another study (Morales et al., 2017). Also, it is interesting that anxious children were found to display both engagement and disengagement difficulty in another study (Pollak & Tolley-Schell, 2003).

While the empirical evidence remains controversial, inconsistencies in mirroring AB components on AB score calculations are also present in emotional spatial cueing task. As Clarke and colleagues have pointed out (2013), when AB is considered in relation to the shifts in the attentional focus over the time course of stimuli observation, disengagement difficulty index does not necessarily preclude initial occurrence of vigilant engagement with threat.

Another critique to the emotional spatial cueing is related to its ecological validity. Although it is developed as an alternative to the dot-probe task, Bar-Haim and colleagues (2007) have argued that presenting only one stimulus does not allow for stimuli to compete for drawing attention (Desimone & Duncan, 1995) in contrast to dot-probe design, where two stimuli are presented to explore how attention is distributed over concurrently occurred information.

It is noteworthy that dot-probe's inefficiency in differentiating whether vigilance towards threat is composed of initial orienting or disengagement difficulty has been recognized by some AB researchers (Van Bockstaele et al., 2014; Koster et al., 2004; Koster et al., 2006). Koster and colleagues (2004) have proposed a novel way of calculating AB scores with a slight tweak in the task design. In the proposed design, neutral-neutral stimuli pairs were presented in some trials to have a baseline index of spatial attention.

As a result, engagement scores were obtained by subtracting average reaction times on emotion congruent trials from average reaction times on neutral-neutral trials. The positive value indicates enhanced vigilance for emotion while negative value indicates slower engagement with emotion. Disengagement scores were obtained by subtracting average reaction times on neutral-neutral trials from average reaction times from emotion incongruent trials. The positive value indicates enhanced difficulty in disengaging from emotion while negative value indicates faster attending away from emotion. By comparing effect of congruency and emotion with baseline attention allocation, this method outlines whether initial vigilance found via the traditional method comprised of vigilance or disengagement difficulty.

As for visual search task, it is adapted from classic visual search paradigm with emotionally loaded stimuli (Öhman, Flykt, et al., 2001, Öhman, Lundqvist, & Esteves, 2001) to test Öhman's (1996) feature detection model, which predicts that individuals show AB towards biologically prepared, threat signalling stimuli such as snakes, spiders, angry and fearful facial expressions independent of anxiety. Both adult studies (Hansen & Hansen, 1988; Öhman, Flykt, et al., 2001; Öhman, Lundqvist, et al., 2001) and data from children (Lobue, 2009; LoBue & Deloache, 2008; Lobue, Matthews, Harvey, & Thrasher, 2014) seem to support the threat superiority theory in normative populations. In addition, studies have shown that finding threats faster is more magnified in anxious children (Hadwin et al., 2003; Klein et al., 2018; Perez-Olivas et al., 2008; Silvers et al., 2017) and adults (Ashwin et al., 2012; Byrne & Eysenck, 1995) compared to non-anxious individuals.

However, as far as disengagement difficulty and avoidance are concerned, the match between what the task requires participants to do and what anxious people actually do to observe threat information in real life is weak (Yiend, 2010) such that that the complex visual arrays in visual search tasks reduce its ecological validity.

Also, Clarke and colleagues (2013) have argued that detecting the neutral target in an array of threatening distractors might as well be an index of initial vigilance towards followed by maintained attention on threat in contrast to the claims that it is purely an index of disengagement difficulty. Therefore, it may not be sensitive enough to segregate the components of attention and seems to be better suited to examining hypervigilance underlined by threat monitoring in anxious individuals (Richards et al., 2014).

The controversy as to why AB manifests itself as a heterogenous structure has led to the questions revolved around reliability of the tasks measuring AB. Not the reaction times, but the AB scores derived from the reaction times showed poor test-retest reliability for emotional Stroop (Brown et al., 2014; Eide, Kemp, Silberstein, Nathan, & Stough, 2002; Kindt, Bierman, & Brosschot, 1996; Strauss, Allen, Jorgensen, & Cramer, 2005) and for dot-probe (Brown et al., 2014; Cooper et al., 2011; Price et al., 2015; Schmukle, 2005).

In addition to the adult studies, a recent study with 9-year-olds by Brown and colleagues (2014), reported that test-retest reliability of emotional Stroop and dot-probe is very low and not significant with an exception of visual search task, which is again low but significant. No study so far examined the reliability of emotional spatial cueing task to our knowledge.

1.5.3. The role of Stimuli Presentation Duration

Since dot-probe task is the most commonly used task to measure AB, it is imperative to address the role of stimuli presentation length on identifying the direction of anxious people's AB for threat when evaluting the impact of especially dot-probe task on AB literature. Using 500 msec for stimuli presentation has become somewhat typical of AB studies, perhaps because this was the time length used by the developers of the task (MacLeod et al., 1986) in the first ever dot-probe study.

However, the results of the studies using 500 msec for stimuli presentation are mixed. Many adult (Bradley, Mogg, White, Groom, & de Bono, 1999; Calamaras et al., 2012; Lindstrom et al., 2011; Zvielli et al., 2014) and child studies (Eldar et al., 2012; Hommer et al., 2014; Montagner et al., 2016; Reinholdt-Dunne et al., 2012; Salum et al., 2013; Waters et al., 2014) reported vigilance towards threat when stimuli was presented for 500 msec. Some other studies, on the other hand, reported that anxious adults (Calamaras et al., 2012; Cooper & Langton, 2006; Schoorl et al., 2014; Zvielli et al., 2014) and children (Bertó et al., 2017; Carmona et al., 2015; Pine et al., 2005; Salum et al., 2013; Waters et al., 2014) can also show avoidance during 500 msec, suggesting that 500 msec may be long enough for strategic attentional processes come into play (Wolters et al., 2012).

Therefore, testing automatic threat detection in anxious individuals as some theoretical models of AB postulates (Beck & Clark, 1987; Mogg & Bradley, 1998; Öhman & Wiens, 2004; Williams et al., 1988) required subliminal presentation of emotional stimuli very briefly like 17 msec and then introducing irrelevant masking stimuli to prevent elaborated processing of threat stimulus (McCrory et al., 2013; Thomason et al., 2010; Wolters et al., 2012).

Adult studies have somewhat evidenced preconscious, automatic detection of threatening stimuli (Carlson & Reinke, 2008; Carlson, Mujica-Parodi, Harmon-Jones, & Hajcak, 2012; Mogg, Bradley, & Williams, 1995; Reinecke, Cooper, Favaron, Massey-Chase, & Harmer, 2011). But the picture is rather complicated in youth populations. There are studies that indeed evidenced existence of preconscious bias toward threat in anxious children (Thomason et al., 2010; Wolters et al., 2012; Zhang, Kong, Han, Najam Ul Hasan, & Chen, 2014). But other studies have noted that, based on reaction time data, anxious children are not significantly more vigilant to threat than non-anxious children during preconscious threat processing (but see their neurological responses to threat, Britton et al., 2013; McCrory et al., 2013; Monk et al., 2008).

In addition, as discussed in the previous sections, AB can also be manifested in the form of disengagement difficulty or avoidance. In that regard, initial vigilance towards threat is believed to be underlined by automatic attentional processes while disengagement difficulty and avoidance are thought to be underlined by strategic attentional processes (Bar-Haim et al., 2007; Corbetta & Shulman, 2002; Cisler & Koster, 2010). Therefore, disengagement difficulty and avoidance are assumed to be elicited when stimuli are presented longer in contrast to automatic threat detection in shorter presentation durations (Armstrong & Olatunji, 2012). So, using more than one presentation duration and showing stimuli for both short and long durations has become a popular way of exploring how AB for threat unfolds.

Accordingly, in youth studies where presentation duration is manipulated, the short duration was chosen to be 500 msec whereas the long duration is typically 1250 msec or longer (Bertó et al., 2017; Mogg, Wilson, Hayward, Cunning, & Bradley, 2012; Montagner et al., 2016; Salum et al., 2013; Vervoort et al., 2011; Waters, Mogg, & Bradley, 2012). One study reported vigilance at 500 msec, but no strategic bias at 1250 (Vervoort et al., 2011). Three of these studies found no effect of presentation length in either duration in anxious children (Bertó et al., 2017; Montagner et al., 2016; Salum et al., 2013). Also, considering that vigilance is assumed to occur early on viewing, anxious children's vigilance at 1250 msec but not at 500 msec (Mogg et al., 2012) or vigilance both at 500 msec and 1250 msec (Waters, Kokkoris, et al., 2010) further adds to the inconsistency.

With respect to these mixed findings, one critique to the design of probe detection tasks is the restriction in the timing of stimuli presentation. Inferences regarding whether attention is oriented towards threat is made based on the spatial location of the attention just before the probe occurs. It is possible to make more than one attentional shift while observing the stimuli in a matter of 500 msec or longer before the probe (Richards et al., 2014; Weierich et al., 2008); hence, it cannot be warranted that facilitated attention that is inferred from faster reaction times to threat congruent trials is true reflection of the very first attentional orienting towards threat (Fox, 2004; Weierich et al., 2008; Yiend, 2010). In addition, if avoidance can indeed be elicited when stimuli is presented at longer durations such as 1000 msec (Gibb et al., 2011), 1250 msec (Salum et al., 2013), and 1500 msec (Bertó et al., 2017), AB for threat may be time-bound and may have continued in one form or another if it was not cut off by early termination of stimuli presentation like 500 msec (Bradley et al., 1999; Mogg et al., 2004).

Overall, it appears that there is limited benefit of presenting stimuli with varying lengths to understand AB components. This is because, if the stimuli presentation length is kept short to capture automatic vigilance, whether and how AB unfolds cannot be evaluated. On the other hand, if it is kept long enough for strategic attentional processes to occur, this might mask initial automatic vigilance in the reaction times.

1.5.4. Eye-tracking Methodology

Coupled with the limitations of the reaction-time based AB measures as outlined above, the low reliability scores necessitate more sensitive AB measurement techniques. Therefore, there is a growing interest in using eye tracking methodology as a direct measure of eye movements in AB research (Clarke et al., 2013; In-Albon & Schneider, 2010; Richards et al., 2014; Roy, Dennis, & Warner, 2015; Mogg & Bradley, 2016; Weierich et al., 2008).

In AB studies with eye tracking the typical task is free viewing. Participants are only required to look at two concurrently occurring stimuli on the screen for a matter of few seconds without keypress to indicate an aspect of a target stimulus (Bradley et al., 2016; Dodd et al., 2015; Gamble & Rapee, 2009; In-Albon, Kossowsky, & Schneider, 2010; Lisk, Vaswani, Linetzky, Bar-Haim, & Lau, 2020).

Depending on the eye tracker type, eye movements are recorded with varying speeds ranging from 1 gaze sample per 16.67 msec to 1 gaze sample per less than 1 msec (Armstrong & Olatunji, 2012). This means that gazing behaviour can be captured with nearly no temporal gaps during stimuli observation. Typical examples of eye movement data are direction and latency of fixations, which provide information on both temporal and spatial aspects of the gaze (Armstrong & Olatunji, 2012).

As mentioned above, a common limitation of reaction-time based tasks stems from the inconsistencies in mirroring AB components on AB scores. This suggests that how well they reflect the AB components they supposed to reveal is compromised (Clarke et al., 2013; Van Bockstaele et al., 2014; Weierich et al., 2008; Yiend, 2010). The reaction times to the probes only reflect an indirect measure of where the focus of attention has been just before the probe occurs (In-Albon & Schneider, 2010). Given that it is possible to make more than one attentional shift within a time period as short as 100 – 200 msec (Weierich et al., 2008), the cuing tasks are criticised to provide only a “snapshot of attention” (Armstrong & Olatunji, 2012; Bradley, Mogg, & Millar, 2000; Gamble & Rapee, 2009; Garner, Mogg, & Bradley, 2006; Price et al., 2013) rather than providing information on how attention have unfolded during stimuli observation. The challenge in disambiguating initial vigilance for threat from disengagement difficulty once threat is detected is a dominant example of this.

On the other hand, in AB studies with eye tracking, vigilance pertaining to threat is indexed by the direction of the initial fixation (i.e., very first direction of the gaze after stimuli onset) towards threat (Dodd et al., 2015; Garner et al., 2006; Mogg, Millar, & Bradley, 2000; Price et al., 2013; Schofield, Johnson, Inhoff, & Coles, 2012) as well as latency of the initial fixation (i.e., how long it has taken to look at that stimulus) (Bradley et al., 2016; Garner et al., 2006; Sun, Wang, & Luo, 2016). Also, the extent of disengagement difficulty following initial vigilance can be addressed by the length of time fixated on the stimuli that is initially oriented to (Bradley et al., 2016; Garner et al, 2006; Hilt, Leitzke, & Pollak, 2017). In some other studies, the average fixation duration on each stimulus (Fashler & Katz, 2014) and the length of time to look at the location of threat incongruent probe by shifting gaze from threat location (Schofield et al., 2012) have also been taken as indicator of disengagement difficulty. Although very limited, avoidance has also been addressed in some studies by analysing the relative frequency of initially fixating to neutral faces rather than angry faces (Hilt et al., 2017; Gamble & Rapee, 2009).

In addition to the attempts of extracting out the components of AB, eye tracking also appears to be helpful in delineating the time course of AB. This has important implications considering how different AB components are manifested while the underlying automatic and strategic processes are in operation (Cisler & Koster, 2010; Armstrong & Olatunji, 2012). In eye tracking studies, the typical way of exploring time course of AB is to analyse the average gaze dwell times on each stimulus by dividing the overall stimuli presentation duration into smaller time segments and investigating the dwell times segment by segment (Gamble & Rapee, 2009; In-Albon et al., 2010; Shechner et al., 2013; Schofield et al., 2012; Schofield, Inhoff, & Coles, 2013; Seefeldt et al., 2014).

However, despite its clear advantages over the traditional AB tasks, utilizing eye tracking methodology in the measurement of AB has become common especially in the last decade. Therefore, AB data based on eye movements from developmental populations is limited compared to reaction time-based AB tasks (Lisk et al., 2020). Consequently, there is no consensus among researchers as to what should be taken as indicator of vigilance (i.e., direction of the first fixation or speed of the first fixation towards threatening stimuli), disengagement difficulty (i.e., the length of first fixation or the average number of visits on threatening stimuli), or avoidance (i.e., average number of initial fixations on neutral trials or average dwell time on neutral stimuli compared to threatening stimuli).

Another issue is using free viewing while eye movements are recorded. Some argue that free viewing is superior than employing a concurrent task where participants are required to respond (In-Albon & Schneider, 2010) since there may be time between shifting gaze as an indicator of AB and making a motor response to target stimuli, which may in turn lengthen reaction time as artifact. On the other hand, others state that free viewing on its own is not reliable for assessing disengagement difficulty as it does not necessarily require participants to disengage their attention from an information to carry on their ongoing task (Dodd et al., 2015).

Overall, eye tracking appears to be a stronger approach since it can record eye movements continuously; hence, vigilance, avoidance, or disengagement difficulty can be captured within a single observation session while stimuli are presented long enough to allow all AB patterns unfold. However, it may best be used as a complementary measurement along with an AB task. In that regard, cueing tasks appear to be particularly useful while eye movements are recorded because a) in contrast to visual search tasks, motor responding is necessary only after stimuli offset in cueing paradigms, which would not compromise gazing behaviour, and b) participants are required to respond by disengaging their attention in incongruent trials, which allows detailed examination of disengagement difficulty.

1.5.5. The role of Stimuli Type

Emotional valence of stimuli

Since anxiety is characterized with selective processing of threatening information, the most common threat stimuli used in AB research are angry faces paired with neutral faces. Some studies suggest that anxiety disordered children and adolescents can display vigilance for sad faces (Bertó et al., 2017) or slowdown in naming the frame colour of the disgust faces (Benoit, McNally, Rapee, Gamble, & Wiseman, 2007). However, weight of evidence supports threat bias specificity in anxiety for angry (e.g., Dalgleish et al., 2001; Fitzgerald et al., 2016; Pergamin, Bitton, et al., 2016; Ribchester et al., 2010; Monk et al., 2006) and fearful faces (e.g., Price et al., 2013; 2014; Price, Allen et al., 2016; Price, Rosen et al., 2016). As for positive stimuli such as happy faces, there is converging evidence that they generally do not show bias for happy faces (but see Waters, Mogg, Bradley, & Pine, 2008, Joorman, Talbot, & Gotlib, 2007; Ho et al., 2017; Stirling et al., 2006; Waters, Henry, Mogg, Bradley, & Pine, 2010; Waters et al., 2014 for alternative evidence). Nevertheless, studies use happy faces in addition to neutral faces as emotional control stimuli.

In relation to why some anxious individuals show AB for generally threatening information while the others do not, disorder congruency of stimuli appear to be critical when examining AB in anxiety disorders. Pergamin-Hight and colleagues' (Pergamin-Hight, Naim, Bakermans-Kranenburg, van IJzendoorn, & Bar-Haim, 2015) meta-analysis study reported that disorder-related stimuli are indeed more salient to elicit greater AB than generally threatening stimuli in adults as well as youth, with *d* = 0.29 and *d* = 0.21 respectively. Especially trauma and panic related stimuli in post traumatic stress disorder and panic disorder populations respectively appear to be more potent than other stimuli. In community sample adults and children, on the other hand, meta-analysis studies suggest that generally threatening stimuli such as angry facial expressions appear to be strong enough to elicit AB (Bar-Haim et al., 2007; Dudeney et al., 2015).

Given that anxiety and depression are highly comorbid conditions, disorder congruency of stimuli is also linked with dissociating cognitive profiles of anxious from depressed individuals. The widely accepted belief is that anxiety is associated with bias for anxiogenic information while depression is linked with bias for depressogenic information such as sad faces (Hankin et al., 2010; Joorman et al., 2007; Mathews & MacLeod, 2005; Mogg et al., 1995; Doost, Taghavi, Moradi, Yule, & Dalgleish, 1997; but see the meta-analysis by Peckham, McHugh, & Otto, (2010) on depressed people's AB for negative information in general including threat). Accordingly, anxious individuals are generally characterized with vigilant attention to threat during automatic processing whereas depressed individuals' biases are thought to involve strategic processing of information due to ruminative evaluation (Mathews & MacLeod, 2005; Mogg & Bradley, 1998).

Although threat specificity in anxiety has been well documented, the evidence regarding whether anxiety-depression comorbidity alters ABs of clinically anxious individuals is inconsistent. Bar-Haim and colleagues' (2007) meta-analysis reported that there is no impact of mood disorder comorbidity on anxious individuals threat bias. However, data from children revealed that comorbid groups can show bias for both sad and angry faces (Hankin et al., 2010) or show no significant bias for neither stimulus (Doost et al., 1997; Taghavi, Neshat-Doost, Moradi, Yule, & Dalgleish, 1999).

Also, differing levels of depression symptomatology may affect ABs of trait anxious individuals. Therefore, to control for effects of depression symptoms on threat bias, studies use a measure of depression when AB is examined within the context of anxiety (e.g., McCrory et al., 2013; Reinholdt-Dunne et al., 2012; Waters, Mogg, et al., 2008; Waters, Kokkoris, et al., 2010).

Diversity of stimulus materials

Although less preferred, words are also used as stimuli in AB research as well as pictures. Using word stimuli has been criticised in that anxious individuals may use threatening words more often while thinking/speaking about events and their own experiences than non-anxious individuals. Thus, biased attention for threatening words in anxious individuals might reflect higher familiarity to and subjective frequency of using threat words (Bar-Haim et al., 2007; Ehrenreich & Gross, 2002).

Children's reading abilities can also impact their reaction times in the tasks (Ehrenreich & Gross, 2002; Waters, Mogg, et al., 2008). To rule this out, one way is to control for discrepancy on reading levels by measuring reading ability (Freeman & Back, 2000; Ribchester et al., 2010; Schippel, Vasey, Cravens-Brown, & Bretveld, 2003) or presenting stimuli for long enough such as above

1000 msec to get data from slow readers as well (Hunt et al., 2007; Lonigan & Vasey, 2009; Puliafico & Kendall, 2006; Vasey, Daleiden, Williams, & Brown, 1995; Vasey, el-Hag, & Daleiden, 1996) or using non-verbal stimuli.

However, presenting stimuli for long presentation durations might contaminate the results since direction of AB appears to depend on how long stimuli are presented. Besides, fast readers might have more time to elaborate on the stimuli compared to slow readers (Schippel et al., 2003), which would alter what pattern of AB they would display.

Furthermore, pictorial stimuli such as emotional faces are thought to have a greater ecological validity as they are universal, more salient, and less abstract compared to words (Telzer et al., 2008; Waters, Mogg, et al., 2008). Therefore, using pictorial stimuli especially in the studies where both children and adolescent populations participate appears to be a more sensitive approach to elicit AB.

1.6. Rationale of this thesis

AB for threat as an exquisite type of information processing bias has been proposed to be a causal or maintaining factor in developing anxiety (Bar-Haim et al., 2007; Cisler et al., 2009; Cisler & Koster, 2010; Dudeney et al., 2015; Ehrenreich & Gross, 2002; Puliafico & Kendall, 2006).

Like anxious adults, clinically or trait anxious children and adolescents also show greater AB for threat compared to their non-anxious counterparts (Dudeney et al., 2015). While modifying attention bias patterns appear to be a low cost and effective treatment to eliminate AB and reduce anxiety (Hakamata et al., 2010; Linetzky et al., 2015), lack of consensus on characterization of AB for threat in anxiety appear to be a contributing factor to inconsistent results regarding efficiency of ABMT.

AB has components (Cisler & Koster, 2010) reflecting components of attention (Posner et al., 1987; Yiend, 2010). Accordingly, it has been conceptualized as either vigilance towards threat, difficulties in disengaging away from threat, or avoidance from threat by early models of AB. However, more recent AB models have a more integrative approach towards understanding AB, and rather than discussing the components of AB, there is an acknowledgement of heterogeneity in manifestation of AB.

So, the differences in anxious individuals' motivation during threat appraisal could underlie this divergency. As such, vigilance could be result of hypersensitivity towards threatening information (Matthews & Mackintosh, 1998; Öhman & Wiens, 2004; Wells & Matthews, 1994; Williams et al., 1988), difficulties in disengaging from threat could be result of greater effort allocated in understanding threat value of the information (Fox et al., 2001), and avoidance from threatening information could be result of aiming to restrict the interaction with threatening information and reduce anxiety in anxious individuals (Mogg & Bradley, 1998).

Reflecting this acknowledgement, given that reaction time based tasks have limited capacity to reflect the components of AB and reveal indirect indices of attention bias, use of eye tracking methodology has gained much interest recently since it provides examination of all attentional patterns within one-single observation period.

Another crucial implication of recent AB models of adults and children is the necessity of understanding what modulates AB (Cisler & Koster, 2010). The modulating factors have the potential to explain the underlying threat appraisal process; and hence to delineate why some anxious individuals show vigilance while others show disengagement difficulty or avoidance.

In addition, identifying modulating variables can also contribute to developing more effective AB training techniques. Furthermore, therapeutic approaches for clinically anxious children and psychoeducation programmes for community sample children with subclinical anxiety can also benefit from this by having a particular focus on improving these variables.

Following an extensive literature review, three developmental variables were identified to be examined further in relation to AB for threat using eye tracking methodology in community sample children within the context of trait anxiety in separate empirical studies.

Based on the scarcity of the studies and the mixed evidence related to the association between parental and offspring AB, the aim of the study in Chapter 3 was to investigate whether parental AB for emotional stimuli is a significant modulator of AB for threat in their children.

Since majority of the attentional control studies with children in relation to AB were carried out with questionnaires previously, the aim of the study in Chapter 4 was to examine the moderator role of the interaction between attentional control and anxiety on threat related AB in children by employing a performance-based measure of attentional control through a computerized task.

Finally, the aim of the study in Chapter 5 was to examine the association between children's emotion regulation strategy use and their AB for emotional stimuli as no previous empirical study conceptualized emotion regulation strategy use as a correlate of threat related AB to the best of my knowledge.

2. CHAPTER TWO: GENERAL METHODOLOGY OF EMPIRICAL STUDIES

2.1. Ethics Approval

This study was reviewed and received ethical approval from Psychology Research Ethics Committee (PREC) of School of Philosophy, Psychology, and Language Sciences, University of Edinburgh on 22.09.2016 (Reference No: 212-1516/2; See Appendix 1).

2.2. Participants

2.2.1. Sample size

To determine the required sample size, power calculation analyses were conducted using G*Power Software (Faul, Erdfelder, Lang, & Buchner, 2007). Since there is not enough data provided by the previous literature to have a conclusive opinion to formulate hypotheses, the empirical studies were deemed as exploratory and thus the following analysis was done by assuming two-tailed alpha of 0.5. For up to 4 predictors in a regression model to detect a small effect size (fs=0.10, α error probability = 0.025, 1-β error probability = 0.75) revealed requirement of 87 participants.

2.2.2. Inclusion Criteria

For children and adolescent participants, the inclusion criteria adopted were a) being between the ages of 8 to 18; b) having normal or corrected to normal vision; c) not having a physical disability to use a computer; d) not having diagnosis of a current mental health difficulty; e) not having diagnosis of a neurodevelopmental disorder; and f) not receiving psychosocial treatment or relevant medication.

For parent participants, the inclusion criteria adopted were the same with an addition requirement of being the child participant’s caregiver and legally able to give consent for participation.

Both children’s and parents’ physical and mental health status were confirmed by parental report.

2.3. Recruitment

The recruitment took place in collaboration with Wee Science Research Group, Psychology Department, University of Edinburgh (https://www.weescience.ppls.ed.ac.uk/). The group has a list of contact details of the families who have shown interest in participating in the experiments going on in the department. Families of which children are within the age range of this project were contacted through email and invited to take part (See Appendix 2 for a copy of invitation emails and Appendix 4 for participant information sheet). In addition, invitation advertisements were also posted on Facebook page (https://en-gb.facebook.com/weescience/) of Wee Science Group (See Appendix 3 for example advertisement posters).

The sample consisted of 82 families. This made overall 194 participants with 82 parents and 112 children at the end of the recruitment. Participant exclusions based on task performance were explained in detail in the data cleaning and pre-preparation sections of each respective empirical chapter.

2.4. Equipment and Measures

2.4.1. Eye-Tracker

To measure attention bias, eye movements were recorded from both eyes using Tobii TX300 Eye Tracker (https://www.tobiipro.com/product-listing/tobii-pro-tx300/, Tobii Technology AB, Sweden). The display screen is integrated with the eye tracker and is a 23” wide-screen TFT monitor with a resolution rate of 1920 x 1080. The eye tracking unit has a built-in camera and infrared lights which are right beneath the monitor. It has a unifying look with the monitor so that it does not distract participants. This eye tracker model has an unobtrusive design such that it does not require chinrest which restricts participants, is robust to head movements, and continues recording almost instantly after head moves back in the reception area.

The computer tasks described in detail below were presented on the monitor of the eye tracker; however, eye movements were recorded only during dot-probe task. Tobii TX300 Eye Tracker has an optional range of sampling rates up to 300 Hz and eye movements in this study were recorded at a sampling rate of 60 Hz (every 16.7 msec) with an average accuracy of 0.4° for both eyes. The study conducted in an illuminated room with standard fluorescent lights. At the beginning of each dot-probe task, a standard nine-point calibration procedure was carried out, where participants followed nine target locations on the screen with their eyes while the eye movements are recorded and mapped with the location of the target points. Calibration procedure repeated if significant drift was detected. The participants sat on a height adjustable chair comfortably and roughly 70 cm away from the monitor, which is within the tracker's optimum operating distance range. Experiments were presented and controlled by using E-Prime 2.0 and E-Prime extensions for Tobii (Psychology Software Tools, Pittsburgh, Pennsylvania).

A fixation was defined as stable eye positions for at least 100 msec in agreement with the previous literature (Dodd et al., 2015; Gamble & Rapee, 2009; Price, Rosen et al., 2016; Shechner et al., 2017; Vahlsing, Hilt, & Jakobsen, 2015).

The eye tracker recorded eye movements during the entire trial timeline. So, six areas of interest (AOI) were defined to map out where participants were looking at during all slides of a trial. For fixation cross slide, the AOI was defined as a rectangular area with the fixation cross in the centre. For stimuli slide, four areas of interest were defined. Two critical AOIs had the same measures as the stimuli pictures, while the other two were on the left and right side of the display screen that divided the screen into two and covered the visual area between stimuli AOIs and the rest of the screen. The final AOI was defined for the probe screen as a rectangular area surrounding the probe location.

All the indices below were extracted from eye movement data sheets using customized scripts in R. All indices were also obtained for happy faces. For details on the definitions and formulas of all the eye movement metrics, see Table 2.1.

Response Definitions

Vigilance

Vigilance for threat refers to the relative ease or speed of selecting the threatening information among an array of information. On the behavioural level, this behaviour is displayed by either detecting threatening information first or detecting threatening information quicker when it is paired with neutral information. In accordance with this, previous researchers developed two indices of vigilance bias as frequency of initial threat selection and speed of initial threat selection. The volume of eye movement literature of attention bias is not large enough to have a conclusive opinion regarding which one is a better index of vigilance. However, Shechner and colleagues' (2013) study, where both indices were analysed, reported that anxious participants looked at angry faces first significantly more often than non-anxious participants; however, this group difference was not observed in the speed of looking at angry faces. Based on this, frequency of initial fixation on angry face was chosen as vigilance index in this project.

To obtain the index, the proportion of trials in which the angry face was fixated upon before neutral face was calculated by dividing the number of trials in which the first face fixated upon was an angry face by the number of trials in which at least one face was fixated upon first (Dodd et al., 2015).

Disengagement Difficulty

Disengagement difficulty refers to the relative difficulty in disengaging attention away from threatening information. On the behavioural level, this difficulty is displayed by looking at threat longer than other visual information after detecting threat. The conceptualization of disengagement difficulty differs based on the task type employed along with eye tracking. In the free-viewing paradigms, participants are not required to respond except observing stimuli. In this case, how long participants look at threatening information after detecting it is the index of disengagement time. However, as discussed in Chapter 1, this paradigm is criticized on the grounds that disengagement may not occur in some participants since it does not require disengaging attention (Dodd et al., 2015). Therefore, by taking the advantage of employing dot-probe paradigm along with eye movement recording, two disengagement difficulty indices were defined as below.

a) Participant inflicted disengagement: To obtain this score, the cumulative durations of all the fixations following first fixation on threatening stimulus until the first shift of gaze away from it was divided by the number of trials where threatening stimulus was initially directed (Garner et al., 2006; Sun et al., 2016). Higher scores indicate greater disengagement difficulty. Participant inflicted disengagement was also calculated for happy faces.

b) Facilitated disengagement: This score was calculated for only under the below conditions (Schofield et al., 2012):

- participants were looking at the angry face when the probe appeared,

- the probe was invalid, such that it appeared in the opposite visual field from the angry face

So, sum of detection time (i.e., duration from when the probe appeared to when they initiate a saccade away from angry faces) across trials was divided by the number of threat incongruent trials in which participant was looking at the angry face when the probe appeared.

Attentional maintenance

Maintained attention refers to the overall time spent looking at threatening information compared to neutral information during the entire stimuli presentation. It does not specify differential attentional bias patterns in relation to stimuli types; however, it is intrinsically linked to the association between early versus strategic information processing stages and different attention biases. So, one can get an insight about the time-wise contingency between different bias types by dividing the total stimuli observation time into smaller time periods and examining what periods involved extensive observation of emotional stimuli.

So, attentional maintenance scores were obtained by dividing 2000 milliseconds into 4 time windows of 500 milliseconds. The absolute viewing times were calculated for each face pair for each time window (Shechner et al., 2013).

Table 2.1. The definitions and formulas of the eye movement metrics

Eye Movement Index	Definition	Formula
Vigilance	The relative frequency of directing attention initially to threatening information	The total number of trials where initially the emotional face was fixated on before neutral face ÷ The total number of trials with initial eye movement to either emotional or neutral face E.g., Calculation of threat vigilance The total number of trials where initially angry face was fixated on before neutral face ÷ The total number of trials with initial eye movement to either angry or neutral face If the ratio of initially fixating on angry face is greater than .50, this indicates preference towards threat. If smaller than .50, this indicates preference towards neutral face. If it is equal to .50, this indicates no preference.
Participant inflicted disengagement	The prolonged fixation times on threatening stimulus between its initial detection and the first shift towards another location	The cumulative durations of all the fixations from initial direction towards emotional stimulus until the first shift of gaze away from it ÷ The total number of trials where emotional stimulus was initially directed (averaged over all valid trials) E.g., Calculation of participant inflicted threat disengagement The cumulative durations of all the fixations from initial direction towards angry face until the first shift of gaze away from it ÷ The total number of trials where angry face was initially directed The outcome value is in milliseconds.

Table 2.1. The definitions and formulas of the eye movement metrics (Continued)

Eye Movement Index	Definition	Formula
Facilitated disengagement	The time period between the final fixation on the emotional stimulus and the first fixation on the emotion incongruent probe location	Under the conditions of: 1) participants were looking at the emotional face when the probe appeared, 2) the probe was invalid, such that it appeared in the opposite visual field from the emotional face Sum of probe detection time (i.e., duration from when the probe appeared to when participant initiated a saccade away from the location of the emotional face) in emotion incongruent trials ÷ The total number of emotion incongruent trials in which participant was looking at the emotional face when the probe appeared (averaged over all relevant and valid trials) E.g., Calculation of facilitated threat disengagement Under the conditions of: 1) participants were looking at the angry face when the probe appeared, 2) the probe was invalid, such that it appeared in the opposite visual field from the angry face Sum of probe detection time (i.e., duration from when the probe appeared to when participant initiated a saccade away from the location of the angry face) in emotion incongruent trials ÷ The total number of angry incongruent trials in which participant was looking at the angry face when the probe appeared) The outcome value is in milliseconds.

Table 2.1. The definitions and formulas of the eye movement metrics (Continued)

Eye Movement Index	Definition	Formula
Attentional maintenance: absolute viewing times	The patterns in the length of attentional distribution over each stimulus during the overall stimuli presentation time	Total stimuli presentation time (i.e., 2000 milliseconds) in each trial is divided into four time-windows of 500 milliseconds (window 1: 0-500, window 2: 501-1000, window 3: 1001-1500, window 4: 1501-2000 milliseconds) For each time window of 500 milliseconds: The dwell time that indicates how long the participant looked at a particular stimulus within a certain time window is obtained by totalling the durations of all fixations on a particular stimulus within that time window (averaged over all valid trials) E.g., Calculation of attentional maintenance on threat in absolute dwell times The durations of all fixations on angry faces in each time window are totalled separately and averaged The outcome value is in milliseconds.
Attentional maintenance: adjusted for dwell times on neutral stimulus	The patterns in the length of attentional distribution over emotional stimulus adjusted to reflect the function of dwell time on the neutral stimulus paired with it	For each time window of 500 milliseconds: The length of cumulative fixations on emotional stimulus ÷ The length of cumulative fixations on neutral stimulus paired with that emotional stimulus E.g., Calculation of adjusted attentional maintenance on threat The length of cumulative fixations on angry faces within a time window ÷ The length of cumulative fixations on neutral stimulus paired with the angry face within the same time window The outcome value is in ratio.

2.4.2. Computer Tasks

Both dot-probe task and Simon task were programmed and administered using E-Prime 2.0. All indices were obtained with customized scripts in R.

2.4.2.1. Dot-Probe Task

As another measure of attention bias, dot-probe task was chosen to be administered along with eye-tracking instead of free-viewing. Because a) requiring a response would make children more focused on the task; b) the task facilitates attentional disengagement in contrast to free-viewing; and c) it would allow comparison with the literature as dot-probe is the most commonly used paradigm for attention bias research.

Facial stimuli were chosen over linguistic stimuli to rule out differences in children's reading ability and they have better ecological validity (Telzer et al., 2008; Waters, Mogg, et al., 2008). So, the stimuli images were selected from a standardized database called the Radboud Faces Database (RaFD), which was developed and validated by Langner and colleagues (Langner et al., 2010). 32 different young adult, Caucasian face images (16 male and 16 female) were used. The images were coloured, photographed on a white background, and were 384 x 576 pixels. Each model depicted an angry, a happy, and a neutral facial expression (See Appendix 6 for a sample of stimuli).

Each trial consisted of a centrally positioned fixation cross for 1000 milliseconds, followed by two faces belonging to the same identity, one on the left and one on the right side of the screen for 2000 milliseconds. Then an asterisk (the probe stimulus) occurred in the location of one of the previous faces until response. Participants were asked to identify the probe location (left or right) by using two separate keys of a joystick as quickly and accurately as possible. Then probe screen was replaced with a blank screen for a random period between 750 milliseconds and 1250 milliseconds. Faces were presented as emotional-neutral or neutral-neutral pairs. Critical trials were where neutral face was paired with an emotional face. If the position of the probe stimulus was aligned with the emotional stimulus, it was a congruent trial whereas if the probe occurred in the opposite location of the emotional stimulus, it was an incongruent trial (Fig 2.1).

The task consisted of 14 practice trials followed by 80 test trials. The images used for the practice trials were not use for test trials to prevent familiarity with stimuli. Test trials were programmed with 8 male – 8 female identities, which summed to 32 angry-neutral, 32 happy-neutral, and 16 neutral-neutral face trials with counterbalancing emotion type, congruency, and identity. The emotional faces appeared either on the right or left side of the screen with equal likelihood and the order of the trials were fully randomized for each participant. The entire task took roughly 15 minutes to complete.

As discussed in previous chapter, stimuli should be presented long enough for both automatic and strategic attention processing operate. Hence, not only vigilance but also disengagement difficulty or avoidance components of AB are allowed to be elicited without early termination of presentation. Previous dot-probe task studies with children typically reported strategic avoidance when stimuli are presented at 1000 msec and longer (Bertó et al., 2017; Salum et al., 2013). Eye movement studies with children, on the other hand, usually present stimuli for at least a few seconds to allow multiple shifts in gazing behaviour during observation (e.g., Gamble & Rapee, 2009; In-Albon et al., 2010; Seefeldt et al., 2014; Shechner et al., 2013). The AB tasks are recommended to be kept as short as possible when working with child samples (Garner, 2010). In addition, our stimuli do not involve complex visual scenes that require longer time for appraisal. So, by taking Price and colleagues' eye tracking study (2013) as example, which had a similar design of dot-probe task and reported avoidance in anxious children when stimuli were presented for 2000 msec, we presented stimuli for 2000 msec.

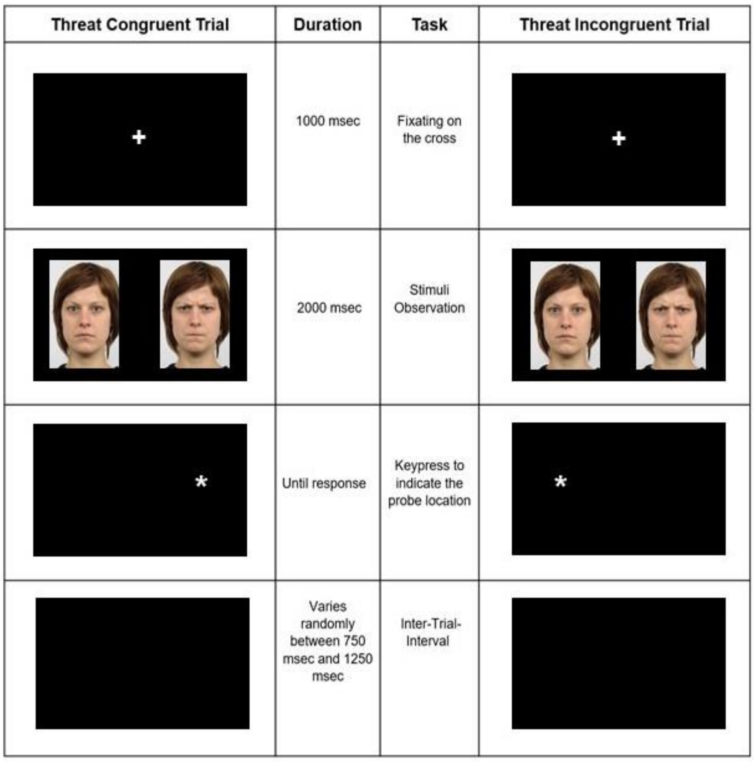


Figure 2.1. Illustrative example of trial timelines for congruent and incongruent trials of dot-probe task in the current thesis

Indicating probe location was chosen as the response style. In some previous studies, experimenters manipulated the characteristics of the probe and asked participants to identify the probe type (e.g., press left if it is letter F, press right if it is letter E; Carmona et al., 2015) rather than its location. However, doing so would increase the conditions in counterbalancing stimuli properties, which would in turn increase the total trial number, and thus increase the task length. Therefore, to keep the task short, we kept responding simple and only asked to respond to the probe location. The blank screen at the end of each trial served as inter-trial-interval and presented for a random period to prevent response automatization (Garner et al., 2010).

Response Definitions

Vigilance- Avoidance

Bias scores were calculated separately for each emotion type by subtracting the average reaction times on congruent trials from the average reaction times on incongruent trials (Mogg & Bradley, 1999). Scores with positive value indicate attention towards the emotional stimuli (vigilance) while scores with negative value indicates attention away from the emotional stimuli (avoidance).

Engagement – Disengagement

Using Koster and colleagues' (2004) method, engagement and disengagement scores were additionally calculated to better understand whether the initial attention towards emotional stimuli in the standard calculation reflects rapid engagement with the stimuli or delayed disengagement from stimuli. So, engagement scores were obtained by subtracting average reaction times on emotion congruent trials from average reaction times on neutral-neutral trials. Disengagement scores were obtained by subtracting average reaction times on neutral-neutral trials from average reaction times from emotion incongruent trials.

2.4.2.2. Simon Task

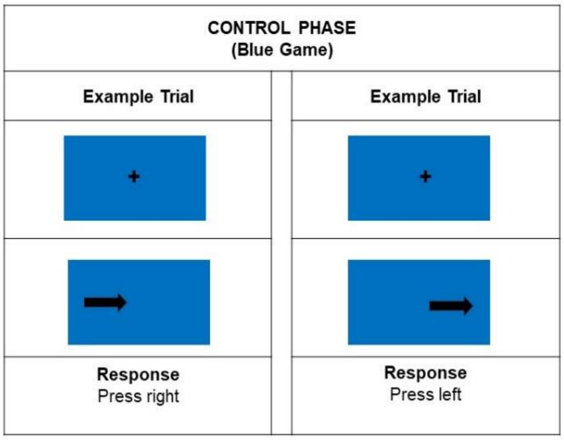
Simon task was used to measure attentional control. The task consisted of a control phase to measure baseline attention, an inhibition phase to measure inhibitory control, and a switching phase to measure task switching, which required rule switching between control phase and inhibition phase.

The control phase (Fig. 2.2A) was introduced as blue game to the participants as all the slides in this phase had a blue coloured background. Each trial started with a centrally positioned fixation cross. Then participants viewed an arrow either on the right or left side of the screen. The direction of the arrows varied. Participants were instructed to respond to the location of the arrow and told to press the left button of the joystick if the arrow was on the left and press the right button if the arrow was on the right as quickly and accurately as possible.

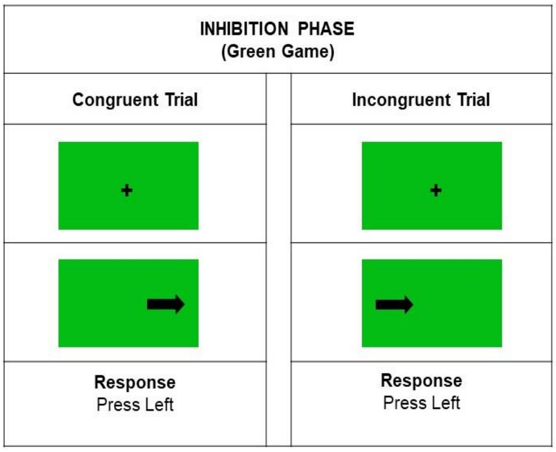
The inhibition phase followed the control phase (Fig. 2.2B). This phase was introduced as green game as all the slides in this phase had a green coloured background. Each trial started with a centrally positioned fixation cross. Then participants viewed an arrow either on the right or left side of the screen. The direction of the arrows varied. Participants were instructed to respond to the direction of the arrow and told to press the left button if the arrow was pointing to the left and press the right button if the arrow was pointing to the right as quickly and accurately as possible. Congruent trials were defined as the trials where the direction of the arrow stimulus is same as its location (e.g., arrow occurring on the right side of the screen and pointing to the right). Incongruent trials were defined as the trials where the direction of arrow was the opposite of its location (i.e., arrow occurring on the left side of the screen and pointing to the right).

After the inhibition phase, the switch phase started (Fig. 2.2C). This final phase was introduced as the mixed game since the background colour served as the cue for the task to be undertaken. Each trial started with a centrally positioned fixation cross. Participants were instructed to play according to the blue game rules (i.e., to respond based on the location of arrow) if the screen colour was blue and green game rules (i.e., to respond based on the direction of arrow) if the screen colour was green as quickly and accurately as possible. Switch trials were defined as the trials where participants switch from responding to arrow location to arrow direction or from responding to arrow direction to arrow location. If the same rule is repeated consecutively through trials, they were defined as NonSwitch trial.

Panel A



Panel B



Panel C

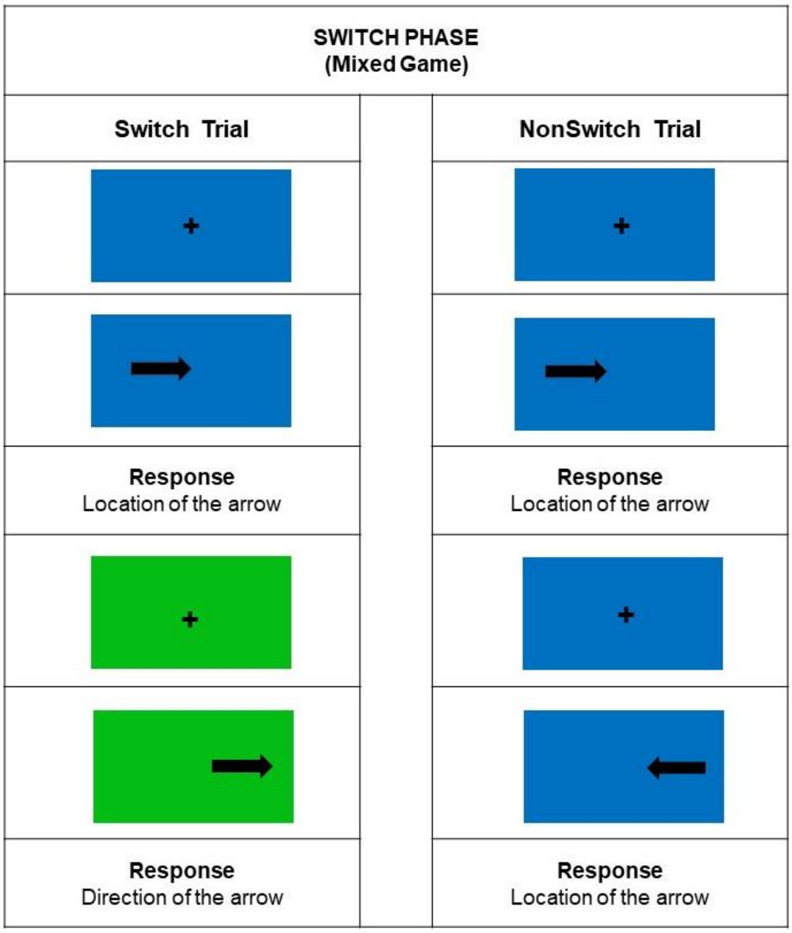


Figure 2.2. Phases of Simon task. Panel A: Control phase. Panel B: Inhibition phase. Panel C: Switching phase

Each phase consisted of two demonstrative and eight practice trials for participants to get familiar with task rules followed by 40 test trials. If a participant had exceedingly high number of inaccurately responded trials, the practice trials were repeated. The test trials were counterbalanced based on the stimuli conditions of each phase. So, the arrows heading towards left or right occurred either on the left or right with equal probability in all the phases. Also, the trial orders within each phase were fully randomized for each participant such that no participant viewed the trials of the phases with the same order.

The task was designed to calculate participants' mean reaction times during the practice trials of each phase and to present stimuli on the screen for the length of their average reaction times during test trials of each phase. Therefore, stimuli presentation length varied from participant to participant for each task type. The entire task took roughly 8 minutes to complete.

Response Definitions

Simon Index

Simon index is a measure of inhibitory control and defines the effect of stimuli characteristic – response congruency on performance. It is obtained for both reaction times and response accuracy.

So, average reaction times on correctly answered incongruent trials and percentage of correctly answered incongruent trials were subtracted from those of congruent trials in inhibition phase of the task.

Switch Indices

a) Switch Cost: Switch cost refers to the performance difference within a mixed block of trials where participants required to switch from one task rule to another (Philipp, Kalinich, Koch, & Schubotz, 2008). The switch cost index is obtained from both reaction times and response accuracy rate. So, it is manifested through slower reaction times and lower accuracy rates on Switch trials compared to NonSwitch trials.

To obtain the switch cost, average reaction times in correctly responded NonSwitch trials and response accuracy percentage of NonSwitch trials were subtracted from those of Switch trials.

b) Mix Cost: Mix cost refers to the performance difference between an isolated block of trials where only one task rule to be carried out and a mixed block of trials where switching between one rule to the other to be carried out (Philipp et al., 2008). In our task, mix costs are obtained by comparing NonSwitch trials of the switching phase and control and inhibition phases.

Accordingly, mean reaction times and accuracy percentage of NonSwitch trials of the switching phase were subtracted from those of control phase and inhibition phase.

2.4.3. Questionnaires

2.4.3.1. Socio-Demographic Questionnaire

Parents filled out demographics form for both themselves and their children (See Appendix 7). The forms consisted of basic demographical information about age, gender, ethnicity, and level of education, and who the child spends most of their time with. The final question was asked because it was thought that the transition process of attention bias from parents to their children might be affected by that.

2.4.3.2. Spielberger State-Trait Anxiety Inventory – Form Y (STAI; Spielberger, 1983)

Parental trait anxiety was measured with Spielberger State-Trait Anxiety Inventory (STAI; Spielberger, 1983). The questionnaire has two subscales based on Spielberger's context-wise distinction on anxious emotions as trait and state anxiety. Trait anxiety refers to the general disposition to feel anxiety across a wide range of situations while state anxiety refers to transitory present feelings of anxiety in certain, potentially anxiety provoking situations (Spielberger, Auerbach, Wadsworth, Dunn, & Taulbee, 1973).

Both trait (STAI-T, Form Y-2) and state (STAI-S, Form Y-1) anxiety subscales are self-report and has 20 items each. The response scales range from 0 to 4 for both subscales; however, STAI-S requires participants to rate themselves based on the intensity ("not at all", "somewhat", "moderately so", "very much so") while STAI-T requires ratings based on the frequency of anxious emotions ("almost never", "sometimes", "often", "almost always").

Mean STAI-S scores were 34.9 (SD, 9.2) for males and 35.7 (SD, 10.4) for females from community sample (McDowell, 2006). Higher scores indicate higher levels of anxiety and individuals with clinical levels of anxiety are estimated to fall in the range of 47 – 61 (McDowell, 2006).

The scale has been one of the most frequently used anxiety measurement in adults (Julian, 2011) and it is highly reliable with internal consistency of $.86 < \alpha < .95$ and two-month test-retest reliability of $.65 < r < .75$ (https://www.apa.org/pi/about/publications/caregivers/practice-settings/assessment/tools/trait-state). Its convergent validity is high as it shows high correlations with Taylor Manifest Anxiety Scale (Taylor, 1953) and Cattell and Scheier's Anxiety Scale Questionnaire (Cattell & Scheier, 1963) with 0.73 and 0.85 respectively (Julian, 2011). Its discriminant power in differentiating depression from anxiety is somewhat limited as it is also found to be highly correlated with the scales developed for depression (McDowell, 2006).

STAI-S was also administered but only STAI-T scores were included in the analyses. In addition, parents also completed Emotion Regulation Questionnaire (ERQ; Gross & John, 2003) and Simon task for future publications. But as they were beyond the focus of this thesis, they were not involved in the analyses.

2.4.3.3. Spence Children's Anxiety Scale-Child Version (SCAS-C; Spence, 1998)

Children's trait anxiety was measured with the self-report child version of Spence Children's Anxiety Scale (SCAS-C; Spence, 1998). The scale assesses symptom severity on various types of anxiety acknowledged in DSM – 4 such as separation anxiety, social phobia, obsessive-compulsive disorder, panic-agoraphobia, generalized anxiety, and fears of physical injury (Spence, 1998). It also provides a total anxiety score which allows evaluating the extent of trait anxiety in children and adolescents. It consists of 44 items in total with 38 items for anxiety measurement and 6 filler items to reduce negative response bias. It is a 4-point Likert type scale where children rate themselves on the occurrence frequency of items.

The scale's internal consistency of the total score is $.92 < \alpha < .94$ (Muris, Schmidt, & Merckelbach, 2000; Spence, 1998; Spence et al., 2011), and six-month test-retest reliability is r =. 60 (Spence, 1998; Muris, Schmidt, et al., 2000). It has good convergent validity that it has strong correlations with various anxiety scales for children (Essau, Muris, & Ederer, 2002; Muris, Schmidt, et al., 2000; Muris, Merckelbach, Ollendick, King, & Bogie, 2002).

The reliability and validity study of the scale was originally carried out with a sample of 8 to 12-year-olds (Spence, 1998). However, it has been validated also for adolescents aged between 12-18 (Muris et al., 2002; Muris, Schmidt, et al., 2000).

The scale was validated in both community and clinical child samples and it successfully differentiates clinical samples from community samples based on anxiety symptom severity (Spence, 1998, Nauta, 2005). The cut off scores are advised to be calculated by standardizing the scale scores to have a mean of 50 and a standard deviation of 10; and 10 point above the mean of 50 is deemed as indicator of elevated anxiety (https://www.scaswebsite.com/index.php?p=1_9).

2.4.3.4. Mood and Feelings Questionnaire – Child: Long Version (MFQ-C; Angold & Costello, 1987)

Because anxiety and depression are two highly comorbid conditions (Cummings et al., 2014), a continuous measure of depression was also taken to better dissociate effects of children's depression and anxiety on other measures. Depression was measured with the self- report, long version of The Moods and Feelings Questionnaire for Children (MFQ-C; Angold and Costello, 1987).

The long version consists of 33 items and youth participants rate themselves on a 3-point Likert type scale by choosing either "true", "sometimes", or "not true". It can be used for both child and adolescent populations (Angold, Costello, Messer, & Pickles, 1995; Klein, Dougherty, & Olino, 2005; Wood, Kroll, Moore, & Harrington, 1995). The scale appears to be highly reliable in that the long version has internal consistency of α =.94 (Wood et al., 1995). The scale has good convergent and criterion validity in that it satisfactorily discriminates youth with major depressive disorder from community sample youth without a disorder. The optimal cut-off point is suggested to be a score of 29 such that individuals scoring higher than 29 have clinical levels of depression (Daviss et al., 2006).

2.4.3.5. Emotion Regulation Questionnaire – Youth (ERQ – CA; Gullone & Taffe, 2012)

To measure children's habitual use of emotion regulation strategies, self-report Emotion Regulation Questionnaire for Children and Adolescents (ERQ-CA; Gullone & Taffe, 2012) was used. It is a revised version of Emotion Regulation Questionnaire (ERQ; Gross & John, 2003) to measure of emotion regulation strategy use in youth populations. Like ERQ for adults, the ERQ-CA also has two factor structure; with cognitive reappraisal and expressive suppression (Gross & John, 2003; Gullone & Taffe, 2012).

It is a self-report questionnaire consisting of 10 items. The youth participants rate themselves on a 5-point Likert type scale ranging from 1=strongly disagree to 5=strongly agree. Higher scores indicate higher uses of the strategies.

The scale has good internal consistency with α = .83 and α =.75 for reappraisal and suppression respectively (Gullone & Taffe, 2012). The 12-month test-retest reliability shows moderate stability that ranged between .37 < r < .47 for appraisal and .40 < r < .63 for suppression (Gullone & Taffe, 2012). Similar to adult ERQ (Gross & John, 2003), the suppression subscale has shown positive correlations with negative affect measures while reappraisal subscale has shown positive correlations with measures of positive affect (Gullone & Taffe, 2012), which suggests the scale has good convergent validity.

The questionnaire was initially validated with a normative youth population aged between 10 and 18 (Gullone & Taffe, 2012). In addition, the data from 9-year-olds also conforms well with the two-factor structure of the scale (Bariola, Gullone, & Hughes, 2012; Ehrenreich-May & Bilek, 2011; Gullone, Hughes, King, & Tonge, 2010; Jaffe, Gullone, & Hughes, 2010). For 8-year-olds there is no data available in the literature; however, the language of the scale was determined to be simple enough to be administered to children aged 8 with the help of a research assistant in consultation with the supervisors of this project.

2.4.4. Data Collection Session Procedure

All data collection sessions took place in the Child Development Lab, Psychology Department, University of Edinburgh, 7 George Square, Edinburgh, EH8 9JZ. The sessions were carried out outside the school hours during weekdays sometime between 3 pm and 7 pm or during weekends.

Before the study began, parents and children were given verbal information on the study again and were given the chance to ask questions if they have. Then parent signed consent forms for their participation and their children's participation. In addition, children also gave consent and wrote their names on the consent forms (See Appendix 5).

While parent was filling out the questionnaires with the aid of a research assistant, the child undertook the tasks with the PhD student in the eye tracking room. Then the child participant filled out the questionnaires with the aid of a research assistant while their parent was undertaking the tasks. To account for order effects, half of the families completed dot-probe task first and Simon task second while the other half completed the tasks the other way around.

After the parent finished participating, both children and parents were verbally debriefed about the aims of the research and their questions were answered. Verbal, face-to-face debriefing was chosen over written debriefing since it better encourages participants to ask questions and get an instant reply.

The entire data collection session took roughly an hour and a half for a parent-child pair. If a parent came with more than one child, each child participation added another half hour to the total time.

At the end of the experiment, parent was given £10 cash and each child were given £5 worth Amazon voucher to show our gratitude for their time and effort to come to the lab and take part in our study.

All the participants completed all the questionnaires and computerized tasks.

3. CHAPTER THREE: EXPLORING TRANSMISSION OF ATTENTION BIAS FOR THREATENING INFORMATION FROM PARENTS TO CHILDREN

3.1. LITERATURE REVIEW

3.1.1. How are parents involved in development of childhood anxiety disorders?

It is well known that the nature of parent-child interactions is a prominent risk factor for development of anxiety disorders in children and adolescents (Al-Biltagi & Sarhan, 2016; Beesdo et al., 2009; Creswell, Murray, Stacey & Cooper, 2011; Lebowitz, Leckman, Silverman, & Feldman, 2016; Rapee, 2012; Seehagen, Margraff, & Schneider, 2014; Vallance & Fernandez, 2016).

What underpins these interactions that take place within family and lead to anxiety in youth has been investigated extensively. Accordingly, genetic predisposition plays an important role in the familial transmission of anxiety. As such, there is a heightened risk of developing an anxiety disorder in the children of parents with an anxiety disorder compared to the children of parents with no anxiety (Beidel & Turner, 1997; Lawrence, Murayama, & Creswell, 2019). Consistently, anxiety symptomatology has been found to be highly heritable and runs in the families (McGrath, Weill, Robinson, Macrae, & Smoller, 2012) with heritability estimates of 30-40% based on the disorder type (Hettema, Neale, & Kendler, 2001).

However, genetic transmission explains a limited part of the aetiological variance for childhood anxiety (Eley, 2001, as cited in Fisak & Grills-

Taquechel, 2007). So, the way parents engage with their children appears to be another familial determinant of childhood anxiety. Attachment quality is a factor en route to anxiety within family such that youth without secure attachment have more likelihood of having anxiety disorders or anxiety symptomatology (Bögels & Brechman–Touissant, 2006; Brumariu & Kerns, 2008; Manassis, 2001) with an effect size of r =.30 (Colonnesi et al., 2011). Alike, parenting styles, especially parental control and lack of parental warmth, have been found to pose a risk to developing anxiety in children (Beesdo et al., 2009; Creswell, Murray, et al., 2011; McLeod, Wood, & Weisz, 2007; Wood, McLeod, Sigman, Hwang, & Chu, 2003).

However, it is important to acknowledge that understanding how child or parental anxiety feed each other is challenging due to the bi-directional nature of the associations on the behavioural level (Belsky, 1984; Fisak & Grills-Taquechel, 2007; Murray, Creswell, & Cooper, 2009). More specifically, research indicate that the anxiety related parenting styles that parents adopt may not necessarily stem from parents' own anxiety per se, but may rather occur as a response to certain child characteristics such as being highly anxious or having behaviourally inhibited temperamental style (Bögels, & Brechman–Touissait, 2006; Rapee, Schniering, & Hudson, 2009; Vasey, Bosmans, Ollendick, 2014), which may also partially be attributed to genetic inheritance (Murray et al., 2009).

A final and less well researched risk factor is children's learning processes such that they might learn to be anxious from their parents (Bögels &

Brechman–Touissant, 2006; Creswell, Murray, et al., 2011; Murray et al., 2009; Rapee et al., 2009).

3.1.2. A specific pathway: Acquisition of Anxiety Through Learning

Rachman (1977, 1990) asserted that vicarious (observational) learning and information transfer are two other pathways to acquisition of fears and anxiety apart from classical conditioning. Vicarious learning of anxiety and communicating anxiogenic information naturally take place in parental environment and contribute to children's anxiety (Fisak & Grills-Taquechel, 2007; Rachman, 1977).

Support for Rachman's (1977; 1990) suggestions comes from a range of studies that focus especially on investigation of parental modelling of anxious behaviours. Accordingly, how children acquire fear within the context of family can be traced back to infancy/toddlerhood years. Social referencing is one pathway towards learning what one should be afraid of by observing environmental clues such as others' interpretation or appraisals of objects / events in the environment (Gerull & Rapee, 2002).

As such, social referencing studies with infants and their mothers with varying degrees of anxiety have revealed that there is indeed a transmission of fear through observation of mothers' reactions. Gerull and Rapee (2002) showed that infants displayed greater fearfulness towards and avoidance from the toys following their mothers' negative reactions to these toys. In a similar vein, it was found that mothers with social anxiety engaged significantly less and encouraged their babies less to engage with the stranger in the room, which resulted in increased avoidance from the stranger in their babies (Murray, Cooper, Creswell, Schofield, & Sack, 2007; Murray et al., 2008). Interestingly, similar results were found in another study with mothers that have low social anxiety and only acted as anxious during the experiment (de Rosnay, Cooper, Tsigaras, & Murray, 2006). The results of this study were somewhat supported by another study, where parental anxious expression but not parental anxiety disorder status was associated with infants' fear or avoidance (Aktar, Majdandžić, de Vente, & Bögels, 2013). This highlights the effect of anxiety transmission through learning when genetic influences are ruled out. The literature also shows that mothers' negative expressions for not only fearful but also emotionally neutral toys were strong enough for toddlers to avoid from them (Dubi, Rapee, Emerton, & Schniering, 2008).

As children grow older, their cognition gets more mature to accommodate more complex interactions with their parental environment. In line with this, research have sought to delineate how parental modelling of anxious behaviour operates in older children. A study on children undergoing a medical procedure found that high parental anxiety was associated with occurrence of children's fearful behaviours after the procedure in contrast to the children of non-anxious parents (Bevan et al., 1990). Similarly, the frequency of maternal expressions of fears was found to be associated with their school aged children's fearfulness (Muris, Steerneman, Merckelbach, & Meesters, 1996). To directly measure parental modelling on the behavioural level, Burstein and Ginsburg (2010) offered an experimental paradigm. Accordingly, parents acted anxiously or relaxed concerning a spelling test that their child undertake. The results revealed that children of parents who acted anxiously before the test reported more anxious feelings (Burstein & Ginsburg, 2010).

Researchers have also sought to examine the transmission of parental avoidance from threat through observation. In one study, two groups of parents were formed as escape and control conditions and parents were instructed to terminate a hyperventilation exercise early or late to signal avoidance while their children were observing their parents (Bunaciu et al., 2014). They found that although children did not differ based on anxiety levels, children in the escape group discontinued the exercise significantly earlier than children in the other group (Bunaciu et al., 2014). In another novel study, the relation between mothers' frequency of actual behavioural avoidance from spiders and their children's fear of spiders were examined (Lebowitz, Shic, Campbell, MacLeod, & Silverman, 2015). An equipment that is akin to virtual reality games with kinetic sensors was used, and mothers' avoidance from the side of the screen where a virtual spider occurs while catching a virtual ball was taken as measure of interest. Interestingly, they found that mothers' increased rate of spider avoidance was significantly correlated with fear of spiders in their children (Lebowitz et al., 2015).

It is widely accepted that the way anxiety provoking situations are communicated between parents and children can also be one form of modelling apart from observation of anxious behaviours (Rapee, 2012). Observational studies in laboratory environments that utilize family discussion paradigms (i.e., parents and kids are asked to discuss the end of hypothetical ambiguous stories together) provide empirical evidence that parents can encourage avoidant behaviours in their anxious children when a challenge is present. One such study has shown that parents of anxious children expected their children to display avoidant coping strategies (Barrett, Fox, & Farrell, 2005; Cobham, Dadds, & Spence, 1999). It was also found that children's own avoidant interpretations of the situations increased after discussions with their parents (Barrett, Rapee, Dadds, & Ryan, 1996) and that parental reciprocation and somewhat approval of children's avoidant coping strategies increased children's final resolution to be an avoidant strategy (Dadds, Barrett, Rapee, & Ryan, 1996). Avoidance is a common maladaptive type of coping strategy that anxious individuals adopt to reduce anxious emotional arousal. In relation to this, the results of the above studies point out that avoiding from stress provoking situations could be reinforced within the families of anxious children.

However, it is not only avoidance that is modelled by parents. The studies on children/adolescents' perceived anxious upbringing revealed that anxious parental behaviours or cognitions also impact children's overall anxiety symptomatology. Accordingly, children's self-report ratings concerning their parents on questionnaire items such as "Your parents are afraid that something might happen to you." or "Your parents warn you against all possible dangers" (EMBU-C; Muris, Bosma, Meesters, & Schouten, 1998) were found to be associated significantly with their elevated anxiety symptoms (Grüner, Muris, & Merckelbach, 1999; Muris & Merckelbach, 1998; Muris, Meesters, Merckelbach, & Hülsenbeck, 2000; Roelofs, Meesters, Huurne, Bamelis, & Muris, 2006). Similarly, Wei and colleagues (Wei & Kendall, 2014) found that children's anxious self-statements were positively associated with their mothers' anxious self-statements, which suggests that modelling parental anxiety also takes place in formation of children's cognition.

3.1.3. Parental origins of AB for threat in children: Empirical Evidence

One aspect of cognitive vulnerabilities to childhood anxiety is biased processing of threatening information. Compounding the influence of parental environment in development of anxious affect in children and children's information processing biases, Rapee (2001, as cited in Hadwin et al., 2006) argues that information processing biases might mediate the association between parental factors and children's anxiety.

In agreement with this, accumulating evidence do highlight an association between children's information processing biases and parental impacts on these. Most of the evidence comes from parental origins of interpretation bias as recent studies have revealed. As such, parental anxious modelling is associated with children's threat interpretation over time (Fliek, Roelofs, van Breukelen, & Muris, 2019); children's interpretation bias mediates the link between parental anxiety and their own anxiety (Affrunti & Ginsburg, 2012); and parents' own interpretation biases are linked with their children's interpretation biases (Creswell, Shildrick, & Field, 2011).

Albeit literature allows drawing consistent conclusions regarding parental factors that enhance children's interpretation biases (Affrunti & Ginsburg, 2012; Creswell, Shildrick, et al., 2011; Fliek et al., 2019), how these factors operate in children's attention biases is less well understood.

Anxiety Heritability

Following the heritability estimates reported above, Brown and colleagues' twin study (2013) explored the impact of anxiety heritability and parental environment on children's AB for threat. The study reported a significant association between children's anxiety scores and their avoidance from threat. However, this association was not qualified by genetic heritance or parental environment as indicated by the nonsignificant correlation between the twins' attention bias scores.

On the contrary, Gibb and colleagues' study (2011) supports the role of genetic predisposition. Their study examined the relation between children's AB for threat and 5-HTTPLR gene polymorphism (i.e., an acknowledged biomarker for internalising disorders; Gregory & Eley, 2011). They found that children with short allele of this gene displayed significantly more AB for angry faces compared to children with long allele.

Parenting Styles

Gibb and colleagues (2011) also examined the role of parenting styles on children's AB in the same study. In addition to gene variation, they reported that when maternal criticism was involved in the analysis, angry avoidance of children with short allele remained intact if their mothers were highly critical in contrast to the children with short allele and experiencing low maternal criticism (Gibb et al., 2011). This suggests that negative parenting styles have their own impact on increased AB for threat in children apart from anxiety heritability. Remarkably, two other studies noted the role of negative parenting such that children's vigilance towards threat were found to mediate the association between their anxiety symptoms and their parents' parenting styles such as over involvement (Perez-Olivas et al., 2008) and authoritative parenting (Gulley, Oppenheimer, & Hankin, 2014).

Parental Psychopathology

The role of parental psychopathology, especially anxiety linked disorders/symptoms, on children's threat AB have also been investigated. An early study by Moradi and colleagues (Moradi, Neshat-Doost, Teghavi, Yule & Dalgleish, 1999) compared children of parents with PTSD with control children; and reported that children of parents with PTSD showed greater Stroop interference for threat related words compared to the control children.

Similarly, Schneider and colleagues (Schneider, Unnewehr, In-Albon, & Margraf, 2008) explored whether being at high risk of developing panic disorder in children of panic disorder patients would result in heightened AB for panic related words using Emotional Stroop. Three groups of children based on parental psychopathology (panic disorder, specific phobias, control) were tested to examine the specificity of panic disorder. Contrary to their expectations, the authors could not find Stroop interference for panic related words in children of panic disorder patients. However, children of parents with phobia showed significantly greater AB for phobia related words compared to children of parents with no disorder. Grouping children as anxious and non-anxious to better differentiate whether the existent AB is due to parents' or children's own psychopathology revealed no significant group differences in AB for threat.

This study used Emotional Stroop task as a measure of attention bias; however, it is now acknowledged that Emotional Stroop is not an ideal measure of attentional distribution over stimuli to pinpoint attention bias, but instead a measure of inhibition ability in the presence of emotionally relevant distractors. Nevertheless, the specificity of AB towards phobic stimuli in children with phobic parents somewhat points out a link between parental transmission of phobia. This is especially pronounced given that children's own diagnostic status was not associated with their attention biases. Also, considering the cumulative evidence that phobia is characterised with fear of specific types of stimuli and its transmission through observational learning is common (Muris & Field, 2010), differential attention patterns phobic stimuli could be stronger than panic related stimuli.

Montagner and colleagues' study (2016) provides further evidence on how mothers' psychopathology status affects their children's AB towards theat. They tested children of mothers with anxiety disorder, mood disorder, comorbid anxiety and mood disorder by comparing children of parents with no disorder using dot-probe task. While gender differences in children's AB were also reported, mothers' clinical status predicted greater AB for threat in children, independent of children's own symptoms.

The results of the above studies converge in highlighting the association between parental anxious psychopathology and increased AB for threat in their children. However, to explore whether children indeed learn doing AB from their parents, and hence to draw direct links as to whether children's AB patterns are similar to that of their parents, parental attention bias should also be measured.

Parental AB Patterns

Mogg and colleagues (2012) study is the first study of this kind. They examined transmission of anxiety related attentional processing styles in daughters of mothers with current panic disorder, with history of panic disorder and with no disorder history using dot-probe task with short (500 milliseconds) and long (1250 milliseconds) stimuli presentation duration and with physical threat and neutral pictures and words. Their results clearly evidenced the role of maternal anxiety on daughters' attentional bias for threat cues during long version of dot-probe task. As such, daughters of mothers with lifetime panic disorder were more vigilant to threat compared to daughters of control mothers. Furthermore, daughters' own anxiety diagnostic status and trait anxiety was not associated with their threat bias except their worries regarding physical health, which again supports influence of maternal psychopathology on their threat processing. However, the correlations between maternal AB and daughter AB for threat cues did not reach significance, suggesting that albeit maternal environment has contributed daughters' sensitivity to information signalling threats to physical health, they do not deploy attention to this information in a similar way.

Another study with a similar design was carried out by Waters and colleagues (Waters, Forrest, Peters, Bradley, & Mogg, 2015). They examined whether children's AB for emotional faces were a function of maternal anxiety/depression status and whether these would be related to their mothers' AB using face dot-probe task with 500 millisecond stimuli presentation duration. In contrast to results of Mogg and colleagues (2012) study, they reported that children's threat AB in maternal psychopathology group did not differ significantly compared to threat AB of children of mothers with no psychopathology. Interestingly, however, they reported that threat vigilance of children at high risk of psychopathology was significantly associated with reduced maternal vigilance for positive information. Given that lack of AB toward positive information or AB for sad information is common in depressed individuals, reduced maternal AB for positive stimuli could be attributed to the study's mixed sample composition as some mothers in the sample had major or comorbid depression. However, the association stayed significant even after controlling for maternal and child symptoms (Waters et al., 2015). Their results suggest that there could be no simple transmission of AB as would be indicated by similar AB patterns between children and their parents. Instead, the authors suggested that daughters' increased threat AB in the presence of reduced maternal AB for positive stimuli could be because of daughters being exposed to more negative stimuli by their mothers (Waters et al., 2015), which would increase selective attentional processing of negative stimuli in daughters.

Additionally, Waters and colleagues (Waters, Candy, & Candy, 2018) reported the follow up results on the same sample at Waters et al. (2015) as a preliminary longitudinal study. The association between maternal anxiety and increased threat bias in children was supported by the significant positive correlation between mothers' AB for threat at time 1 and their children's anxiety scores at time 2 in the high risk group. However, no significant associations were found between maternal – child threat AB in either risk group in either time points. The association between maternal positive AB and child threat AB at time 1 was close to significant in alignment with Waters et al., (2015) but not significant at time 2.

3.1.4. Current study: Aims

The accumulating literature have evidenced that parental factors operate in children's acquisition of fear and anxiety through learning mechanisms such as observation and information transfer. Consistently, given that a) these learning mechanisms have the potential to impact children's information processing styles and b) anxious children are characterised with biased processing of threatening information, it is plausible to assume that children might learn prioritizing processing of threatening information through interactions with their parents.

Converging evidence posits that parental anxiety disorder status is a significant risk factor for their children to display AB for threat. However, there are few studies that directly compared parental AB with child AB and their results are far from being conclusive to suggest that children's threat prioritizing through visual observations is associated with that of their parents. While Waters et al., (2015) reported that mothers' reduced AB for positive stimuli is associated with their children's increased AB for threat in high risk sample, Mogg et al., (2012) and Waters et al., (2018) reported no significant associations between parental and child AB in either direction for either emotional stimuli.

The transmission of AB vulnerability from parents to children may indeed be more complicated than children simply mimicking their anxious parents' threat prioritization. However, more research is needed to draw firm conclusions. Therefore, the overarching goal of the current chapter is to explore parental origins of threat related bias within the context of trait anxiety in community sample children and adolescents. Specifically, we aimed to examine a) children's attention biases by comparing them with that of their parents, b) whether children's attention biases would be associated with that of their parents, and if so c) whether parental AB would moderate the relation between their children's AB and anxiety.

This study is rather exploratory since the inconsistent results related to the links between parent-child AB did not allow us to have specific hypotheses regarding the nature of the tested associations. Thus, statistical significance was evaluated two-sided in all the tests.

3.2. METHODOLOGY

Data for this study were collected in conjunction with the studies in Chapter 5 and Chapter 6. So, details regarding ethics approval, participant inclusion/exclusion criteria, sample size calculations, participant recruitment procedure, data collection procedure, all the measurement tools, and the respective response definitions were described in Chapter 2. The following section will summarize the aspects of the methodology that are specific to this study.

3.2.1. Measurement tools specific to Chapter 4

3.2.1.1. Symptom Measures

For children, questionnaires SCAS-C and MFQ-C: Long version were used. For parents, STAI-T was used.

3.2.1.2. Attention Bias Measures

Attention bias was measured with eye tracking and participants' gazing behaviour were recorded while they undertook dot-probe task. Therefore, attention bias indices were obtained from both eye movement data and dot-probe data.

Eye movement data indices were probabilities of first fixation location, participant disengagement length, and average dwell times on angry, happy, and neutral stimuli across 4-time windows of 500 milliseconds. Dot-probe data indices were mean reaction times, vigilance - avoidance, and engagement - disengagement scores for angry, happy, and neutral faces.

Regarding details on index definitions and how they are obtained, please refer to Chapter 2.

Descriptive statistics for sample characteristics, eye movement data, and dot-probe data were summarized in Table 3.1, Table 3.2, and Table 3.3, respectively.

3.2.2. Participants

The data from parent-child couples are important for the purposes of this study. Therefore, it is made sure that there is parental data for each child or there is data from at least one child for each parent. So, if the participants to be removed were off-spring and if they were the only child that the family attended with, the data from the entire family were removed all together even though parent data was intact. If the participants to be removed were parents, then the data from the entire family were removed all together even though child data was intact. Subject observations were not completely independent since more than one child from the same family were tested for 17 of the families. So, after participant exclusion procedure (See Figure 3.1. for a diagram of participant reduction process step by step), the remaining sample consisted of 71 families, with 71 Parents and 88 children.

Child Sample

Child sample consisted of 88 children and adolescents (male=39, female = 49) aged between 8 and 16 (*M* = 10.79, *SD* = 2.21). All of the youth spoke English as their first language or fluently (87.5% Caucasian). Majority of the children spent time with both of the parents equally (65.9%), the remaining spent most of their time with their mothers (31.8%).

SCAS-C showed high internal reliability with pooled Cronbach's α = .839 in our sample. The mean of SCAS-C scores is 24.69 (*SD* = 12.69). Previous studies with normative samples reported SCAS-C means that range between 16.09 – 27.35 (Essau et al., 2002; Muris Schmidt, et al., 2000; Muris et al., 2002; Spence, Barrett, & Turner, 2003, https://scaswebsite.com/docs/normstotalscas.pdf). So, the current overall youth sample remains within normative ranges of anxiety. However, it appears that children's anxiety scores in the present sample show considerable variability. A recent validity study reported a mean score of 36.11 in children with clinical anxiety (Reardon et al., 2019). By taking this value as a standard, 20% of the current sample demonstrated clinically significant anxiety scores.

Similarly, reliability of MFQ-C was also high with pooled Cronbach's α = .885. The MFQ scores of children (*M* = 11.97, *SD* = 8.59) resemblances data from normative children with no mood disorder (*M* = 11.6, *SD* = 9.9; Daviss et al. 2006).

Parent Sample

Parent sample consisted of 71 individuals (mother = 60, father = 11). Their age ranged between 30 and 58 (*M* = 43.80, *SD* = 6.31). All of them spoke English as their first language or fluently (94.4% Caucasian). The latest level of education attained was tertiary level for majority of the parents (98.6%).

Pooled Cronbach's α was .930 for STAI-T for the current sample. The mean trait anxiety scores in community populations as measured by STAI-T are 34.9 for men and 34.8 for women (McDowell, 2006). So, trait anxiety of parents in the current sample appears to be marginally above the normative scores (M = 37.60, SD = 10.05). The score for clinical threshold is reported to vary between 47 and 61 in psychiatric patients (McDowell, 2006). By this criterion, 18% of parent participants in this current sample appear to have high trait anxiety.

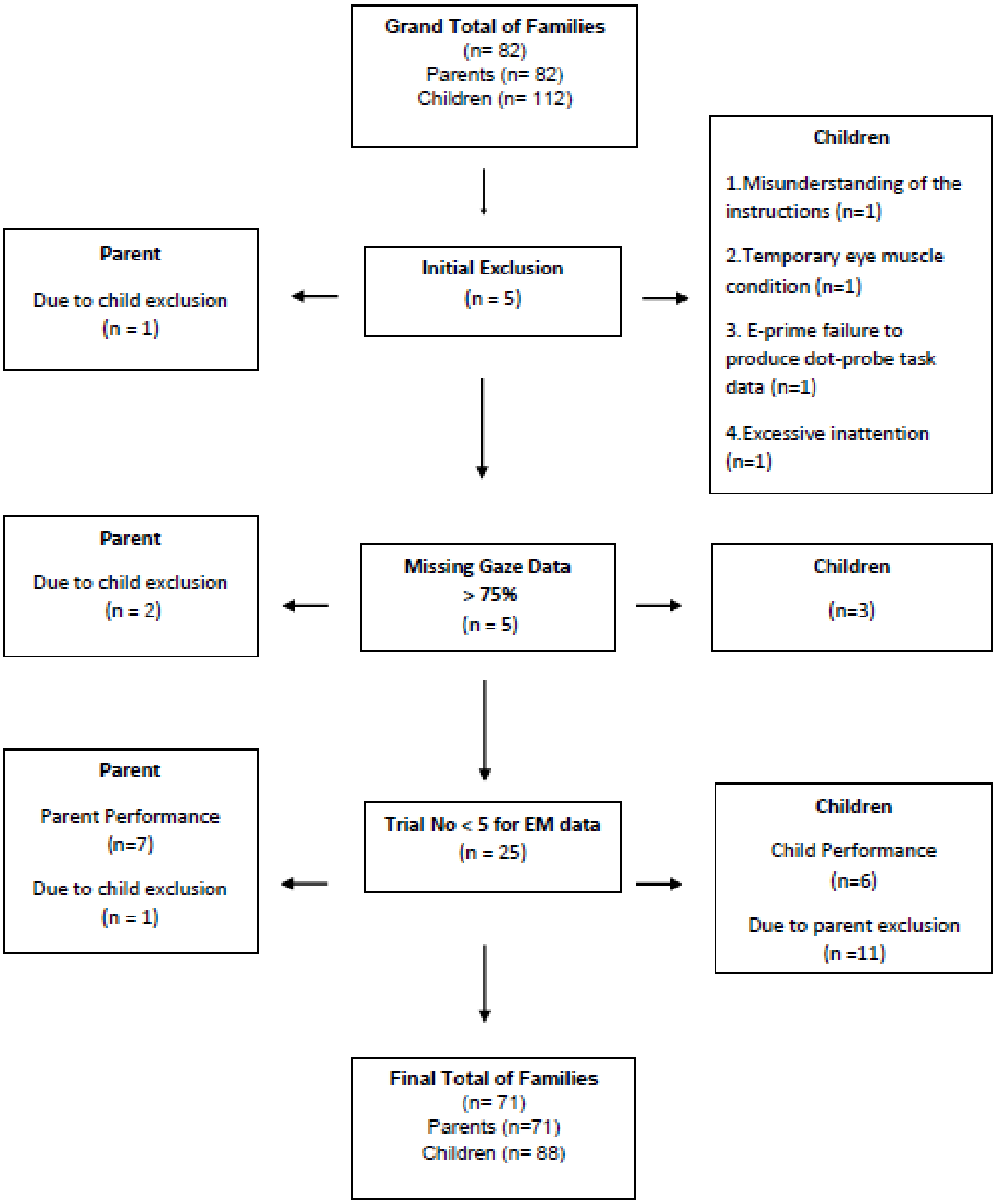


Figure 3.1. Flow diagram of participant exclusion process for Chapter 3

3.2.3. Data Integrity Check and Preparation

3.2.3.1. Questionnaire Data

Questionnaire data had user missing data due to participants skipping some items in the questionnaires. So, SCAS-C, MFQ and STAI-T data were checked against missing values with missing data analyses. The amount of overall missing data was 0.44%. The questionnaire data were assumed to be missing at random since results of Little's MCAR test was significant ($p < .05$) and separate variance t-tests revealed that probability of missingness in a variable was not a function of another variable. Although the amount of missing data was small, the missing data were replaced with linear regression multiple imputation ($n = 5$) so as not to reduce sample size and the statistical power in turn.

3.2.3.2. Eye Movement Data

Off-screen glances and blinks identified by loss of corneal reflection were defined as missing gaze data (Gamble & Rapee, 2009). Trials which have more than 75% missing gaze data were identified and removed for each participant (Price et al., 2013). Trials with erroneous responses in dot-probe task were removed. Trials with inattentive responses in dot-probe task were removed.

After the initial cleaning procedure, participants with more than 75% total discarded data in their entire gaze sample were removed.

Each eye movement index requires working with eye movement patterns under specific conditions. Therefore, the minimum number of usable trials for each experimental cell (i.e., on which an average index score is based) is identified as five to obtain a reliable mean. So, the participants, whose eye movement indices were calculated with less than 5 trials were removed. Some indices could not be calculated for some participants due to the nature of their gazing behaviour (i.e., not looking at the critical AOIs under respective conditions). These participants were also removed from further analysis.

For this reason, either mean facilitated disengagement scores could not be calculated or calculated with fewer than five trials for a very high number of participants (n= 86). Therefore, instead of list-wise deletion of these participants from the analyses, not using this score were chosen to keep sample size intact.

After the initial cleaning procedure explained above (Fig. 2.2), there was no missing data in the computerized task data since all the participants completed all of them during data collection.

3.2.3.3. Dot-Probe Data

Trials with erroneous responses were identified and removed. Consistent with previous research (Roy et al., 2008; Telzer et al., 2008; Waters, Mogg, et al., 2008; Weissman, Chu, Reddy, & Mohlman, 2012), trials with reaction times shorter than 200 milliseconds and longer than 2000 milliseconds were identified as inattentive trials and removed as extremely short and long reaction times are considered as signs of inattentiveness (Dodd et al., 2015). Personal outlier trials which were identified as trials with 3 standard deviation above or below the personal mean reaction times were removed.

3.2.4. Outliers and Normality Check

Total scale scores, eye movement indices and dot-probe reaction time data were screened against outlier values through box and whiskers plots. Extreme scores were rescaled through winsorization over list-wise deletion of participants so as not to reduce sample size any further. Following Price and colleagues' winsorization procedure (2013, see their supplement), values above and below 1.5 interquartile ranges from the 25th and 75th percentiles were defined as outliers. These values were then replaced with the next lowest or the highest valid value within that range.

Following winsorization procedure, assumption of normality was tested on each variable. There were several non-normally distributed variables, and these are reported with * in the respective descriptives tables. Both non-parametric and parametric tests were carried out in the investigations involving these non-normally distributed variables. If the results were the same, estimates based on parametric tests were reported. If there was no non-parametric equivalent of parametric tests such as repeated measures ANOVA, parametric tests were conducted. In such cases, the results should be interpreted with caution.

3.3. RESULTS

3.3.1. Sample Characteristics

SCAS-C (*M* = 24.69, *SD* = 12.69) and MFQ (*M* = 11.97, *SD* = 8.59) scores were within the non-clinical range in our sample, meaning that the overall child sample is not trait anxious or depressed. No differences based on gender or ethnicity was found on SCAS-C or MFQ (all p's > .05). Age was not significantly correlated with SCAS-C and MFQ (all p's > .05). SCAS-C and MFQ were significantly correlated to each other (r = .747, p = .000).

Parental STAI-T scores (*M* = 37.60, *SD* = 10.05) were also within the non-clinical range and overall parent sample was not trait anxious. Parental age was not significantly correlated with STAI-T scores. No gender or ethnicity differences were found on STAI-T.

Table 3.1. Descriptive statistics of demographic variables and questionnaires (Study 1)

	Children		Parent	
	N = 88		N = 71	
	Mean / N	SD / %	Mean / N	SD / %
Gender				
Male	39	44.3	11	15.5
Female	49	55.7	60	84.5
Age (year)	10.79*	2.21	43.80*	6.31
Ethnicity				
Caucasian	77	87.5	67	94.4
Asian	3	3.4	3	4.2
Arabian	1	1.1	1	1.4
Mixed	7	8.0	-	-
Spent Time				
Mainly Mother	28	31.8	-	-
Mainly Father	2	2.3	-	-
Both Parents	58	65.9	-	-
Education				
Tertiary	-	-	70	98.6
Secondary	-	-	1	1.4
	Children		**Parent**	
	N = 78		N = 65	
	Mean	SD	Mean	SD
Questionnaires				
SCAS-C	24.69*	12.69	-	-
MFQ-C	11.97*	8.59	-	-
STAI-T	-	-	37.60	10.05

Note. SCAS-C = Spence Children's Anxiety Scale-Child Version, MFQ-C = Mood and Feelings Questionnaire – Child: Long Version, STAI-T = Spielberger State Trait Anxiety Inventory Form Y-2. Presented questionnaire data is raw data prior to winsorization and imputation, so participants whose missing data to be imputed were not reflected in the respective sample.
Variables with * superscript indicates non-normal distribution.

3.3.2. Attention Bias Analysis with EM data

Table 3.2. Descriptive statistics for eye movement data (Study 1)

	Children		Parent	
	N = 88		N = 71	
	Mean	SD	Mean	SD
Missing Data (%)	7.43	13.61	1.61	3.33
Total Discarded Data (%)	9.26	13.88	2.20	3.55
Vigilance Index Score				
Angry	.510	.06	.50*	.07
Happy	.564	.09	.526	.07
Disengagement (msec)				
Angry Trials - Angry	529.302	174.17	544.062*	180.26
Angry Trials - Neutral	500.000*	226.27	503.690	153.35
Happy Trials - Happy	522.121	151.93	540.331*	177.22
Happy Trials - Neutral	450.932*	150.10	482.452*	158.98
AngryTrials – Angry Dwell (msec)				
Window 1	205.903	40.21	237.153	54.18
Window 2	276.051	40.76	282.163*	53.06
Window 3	297.123	47.62	298.879	49.42
Window 4	304.076	60.29	296.468	54.27
AngryTrials – Neutral Dwell (msec)				
Window 1	207.446	46.62	238.176	47.79
Window 2	263.416	43.27	260.602	48.25
Window 3	294.814	47.01	300.822	52.78
Window 4	298.660	60.99	318.777	59.26

Table 3.2. Descriptive statistics for eye movement data (Study 1) (continued)

Angry Trials – Adjusted Dwell				
Window 1	1.018	.19	1.002*	.15
Window 2	1.067	.19	1.096*	.18
Window 3	1.028	.20	1.016	.20
Window 4	1.043*	.24	.946	.17
Happy Trials – Happy Dwell (msec)				
Window 1	204.839	37.06	228.155	46.97
Window 2	282.948	39.24	282.386	44.82
Window 3	298.324	54.54	301.173	58.91
Window 4	304.718	59.35	315.682	64.23
Happy Trials – Neutral Dwell (msec)				
Window 1	204.756	42.07	239.430	51.15
Window 2	253.601	41.25	257.994*	50.30
Window 3	297.240	47.47	296.461	54.66
Window 4	291.135	63.75	293.036	64.97
Happy Trials – Adjusted Dwell				
Window 1	1.020	.17	.962*	.12
Window 2	1.143*	.24	1.121	.22
Window 3	1.018	.21	1.045*	.27
Window 4	1.077	.23	1.110*	.26

Note. Presented EM data is raw data prior to winsorization.
Variables with * superscript indicates non-normal distribution.

3.3.2.1. Initial Vigilance

Independent samples t-test yielded no difference between children (*M* = .510, *SD* = .066) and their parents (*M* = .500, *SD* = .078) in directing their first fixation to angry faces (t(157) = .890, p = .375). To determine the degree of vigilance in each group, one-sample t-tests were also carried out. Accordingly, the proportion of fixating on angry faces was not significantly greater than chance (0.50) for either group.

Analysis of happy-neutral trials revealed that vigilance for happy faces were significantly greater than chance for both children ($t(87) = 6.325$, $p = .000$), and their parents ($t(70) = 2.781$, $p = .007$). Also, children ($M = .564$, $SD = .094$) were more vigilant towards happy faces than their parents ($M = .526$, $SD = .079$) ($t(157) = 2.663$, $p = .009$) (Fig. 3.2).

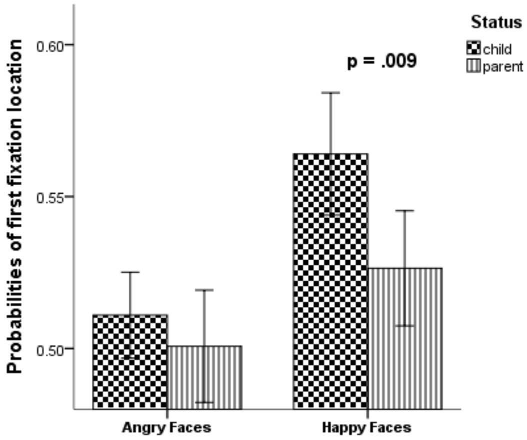


Figure 3.2. Proportion of first fixation location based on groups and emotion type. Error Bars represent 95% CI.

3.3.2.2. Disengagement

To test disengagement difficulty, 2 x 2 x 2 mixed design ANOVA with trial type (angry, happy) and disengagement type (emotion, neutral) as within subjects factors and status (parent, child) as between-subjects factor was carried out on participants' disengagement duration.

Main effects of disengagement type ($F(1, 157) = 72.448$, $p = .000$, partial $\eta 2$ = .316) and trial type ($F(1, 157) = 6.900$, $p = .009$, partial $\eta 2 = .042$) was qualified by trial type x disengagement type interaction ($F(1, 157) = 4.229$, $p = .041$, partial $\eta 2 = .026$). To follow up the interaction, paired samples t-tests with trial type on each level of disengagement type were carried out. Accordingly, disengaging from neutral faces on angry trials took longer than disengaging from neutral faces on happy trials in the overall sample (Fig. 3.3). No other main or interaction effects that involve group membership was found.

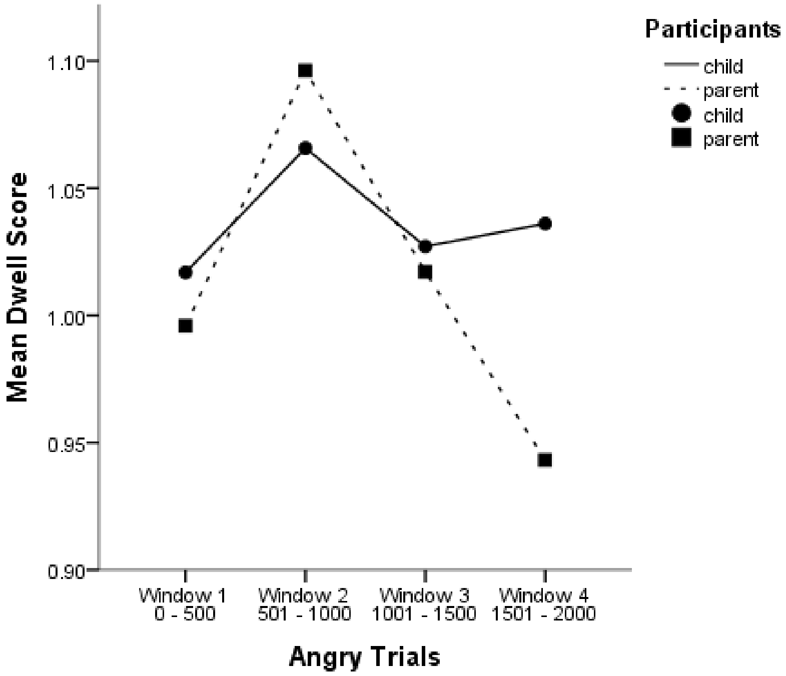
Figure 3.3. Mean disengagement durations based on emotion type across children and parents, Error Bars 95% CI.

3.3.2.3. Maintained Attention

In order to reduce the number of analyses for maintained attention, the dwell times for emotional stimuli were adjusted to reflect the function of dwell time on neutral pair by dividing the absolute emotion dwell time by that of neutral stimulus for each emotion type in each time window (Seefeldt et al., 2014). Two 2 x 4 mixed design ANOVA with time window (0-500, 501-1000, 1001-1500, 1501-2000 milliseconds) as within-subjects and status (parent, child) as between groups factors were carried out on participants' dwell scores for each emotion type. Greenhouse-Geisser correction was applied for violation of the assumption of sphericity when required.

For maintenance on angry faces, the analysis revealed main effect of time ($F(3, 471) = 6.759$, $p = .000$, partial $\eta2 = .041$), which was qualified by a significant time x group interaction ($F(2, 471) = 2.823$, $p = .038$, partial $\eta2 = .018$). Accordingly, the between-groups divergence in dwelling on angry faces is significantly greater in time 4 compared to time 2 ($F(1, 157) = 8.787$, $p = .004$, partial $\eta2 = .053$) such that parents showed reduced interest on angry faces in time 4 compared to their children, who showed increased interest. Also, parents' angry dwell was marginally different than that of children's on time 3 compared to time 4 ($F(1, 157) = 3.549$, $p = .061$, partial $\eta2 = .022$) revealing where the divergence in dwell time begun to start (Fig. 3.4A).

For maintenance on happy faces, the analysis yielded only main effect of time ($F(2.727, 428.173) = 15.838$, $p = .000$, partial $\eta2 = .092$). Accordingly, dwelling on happy faces is significantly shorter in time 1 ($F(1,158) = 21.317$, $p = .000$, partial η2 = .119) and time 3 ($F(1,158) = 6.484$, $p = .012$, partial η2 = .039) compared to time 4; and dwell scores in time 2 is significantly greater than time 4 ($F(1,158) = 4.059$, $p = .046$, partial η2 = .025) (Fig. 3.4B).



PANEL A

PANEL B

Figure 3.4. Attentional maintenance patterns based on emotion type across children and parents. Panel A: Angry Trials. Panel B: Happy Trials

3.3.3. Correlations

A series of t-tests and correlations were carried out on critical variables (See Appendix 8 for the variable correlogram) to identify potential predictors and covariates for a regression model that tests whether parental bias moderates the association between children's bias and anxiety symptomatology.

Examination of covariates in children yielded no gender related variations or age-related associations in bias scores for either emotion type. Also, neither anxiety nor depression symptoms were significant associates of children's AB for either emotion.

For parents, no significant gender differences were found except dwell score in window 1 in happy trials, where mothers' (*Mdn* = .937) happy dwell score was higher than fathers (*Mdn* = .916) (*U* = 312.500, p = .040). Parental age was not associated with bias scores except angry adjusted dwell on window 1 (r_t = -.453, p = .05). Parental anxiety was not associated with parental attention bias for either emotion.

Critically, parents' anxiety score was not associated with children's anxiety or depression scores (all p's > .05). Also, no significant associations were found between parent – child threat AB or parent-child positive AB indices.

Because Water and colleagues (2015) found that reduced maternal attention bias for positive information was related to increased attention bias for threat in children, we also examined the cross correlations between angry and happy biases in both groups. The results were not consistent with Water and colleagues' (2015) study. Children's and parents' dwell scores in each time window for each emotion type revealed no significant associations except the positive correlation between children's happy dwell score on window 3 and parents' angry dwell score on window 2 (r_t = .215, p <.05).

3.3.4. Supplementary Analyses

3.3.4.1. Subsample Analysis

The non-significant associations between parent and child AB indices did not allow for developing a regression model to test whether parental attention bias moderate children's anxiety and attention bias relation.

Failure to find significant associations between parental and child variables could be due to the samples being drawn from community and not being trait anxious. However, previous studies (Mogg et al., 2012; Waters et al., 2015;

Waters et al., 2018) compared children based on maternal psychiatric diagnostic status as high and low risk children groups. Therefore, we extracted out a subsample of relatively more anxious parents (n = 42) based on median split of their STAI-T scores (*Mdn* = 38) and further investigated the same associations with their children through a set of correlation analyses.

Despite narrowing down the samples based on relatively higher parental anxiety, the new parent and child samples remained not trait anxious (*M* = 44.97, *M* = 25.7 respectively). As a result, parental anxiety was not an associate of children's anxiety. No significant correlations emerged between parental and children's vigilance or disengagement difficulty. Similarly, no significant associations were found between parents' and children's attentional maintenance scores.

3.3.4.2. Attention Bias Analysis with Dot-Probe data

Table 3.3. Descriptive statistics for dot-probe data (Study 1)

	Children		**Parent**	
	N = 88		N = 71	
	Mean	SD	Mean	SD
Error Trials (%)	0.838	1.41	0.440	0.82
Total Discarded Data (%)	3.153	2.43	1.775	1.17
Mean RT (msec)				
Angry Congruent	647.621	143.00	571.592*	95.32
Angry Incongruent	653.590*	155.56	562.514	84.49
Happy Congruent	646.078	148.60	557.940	84.79
Happy Incongruent	655.217*	142.33	565.568	92.10
Neutral - Neutral	660.226*	156.18	571.782	96.61
VA Bias Scores				
Angry	5.968	62.36	-9.078	35.22
Happy	9.139	47.16	7.627*	34.51
Engagement Bias Scores				
Angry	12.604	53.90	.189*	33.26
Happy	14.148	52.02	13.84	33.17
Disengagement Bias Scores				
Angry	-6.636	47.90	-9.267	30.44
Happy	-5.008	54.02	-6.213	33.11

Note. Presented Dot-Probe data is raw data prior to winsorization.
Variables with * superscript indicates non-normal distribution.

Since results of many previous studies were obtained from dot-probe data, we also analysed our dot-probe task reaction time data to facilitate comparisons.

For angry-neutral trials, analysis of 2 x 2 mixed design ANOVA with congruency (congruent, incongruent) and status (parent, child) on reaction times yielded only main effect of status such that children responded to the location of the probes significantly slower than their parents ($F(1,157) = 20.243$, $p = .000$, partial $\eta 2 = .114$). No other main or interaction effects were found.

For vigilance-avoidance scores, one sample t-tests revealed that children did not show AB significantly different than zero while parents showed marginally significant avoidance from threat ($t(70) = -1.958$, $p = .054$). However, no significant group differences emerged.

For engagement scores, one sample t-tests revealed that children's threat engagement was significantly different than zero ($t(87) = 2.094$, $p = .039$) while parents showed no significant engagement. However, group difference did not reach significance. For disengagement scores, children's disengagement was not significantly different than zero while parents scores were significantly lower than zero ($t(70) = -2.411$, $p = .019$), suggesting greater ease in disengaging from angry faces, which is consistent with their significant avoidance scores. However, group difference did not reach significance.

For happy-neutral trials, the same mixed model yielded main effect of status again ($F(1,157) = 23.541$, $p = .000$, partial $\eta 2 = .130$), which means children responded slower than their parents. Also, main effect of congruency emerged

(F(1, 157) = 5.843, p = .017, partial η2 = .036) such that responses were faster on congruent trials than incongruent trials for happy faces in the overall sample.

Analyses of vigilance-avoidance scores for happy faces revealed that both children (t(87) = 1.818, p = .073) and parents' (t(70) = 1.612, p = 0.97) vigilance for happy faces were only marginally significant and no significant group differences emerged.

For engagement scores, both children (t(87) = 2.894, p = .005) and parents (t(70) = 3.484, p = .001) engagement with happy faces were significantly greater than zero while no group differences emerged. As for disengagement scores, children showed no significant bias while parents' disengagement scores were marginally lower than zero (t(70) = -1.704, p = .093). No group differences were found.

Tests of symptom-bias associations revealed that children's anxiety and depression scores were not significantly associated with any of children's attention bias scores for either emotion type (See Appendix 9 for the variable correlogram). Interestingly, parental anxiety emerged to be associated with children's vigilance towards angry faces (r = .317, p = .002) while no other significant associations was found. Parental anxiety was not associated with any of parent's attention bias scores for either emotion type.

Tests of associations between parental and children attentional biases did not reveal any significant associations for either emotion. So, testing a moderation model was not plausible for dot-probe data, either.

3.4. DISCUSSION

The overarching aim of this chapter was to investigate the parental underpinnings of attention bias for threat in children and adolescents through examining parent-offspring group similarities and divergences as well as associations. To my knowledge, this is the first study conducted with families from community sample to examine parental transmission of AB within the context of trait anxiety.

Comparisons of Parent-Child Attention Bias Patterns

Considering the individual differences in terms of the type of attention bias patterns displayed, several different indices of AB were obtained. Specifically, the frequency of locating initial fixations on angry faces was similar across parents and children. Neither children nor parents looked at angry faces initially more often than neutral faces, which replicate results of healthy control groups in previous eye tracking studies where threat-neutral biases were compared (Shechner et al., 2013; Seefeldt et al., 2014; Stevens, Rist, & Gerlach, 2011).

On the other hand, both children and parents showed increased initial vigilance for happy faces. This contrasts with Shechner et al. (2013), where no happy face vigilance was evidenced in non-anxious children and adolescents. However, although less common, some dot-probe task studies have suggested that happy biases can be observed in non-anxious populations or community samples (Joorman et al., 2007; Ho et al., 2017; Stirling et al., 2006; Waters, Henry et al., 2010; Waters et al., 2014) due to happy faces being emotionally more salient than neutral faces. Therefore, initial vigilance towards happy faces paired with neutral faces might reflect stimuli saliency in the current study.

As for disengagement difficulty, both parents and children showed longer attentional engagement with emotional stimuli compared to neutral stimuli. However, as specific to angry trials, both children and parents took longer time to disengage their attention from neutral faces in angry trials compared to the disengagement times for neutral faces in happy trials. Given that a) the proportion of initial fixations on angry faces were not significantly more than neutral faces as indicated by non-significant one-sample t-test, and b) the average dwelling on angry faces until the first gaze shift was longer than the average dwell time on neutral face pair, longer attentional maintenance on neutral faces on angry trials compared to happy trials is unlikely to reflect avoidance.

From stimuli appraisal perspective, previous explanations offered regarding bias for neutral faces were along the lines of neural faces being more ambiguous compared to emotional faces (Cooper & Langton, 2006; Fani, Bradley-Davino, Ressler, & McClure-Tone, 2011; Pergamin-Hight, Bitton, et al., 2016; Schofield et al., 2013).

In that regard, a possible explanation of longer attentional maintenance on neutral faces paired with angry faces may be due to clearer emotional saliency of angry faces. As such, the information depicted by neutral faces compared to angry faces might have seemed more ambiguous to the children so that they might have dwelled on neutral faces longer for further appraisal of their emotional content.

However, this interpretation requires caution since the information signalled by neutral faces can also seem more ambiguous compared to the emotional information depicted by happy faces. So, further eye movement studies are required to test the specific effect of stimuli presentation context on neutral stimuli in community sample children to have a conclusive opinion.

The findings regarding the overall attentional maintenance patterns have added prior research since no previous study has compared parent-child attentional distribution over emotional stimuli across the entire observation duration. While children and parents' attentional maintenance patterns during happy trials were almost identical, the divergences in the second half of the observation in angry trials revealed interesting results. Specifically, parents showed gradual avoidance from angry faces while children's attention returns to angry faces in the final observation window following a brief avoidance during the second half of the observation time. This divergent pattern appears to suggest differences in automatic-strategic threat appraisal process between parents and children.

According to the vigilance-avoidance hypothesis (Mogg & Bradley, 1998), anxious individuals show avoidance from threat to reduce anxious arousal caused by initial vigilance, which may be followed by attention focusing back and forth on threat. In contrast, non-anxious individuals show avoidance (or reduced interest) from threat after appraisal since allocating attentional resources on an unimportant information is not useful.

Given that the parents in the current sample were non-anxious, their reduced dwelling on angry faces in the second half of observation is in partial support of the hypothesis for non-anxious individuals (Mogg & Bradley, 2004). It is possible that parents might have evaluated threat value of angry faces more efficiently than their children during the first half of the observation and successfully ignored them during strategic stages of processing. In contrast, children's returned attention on angry faces, which imply that they needed further time to evaluate threat value of angry faces, resembles vigilance-avoidance patterns of anxious individuals predicted by the model.

However, considering that children's attention biases cannot be attributed to anxiety as they were low trait anxious, this discrepancy between parents and children are more likely to be due to differences in developmental stage such as adults having greater abilities in attentional control and emotion regulation (Ehrenreich & Gross, 2002; Puliafico & Kendall, 2006). It could be that cognitive immaturity has resulted in children having poorer attentional control abilities to shift their attention to neutral faces after initial evaluation of angry faces (Eysenck, 2007) or not having as much experience in emotion regulation through reallocating their attention (Cisler & Koster, 2010) compared to their parents.

Associations Between Parent-Child Attention Bias

Neither parental anxiety nor children's anxiety was significant associates of children's attention biases for either emotion. Also, no significant associations were found between parent-child threat AB or parent-child positive AB.

These results might therefore suggest that there is no direct parental transmission of AB vulnerability, replicating previous studies which reported no significant associations between parent-child biases for same stimuli (Mogg et al., 2012; Waters et al., 2015; Waters et al., 2017). However, the fact that both parents and children were non-anxious in the current study poses a key contrast to samples of previous studies, where parental psychopathology status was a key variable.

So, to make the sample characteristics of the current study more comparable with that of previous studies, additional analyses were performed with a subsample of parents with higher levels of anxiety and their children. These additional findings did not reveal significant AB associations either. One explanation is that the anxiety level of this subsample was still within the low to medium range of trait anxiety. It is therefore important to note that the current results are limited in their ability to be generalized to individuals with higher level of anxiety.

On the other hand, dot-probe data revealed that increased parental anxiety was significantly correlated with children's enhanced vigilance for threat, which is in line with Montagner et al. (2016) findings. This might suggest that parental trait anxiety can be a key factor in the formation of children's attention biases for threat even in typically developing children. However, the limitations of vigilance-avoidance score calculation requires caution in interpretation. Vigilance-avoidance scores are based on the stimuli-probe congruency effect (Mogg & Bradley, 1999) rather than a conjoined effect of emotion and congruency adjusted for attention to neutral stimuli (Koster et al., 2004). Indeed, the association between parental anxiety and children's engagement scores, which were obtained using Koster and colleagues' (2004) formula, became nonsignificant.

Similar to the eye movement data, dot-probe data also yielded no associations between parent-child attention biases, which support the results of Mogg et al. (2012) and Waters et. al. (2017) studies. So, our dot-probe data also suggest that AB vulnerability is not transferred from parents to children in disorder free families.

Limitations and Conclusion

This was the first study that explored parental underpinnings of children's attention bias within the context of trait anxiety using eye tracking methodology, which allowed direct and extensive comparisons regarding distribution and time of overt attention throughout the total stimuli observation time. However, the main limitation of this study is the lack of high trait anxious parents and children in the sample. So, it is worthwhile for future research to replicate this study with samples with a wider range of trait anxiety, and desirably also with a clinical sample for comparison.

Nevertheless, while vigilance and disengagement indices were comparable to the control samples of previous eye movement studies, especially the result of attentional maintenance patterns for threat appear to be our key finding. Accordingly, parent-child divergences during strategic threat appraisal highlight the role of other variables such as attentional control and emotion regulation on attention allocation in a developmental context, which will be explored in Chapter 4 and Chapter 5 respectively.

Another limitation is that this study was correlational and no conclusions regarding causality can be drawn. If there is transmission to children through parental anxiety or parental attention bias, longitudinal studies can better address how this transmission develops in time. Waters et al. (2017) is one example of this and suggested that maternal anxiety at time 1 predicts children’s vigilance towards threat in time 2. Although this study on its own also requires replication due to its small sample size and having only two data collection points (Waters et al., 2017), replicating the current study with trait anxious families can reveal information as to whether parental transmission of threat AB could alter anxiety status of children in the future by carrying them towards clinical diagnosis of anxiety.

4. CHAPTER FOUR: EXPLORING CHILDREN'S ATTENTIONAL CONTROL MECHANISM IN RELATION TO THEIR THREAT RELATED ATTENTION BIAS

4.1. LITERATURE REVIEW

4.1.1. Attentional Control Theory of Anxiety (Eysenck et al., 2007)

How attention mechanisms operate during biased threat processing has been subject to many explanations. One aspect of attention bias that has been examined by many studies is related to the level of attentional control exerted over attention distribution in the presence of threatening information. This is inherently linked to how stimulus is entered into the processing system and how it is processed further.

In relation to this, several AB models have highlighted the role of voluntary effort on attention to stay focused on the relevant information in the presence of distractors (Matthews & Mackintosh, 1998; Williams et al., 1997) or to scan the environment against threat (Wells & Matthews, 1994) as well as automatic threat detection (Matthews & Mackintosh, 1998; Mogg & Bradley, 1998; Öhman & Wiens, 2004; Williams et al., 1988).

A more recent account of attentional control and attention bias for threat is Attentional Control Theory proposed by Eysenck and colleagues (2007). The theory is an extension of Processing Efficiency Theory (Eysenck & Calvo, 1992), which is based on the idea that anxious thoughts preoccupy anxious individuals' cognitive resources (i.e., the central executive in Baddeley's (1986) working memory model) and the remaining cognitive capacity is not enough to carry out the tasks at hand (Eysenck, 1988). So, Attentional Control Theory was proposed to outline a more fine-grained explanation of the impact of anxiety on cognitive operations by bringing together Corbetta and Shulman's (2002) Attentional Systems as higher order cognitive mechanisms and Miyake and colleagues' (2000) latent variable analysis on executive functions as lower level mechanisms involved in attentional operations.

Main-stream attention literature posits that the fundamental function of attention is to prioritize selection of relevant information to respond them in the most appropriate way (Chica et al., 2013). In an environment full of information, however, attention needs to be focused on the relevant information by resisting distractors while monitoring other stimuli at the same time to avoid or approach as response (Chica et al., 2013). In accordance with this, Corbetta and Shulman (2002) suggest two interlinked attentional systems related to attention orientation. Goal-driven attentional system is responsible for selecting the appropriate stimulus relevant to current goal and behaviour while stimulus-driven attentional system carries out selection dependent on saliency of stimulus (Corbetta & Shulman, 2002). Therefore, the model assumes that anxiety impacts the balance between these two systems in favour of stimulus-driven attention. So, the influence of goal-directed attention decreases resulting in poor attentional control (Eysenck et al., 2007; Derakshan & Eysenck, 2009; Eysenck, 2010).

In contrast to Wells and Matthews' (1994) and Matthews and Mackintosh's (1998) models, Eysenck and colleagues formulated attentional control mechanism with more precision. Particularly, attentional control is associated with Baddeley's central executive as a key feature of the mechanism in their model. So, based on Miyake and colleagues' work (2000), they have proposed that inhibition, shifting, and updating functions are the main functions of central executive and play a role in recruitment of attentional control (Eysenck, 2010). Since updating refers to monitoring and updating transient storage of information, and thus related to the memory mechanisms rather than attention, it is only affected by anxiety under stressful conditions (Berggren & Derakshan, 2013).

While accumulating evidence show hindering effect of anxiety on tasks measuring inhibition and shifting abilities where no emotional stimulus involved (for reviews see Derakshan & Eysenck, 2009; Eysenck et al., 2007; Eysenck, 2010; Eysenck & Derakshan, 2011), Attentional Control Theory has become an influential model in explaining processing of threat related stimuli in the context of anxiety (Berggren & Derakshan, 2013; Cisler & Koster, 2010; Mogg & Bradley, 2016). As such, the theory posits that either a) inhibition function is impaired in anxious individuals with poor attentional control so that they cannot resist allocating their attention on threat information, or b) shifting function is impaired so that attention cannot be allocated flexibly to remain focused on task relevant stimulus (Derakshan & Eysenck, 2009; Eysenck et al., 2007).

It is worth noting that the theory acknowledges not only vigilant attention towards threat but also delayed disengagement from threat as a form of attention bias and offers explanation for it.

4.1.2. The role of Attentional Control on Attention Bias for Threat: Empirical Evidence from Adult Literature

Attentional Control Scale (ACS) developed by Derryberry and Reed (2001) has been a highly recognised tool to measure attentional control. It is a self-report questionnaire and measures elements of attentional control ability such as focusing (i.e., "My concentration is good even if there is music in the room around me"), attention shifting between the tasks (i.e., "It is easy for me to read or write while I am also talking on the phone"), and controlling thoughts flexibly (i.e., "I can become interested in a new topic very quickly when I need to") (Derryberry & Reed, 2002).

The seminal study by Derryberry and Reed (2002) have provided preliminary results regarding the association between attention bias for threat and attentional control as measured by ACS in adults. Attention bias was measured using a reaction time-based task with short and long stimuli presentation durations to account for the effects of automatic and strategic attentional control. Their results revealed that trait anxious adults drawn from community sample with poor attentional control had delays in disengaging their attention from threatening stimulus at long stimulus presentation in contrast to trait anxious participants with good attentional control, suggesting that the distractor effect of threat stimulus continues at long stimuli exposure for anxious individuals with poor attentional control.

Bardeen and Orcutt (2011) replicated their study in adults with PTSD and reported similar results. They found that attentional control ability was not associated with bias scores on its own; however, the interaction between

PTSD symptomatology and low attentional control predicted bias for threat at long stimuli exposure, but not bias for threat at short exposure duration.

The impact of attentional control on adult PTSD was also shown by Schoorl and colleagues (2014). Interestingly, their sample displayed avoidance from threat rather than delayed disengagement measured with dot-probe task at 500 milliseconds such that high PTSD symptomatology and low attentional control was associated with avoidance from threat. Their results point out that avoidance as a form of maladaptive coping strategy could also be linked to poor ability to exert attentional control in anxious individuals.

Putman and colleagues (Putman, Arias-Garcia, Pantazi, & van Schie, 2012) explored the role of attentional control on the association between trait anxiety and threat bias measured by Emotional Stroop Task. Although trait anxiety was not associated with Stroop Interference, focus sub-scale of ACS correlated significantly with Stroop interference. Failure to find significant correlation between anxiety and Stroop interference could be due to the sample composition since their sample was not a clinical one, but it consisted of participants drawn from community with varied anxiety scores within non-clinical range. Nevertheless, their results still suggest a trend in involvement of attentional control in threat processing. However, because Emotional Stroop task is acknowledged as a measure of response inhibition ability (Puliafico & Kendall, 2006) in the presence of emotional distractors rather than biased allocation of visual attention, the two measures of interest may be measuring the same construct, and the results should be interpreted with caution.

Taylor and colleagues (Taylor, Cross, & Amir, 2016) explored how elements of attentional control might interact with social anxiety scores differently to predict engagement and disengagement bias scores. They used focus and shifting sub-scales of ACS separately and obtained engagement and disengagement bias scores through dot-probe task by comparing the reaction times with baseline attention. Accordingly, low scores on shifting subscale of Attentional Control Scale were found to be associated with longer delay in disengaging attention from disgust faces in high socially anxious individuals. No effects of focus subscale on disengagement or engagement scores were found. However, because disgust faces were used as negative information rather than specifically anxiety evoking stimuli such as angry or fearful faces, they may not be salient enough to serve as distractor to trigger stimulus-driven attention.

One tenet of Attentional Control Theory is that it facilitates operationalizing and measuring the constructs involved in attentional control such as executive shifting and inhibition abilities. In addition, determining attentional control ability with performance-based tasks provides a more objective measure.

In line with this, Reinholdt-Dunne and colleagues (Reinholdt-Dunne, Mogg, & Bradley, 2009) examined effects of attention control on attention bias using Attention Network Task and Emotional Stroop Task in community sample adults with trait anxiety. Accordingly, participants with poor attentional control and high trait anxiety showed significantly greater Stroop interference for all emotional faces compared to participants with poor attentional control and low trait anxiety. Their results suggest that poor attentional control might contribute impaired attentional processing of not only information with threat value but also emotional information in general in anxious individuals. However, attentional control scores obtained from Attention Network Task are related to response inhibition ability. Therefore, similar to Putman and colleagues (2012) study, Stroop Interference and attentional control scores, which were operationalized as two separate variables, might be underlined by the same construct. So, their results should be interpreted with caution.

Overall, empirical evidence gathered from adult data seems to nest well within Attentional Control Theory (Eysenck et al., 2007). More specifically, attentional control ability appears to moderate threat bias – anxiety symptomatology association in that high anxious individuals with low attentional control appear to display greater biases for threat compared to high anxious individuals with high attentional control and non-anxious individuals. Even though why some high anxious individuals have intact attentional control ability requires clarification, the debilitating effect of poor attentional control is especially evident in delayed disengagement from threat.

How inhibition and shifting mechanisms operate during prolonged attention allocation on threat is not so clear since the studies outlined above used total ACS score except Taylor and colleagues' study (2016). Their results suggest that poor shifting ability is particularly associated with lengthened attention allocation on threat (Taylor et al., 2016). Attentional Control Theory explains this as impaired shifting does not allow attention to move back and forth between stimuli flexibly, hence participants with poor shifting ability took longer time to indicate the location of the probe that occurred in the opposite location of the threat related stimulus.

4.1.3. The Place of Attentional Control in Childhood AB Models

One common theme in childhood models of AB is the stress they put on children's developing cognitive abilities and that this might impact how children allocate their attention in the presence of threat information.

The preliminary results on this comes from Kindt and colleagues set of Emotional Stroop Task studies (Kindt & Brosschot, 1998; Kindt & Brosschot, 1999; Kindt, Brosschot, et al., 1997; Kindt et al., 2003; Kindt et al., 2000; Kindt, Bierman, et al., 1997). They found that all children under the age of roughly 10 showed Stroop interference for threat regardless of anxiety levels (Kindt, Brosschot, et al.,1997; Kindt et al., 2000; Kindt, Bierman, et al., 1997). However, this pattern diverged as children gets older such that only high anxious children showed Stroop interference (Kindt, Brosschot, et al.,1997; Kindt et al., 2000; Kindt, Bierman, et al., 1997). The authors explained the existent threat bias, which is independent of anxiety symptomatology in younger children, with immature ability to inhibit predominant response. According to their view, it is anxiety that impacts normative development of inhibition ability and the difference in the threat bias scores emerges at around middle childhood such that anxious children show Stroop interference for threat while non-anxious children learn to exert control over their inhibition ability and they don't show threat bias as they get older.

While their results are intriguing, other empirical studies employing Emotional Stroop Task to measure attention bias failed to replicate them. Accordingly, anxious adolescents did not show greater Stroop interference for words related to depression or anxiety compared to non-anxious counterparts, suggesting that inhibition ability could still be intact in anxious adolescents (Dalgleish et al., 2003). Anxious children aged between 7-10 can show Stroop interference as well as accelerated responses suggesting that there could be individual differences at the timing of acquiring fully grown inhibition ability in younger children (Heim-Dreger et al., 2006). Finally, moderately anxious young children aged between 7 and 10 showed significant Stroop interference compared to their non anxious counterparts suggesting that non anxious young children can also display effective inhibition ability towards threatening distractors (Reinholdt-Dunne et al., 2012).

The contrasting findings could be due to the sampling differences between the studies. Majority of the studies by Kindt and colleagues were carried out with children that have a specific spider phobia whereas studies with contrasting results were mostly carried out with community sample children with trait anxiety. It could be that phobia related stimuli are particularly salient distractors and could be more difficult to ignore compared to stimuli relevant to general threat. Nevertheless, Kindt and colleagues' cognitive inhibition hypothesis has led the way for attention bias research that warrants examination of developing cognitive control and children's threat bias.

The other influential account of childhood AB is Lonigan and colleagues' (2004) temperamental model of attention bias. Their model of attention bias is based on Rothbart and colleagues' (Rothbart et al., 2000) conceptualization of temperament. According to Rothbart and colleagues (2000), temperament can be considered within three personality dimensions. They defined positive affectivity as the propensity to express impulsivity, high activity, and frequent experience of positive affects in contrast to negative affectivity, which encompasses feelings of frustration, discomfort, anger, and fear. The third dimension is called effortful control, which is responsible for inhibitory control, attentional focusing, and perceptual sensitivity. This dimension is related to self-regulation of the child, and thought to regulate affect, attention, and behaviour during children's socialization (Rothbart et al., 2000).

Accordingly, Lonigan and colleagues (2004) suggested that negative affectivity on its own may not be enough for development of anxiety given that possession of high effortful control ability can serve to regulate negative affect. Therefore, low effortful control appears to be a key element of developing psychopathology. Furthermore, they operationalized attention bias to threat in anxious individuals as a behavioural reflection of reactive control and posited that individuals with good effortful control can re-direct their attention as a form of self-regulation, which overrides reactive control and reduces negative affect (Lonigan et al., 2004; Lonigan & Vasey, 2009).

To test the suggested associations between children's temperamental characteristics and attention bias for threat, they measured temperamental characteristics with questionnaires and attention bias with dot-probe task with a large sample of community children and adolescents (Lonigan & Vasey, 2009). Given that stimuli should be presented long enough for effortful control to operate, they presented stimuli at 1250 milliseconds. Their results supported the assumptions of the model such that effortful control ability moderated the association between children’s negative affectivity level and attention bias towards threat. Accordingly, children high in negative affect and low in effortful control showed greater attentional bias for threat compared to children high in negative affect and high in effortful control.

There are apparent parallels between Eyseck and colleagues’ (2007) Attentional Control Theory and Lonigan and colleagues’ (2004) temperamental hypothesis of attention bias. Reactive control against effortful control bears high resemblance with stimulus-driven attentional control and goal-driven attentional control. Given that anxiety symptomatology is highly linked with greater distraction by threatening information, the way attention regulative effects of goal-driven attention and effortful control is formulated in the same way in both models. More specifically, both models predict that high control on attention allocation can have buffering effects against displaying disproportionate attention bias for threat in anxious individuals. Although attentional control is only one of the many elements that effortful control encompasses, the similarity of the results obtained from Lonigan and Vasey data (2009) and the above outlined adult studies on attentional control is noteworthy.

4.1.4. Exploring the Role of Attentional Control on Children's Threat Bias: Empirical Evidence

Following Kindt's and Lonigan's works, interrogation of the impact of children's "mastery of selective attention" and executive functions responsible for voluntary response suppression on their threat processing has been requested by reviewers (Ehrenreich & Gross, 2002; Puliafico & Kendall, 2006).

Albeit effortful control ability, by definition, refers to a broader concept involving ability to regulating affect and behaviour in the form of self-regulation, its overlap between attentional control has led the researchers sometimes use these terms interchangeably. Hence, in order to aid the review of these studies revolving around the association between attentional control and attention bias in children, attentional control and effortful control ability were treated as the same constructs. Also, because temperamental fearfulness is linked with anxiety in children, studies exploring bias and attentional control in fearful or anxious samples were evaluated together.

Subscales of attention (i.e., measures the strength of effortful attention focus and shifting) and inhibitory control (i.e., measures suppression of inappropriate responses) of Early Adolescent Temperament Questionnaire – Revised (EATQ-R; Ellis & Rothbart, 2001) and child version of Attentional Control Scale (ACS-C; Muris, de Jong, & Engelen, 2004) have been two commonly used measures of attentional control in attention bias research with children and adolescents.

Using EATQ-R, Vervoort and colleagues (2011) compared mixed clinically anxious adolescents with non-clinical counterparts on their attentional control ability and attention bias with dot-probe task at 500 and 1250 milliseconds stimuli presentation durations. No main effect of effortful control or its interaction with group type significantly predicted attention bias at short presentation duration, but these effects were observed at 1250 milliseconds. However, the moderation was not in the expected direction in that high effortful control predicted greater avoidance from threat in non-anxious adolescents and no effect of effortful control was found in anxious adolescents. While non-anxious adolescents' avoidance could be viewed as adaptive allocation of attention on neutral stimuli through good attentional regulative capacities, no effect of effortful control in anxious adolescents' strategic bias is contradictory with previous theories of attentional control.

Ho and colleagues' study (2016) with community sample adolescents also revealed a mixed picture. Accordingly, while attentional control and AB for threat interacted to predict trait anxiety, the nature of the associations were not in the expected direction like Vervoort et al., (2011) study. As such, adolescents with high level of attentional control and threat vigilance showed low trait anxiety while interaction of low attentional control and threat vigilance was not associated with anxiety.

Pergamin-Hight and colleagues' (Pergamin-Hight, Bitton, et al, 2016) study compared clinically anxious and non-anxious children and adolescents. Youth with social anxiety disorder and non-anxious youth were tested using emotional spatial cueing task as 200 msec. Accordingly, although no interaction was found, main effects of low level of attentional control and longer disengagement difficulty were significant predictors of social anxiety diagnosis.

Finding main effect of attentional control that predicts anxiety diagnosis is contradictory to Vervoort and colleagues (2011) study. Provided that the clinical group in Vervoort and colleagues study involved adolescents with diagnoses of various anxiety disorders, exploring anxiety diagnoses in isolation might give a better indication of the link between operation of attentional control and attention bias. However, it is noteworthy that, Pergamin-Hight and colleagues presented stimuli for only 200 milliseconds, and it may not be long enough for strategic attentional control to operate. So, it remains unclear whether the disengagement scores obtained at 200 msec were truly underlined by strategic attentional control. While low effortful control and delay in disengaging attention from threat predicted anxiety diagnosis separately, their lack of interaction may be explained by that.

Helzer and colleagues (2009) tested how fearful temperament (i.e., a construct that overlaps with negative affectivity) and attentional control interact to predict attention bias in children aged between 10-13. Attention bias was measured with dot-probe task with 20 milliseconds and 1250 milliseconds presentation durations to examine vigilant attention to threat cues and delayed shift in attention to neutral cues. According to the predictions of Lonigan and colleagues' temperament model or Attentional Control Theory, children with high fearfulness and low attentional control should be expected to show greater disengagement difficulty or vigilance for threat compared to children with high attentional control.

However, the results of Helzer and colleagues' study (2009) do not provide a clear replication. On the low end of attentional control, highly fearful children showed avoidance while the expected disengagement difficulty was observed in children with low fearfulness. It is not possible to evaluate how the elements of attentional control operated during avoidance since only the overall attentional control measure was used in the study. On the high end of attentional control, level of fearfulness was not related to attentional bias, suggesting that high attentional control functioned as a buffering mechanism against attention bias for threat regardless of fearfulness.

The results of Susa end colleagues' (Susa, Benga, Pitică, & Miclea, 2014) study revealed that children's low attentional control and high fearfulness interacted to predict vigilance towards angry faces. By decomposing the vigilance score into its elements, they separately run the analyses for engagement and disengagement scores. Accordingly, low attentional control and high fearfulness significantly predicted initial engagement with threat but not disengagement difficulty. While this is somewhat contradictory to temperamental model, their results could be explained by impaired inhibitory control assumption of Attentional Control Theory such that unable to inhibit the tendency to look at angry faces could underlie this vigilance, rather than unable to shift attention back to neutral face that underlies disengagement difficulty. However, it is noteworthy that stimuli were presented through dot-probe task at 500 milliseconds in this study. Therefore, disengagement difficulty may not have occurred due to relatively shorter presentation duration.

Similar results were also reported in another study by Susa end colleagues (Susa, Pitică, Benga, & Miclea, 2012). They found significant interaction between the overall attentional control and attention bias to predict children's anxiety, such that children with low attentional control and high vigilance for threat had more anxiety symptoms. Also, their study provides preliminary results regarding the individual roles of inhibition and shifting elements of attentional control on attentional bias. Accordingly, the correlations revealed that attentional focusing was not associated with either element of attentional bias, but attentional shifting showed significant negative correlation with disengagement difficulty suggesting that poor shifting was associated with greater disengagement difficulty. Further explorations revealed that both inhibition and shifting abilities interacted with threat bias scores to predict anxiety symptoms. However, the nature of the interactions was not clear since plots of regression slopes were not provided.

4.1.5. Current Study: Aims

Lonigan and colleagues' model or Attentional Control Theory posits that poor attentional control and high fearfulness / high anxiety would interact to predict greater attention bias. Especially, traces of impaired attentional control on attention bias would be observed at long stimuli presentation since control over attention requires longer time.

While adult studies somewhat converge to point out the regulative effects of good attentional control against attention bias for threat, the evidence is mixed for children. On one hand, children with high attentional control ability show reduced attention bias for threat in high anxious (Susa et al., 2012; Susa et al., 2014) and high fearful children (Helzer et al., 2009). On the other hand, other studies reported no effect of attentional control on attention bias in clinically anxious group (Vervoort et al., 2011); no interaction between attentional control and bias to predict anxiety (Pergamin-Hight, Bitton, et al., 2016); that high attention control and high threat bias interacts to predict low trait anxiety (Ho et al., 2017).

Another divergence across studies concerns the role of attentional control ability in emergence of different components of attention bias in children, reflecting differences stimuli presentation duration (short vs long) and bias score calculation method (vigilance-avoidance vs engagement-disengagement). Hence, in some studies, attentional control was associated with vigilance (Ho et al., 2017; Susa et al., 2012; Susa et al., 2014) while significant associations for disengagement difficulty (Pergamin-Hight, Bitton, et al., 2016) or avoidance (Helzer et al., 2009; Vervoort et al., 2011) were also reported in others. However, using long presentation durations to let strategic attention operate and using both formulas to obtain AB scores can allow better comparison.

Inhibition and shifting abilities as two interlinked but separate components of attentional control might be involved in the occurrence of different attention bias components differentially in the presence of threat. So, rather than using one index of overall attentional control ability, examining inhibition and shifting separately can also explain the divergence in the associations addressed above. However, only Susa and colleagues' (2012) study have provided evidence regarding differential involvement of inhibition and shifting in eliciting AB, which requires replication.

Another issue is use of self-report questionnaires to measure attentional control. As discussed in adult studies, the explanations provided by Attentional Control Theory can be feasibly operationalized experimentally and measured by computerized behavioural tests, which would also give a more objective index.

So, the first aim of the current chapter is to investigate the roles of attentional control ability and attention bias in relation to trait anxiety in community sample children and adolescents. Based on the predictions of Attentional Control Theory (Eysenck et al., 2007), our second aim is to investigate the possible moderator role of attentional control ability on the association between children's anxiety symptomatology and attention bias. Therefore, attentional control ability was measured with a computerized task to obtain a behavioural measure of both executive inhibition and shifting abilities. Attention bias was measured with eye tracker while participants undertook dot-probe task at 2000 msec.

To our knowledge, no study so far incorporated eye tracking measure of attention bias and experimental measure of attentional control in the same study with community sample youth. So, the previous mixed results and novelty of our methodology did not allow us to have specific hypotheses such as only children with low attentional control and high anxiety would show attention bias. Due to the exploratory nature of our study, the statistical significance of the tests was evaluated as two-sided.

4.2. METHODOLOGY

Data for this study were collected in conjunction with the studies reported in Chapter 3 and Chapter 5. So, details regarding ethics approval, participant inclusion/exclusion criteria, sample size calculations, participant recruitment procedure, data collection procedure, all the measurement tools and the respective response definitions were described in detail in the Chapter 2. The following section will summarize the aspects of the methodology that are specific to this study.

4.2.1. Participants

The sample size of this study is slightly larger than the one in Chapter 3 since no parental data was involved in this chapter, hence, no child removal based on invalid parental data was necessary. Subject observations were not completely independent since more than one child from the same family were tested for 18 of the families.

13 children were excluded due to the reasons outlined in Fig. 2.2. In addition to that, one child was excluded due to low valid trial number to obtain mean scores for Simon task switch phase.

So, the final sample consisted of 98 community sample children and adolescents (male= 44, female = 54) aged between 8 and 16 (mean = 10.77, SD = 2.25). All of the youth spoke English as their first language or fluently (86.7% Caucasian).

4.2.2. Measurement tools specific to Chapter 4

4.2.2.1. Symptom and Attention Bias Measures

Symptom and attention bias measures were identical to Chapter 3. SCAS-C and MFQ-C long version were used as symptom measures. Eye movement data indices were probabilities of first fixation location, participant disengagement length, and average dwell times on angry, happy, and neutral stimuli across 4-time windows of 500 milliseconds. Dot-probe data indices were mean reaction times, vigilance - avoidance, and engagement - disengagement scores for angry, happy, and neutral faces.

Regarding details on index definitions and how they are obtained, please refer to Chapter 2.

4.2.2.2. Attentional Control Measure

Attentional Control was measured with Simon task with different phases that measure both inhibition and shifting ability. Simon index as a measure of inhibitory control was obtained by subtracting average reaction times on correctly answered incongruent trials and percentage of correctly answered incongruent trials from those of congruent trials in inhibition phase of the task. A low Simon index indicates poorer inhibition ability.

Switch Cost and Mix Cost were calculated as measures of shifting ability. Switch Cost was obtained by subtracting average reaction times in correctly responded NonSwitch trials and response accuracy percentage of NonSwitch trials from those of Switch trials. Mix Cost was obtained by subtracting mean reaction times and accuracy percentage of NonSwitch trials of the switching phase from those of control phase and inhibition phase. Low scores mean low impact of trial switching and mixing.

Descriptive statistics for sample characteristics and eye movement data were summarized in Table 4.1 and Table 4.2, respectively.

4.2.3. Data Integrity Check and Preparation

4.2.3.1. Questionnaire Data and Attention Bias Data

Data pre-processing for questionnaires, eye movement data, and dot-probe data were identical to Chapter 3.

4.2.3.2. Simon Task Data

Trials with erroneous responses were identified and removed. Reaction times shorter than 200 milliseconds and 10000 milliseconds were removed. Personal outlier trials which were identified as trials with 3 standard deviation above or below the personal mean reaction times were removed. Considering that age range is quite wide in our sample, reaction times were log transformed to control for age related baseline differences (Chevalier & Blaye, 2009; Pritchard & Neumann, 2009).

All the participants had satisfactory number of accurate trials to obtain a reliable mean in compliance with eye movement data threshold except one participant, who was excluded.

4.2.4. Outliers and Normality Check

Data testing procedure for the assumptions and requirements of parametric tests were identical to Chapter 3.

Both non-parametric and parametric tests were carried out in the investigations involving non-normally distributed variables, which were denoted with an asterisk in the respective descriptives tables. If the results were the same, estimates based on parametric tests were reported. If there was no non-parametric equivalent of parametric tests such as repeated measures ANOVA, parametric tests were conducted. In such cases, the results should be interpreted with caution.

4.3. RESULTS

4.3.1. Sample Characteristics

SCAS-C showed high internal reliability with pooled Cronbach's α = .88 in our sample. The mean of SCAS-C scores is 24.43 (S.D. = 12.66, min = 4, max = 68). So, the current overall youth sample remains within non-clinical ranges of anxiety based on previous reports with normative samples. Based on Reardon and colleagues' data (2019), 17.3% of our sample demonstrated clinically significant anxiety scores above the score of 36.11.

As for depression, reliability of MFQ-C was also high with pooled Cronbach's α = .89. The MFQ scores of children (mean = 11.58, S.D. = 8.64, min = 0, max = 42) resemblances data from normative children with no mood disorder (mean = 11.6, S.D = 9.9; Daviss et al. 2006).

Overall, reflecting significant positive skew towards low scores, the sample was not trait anxious or depressed.

No differences based on gender or ethnicity was found on SCAS-C or MFQ (all p's > .05). Age was not significantly correlated with SCAS-C and MFQ (all p's > .05). SCAS-C and MFQ were significantly correlated to each other (r = .739, p = .000), consistent with previous literature (Klein et al., 2018).

Table 4.1. Descriptive statistics of demographic variables and questionnaires (Study 2)

	Children N = 98	
	Mean / N	SD / %
Gender		
Male	44	44.9
Female	54	55.1
Age (year)	10.77	2.25
Ethnicity		
Caucasian	85	86.7
Asian	5	5.1
Arabian	1	1
Mixed	7	7.1
	Children N = 85	
	Mean	SD
Questionnaires		
SCAS-C	24.43	12.66
MFQ-C	11.58	8.64

Note. SCAS-C = Spence Children's Anxiety Scale-Child Version, MFQ-C = Mood and Feelings Questionnaire – Child: Long Version. Presented questionnaire data is raw data prior to winsorization and imputation, so participants whose missing data to be imputed were not reflected in the respective sample.

4.3.2. Attention Bias Analysis with EM data

Table 4.2. Descriptive statistics for eye movement data (Study 2)

	Children N = 98	
	Mean	SD
Missing Data (%)	7.154	12.98
Total Discarded Data (%)	8.95	13.24
Vigilance Index Score		
Angry	.513	.69
Happy	.561	.93
Disengagement (msec)		
Angry-Neutral Angry	532.085	183.989
Angry-Neutral Neutral	506.282	227.548
Happy-Neutral Happy	529.193	177.027
Happy-Neutral Neutral	454.084	155.915
AngryTrials – Angry Dwell (msec)		
Window 1	207.695	39.752
Window 2	274.989	40.927
Window 3	301.263	48.584
Window 4	304.560	61.243
AngryTrials – Neutral Dwell (msec)		
Window 1	207.940	45.048
Window 2	264.717	44.309
Window 3	297.359	48.007
Window 4	298.481	62.246

Table 4.2. Descriptive statistics for eye movement data (Study 2) (Continued)

Happy Trials – Happy Dwell (msec)		
Window 1	206.753	36.331
Window 2	283.829	41.071
Window 3	301.686	54.856
Window 4	306.733	61.118
Happy Trials – Neutral Dwell (msec)		
Window 1	205.843	40.864
Window 2	254.087	41.406
Window 3	298.834	50.647
Window 4	292.424	65.158

Note. Presented eye movement data is raw data prior to winsorization.

4.3.2.1. Initial Vigilance

One sample t-tests were carried out to test whether children's probability of first fixating on emotional faces were significantly different from chance (50%). Accordingly, children displayed significant vigilance to happy faces (t(97) = 6.551, p = .000) but their vigilance towards angry faces was only marginally significant (t(97) = 1.865 , p = .065) (Fig. 4.1).

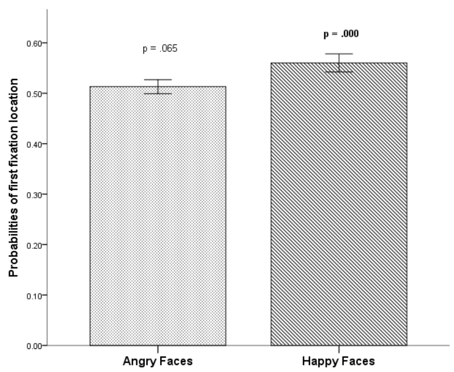


Figure 4.1. Probabilities of first fixation location for each emotion compared to neutral faces, Error Bars 95% CI

4.3.2.2. Participant Disengagement

To test disengagement difficulty, a 2 x 2 repeated measures ANOVA with trial type (angry, happy) and disengagement type (emotion, neutral) as independent variables was carried out on participants' disengagement duration.

Main effects of disengagement type ($F(1, 97) = 36.377$, $p = .000$, partial $\eta2 = .273$) and trial type ($F(1, 97) = 6.514$, $p = .012$, partial $\eta2 = .063$) was qualified by trial type x disengagement type interaction ($F(1, 97) = 4.541$, $p = .036$, partial $\eta2 = .045$). To follow up the interaction, paired comparisons with trial type on each level of disengagement type were carried out. Accordingly, disengaging from neutral faces on angry trials took longer than disengaging from neutral faces on happy trials in the overall sample (Fig. 4.2).

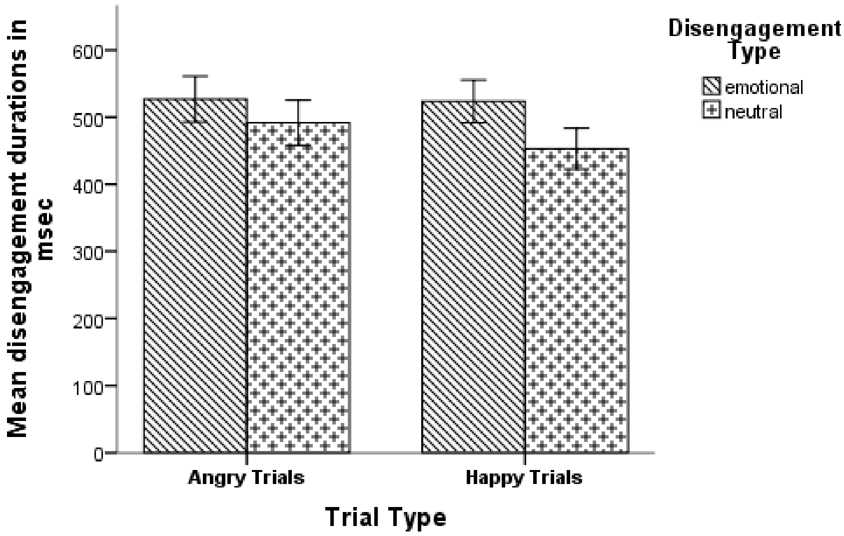


Figure 4.2. Mean disengagement durations across trial types for each emotion, Error Bars 95% CI.

4.3.2.3. Maintained Attention

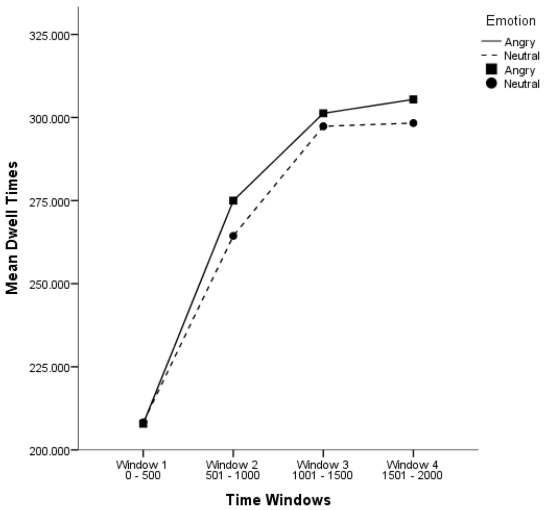
To test maintained attention, two 2x4 repeated measures ANOVA with emotional valence (emotion, neutral) and time window (0-500, 501-1000, 1001-1500, 1501-2000 milliseconds) as independent variables were carried out on children's absolute average dwell times for each emotion type. Greenhouse-Geisser correction was applied for violation of the assumption of sphericity when required.

For angry-neutral comparisons, a significant main effect for emotion emerged ($F (1,97) = 4.041$, $p = .047$, partial $\eta 2 = .040$), suggesting that children dwelled on angry faces longer than neutral faces during the entire observation period. Also, significant effect of time was found ($F (2.76, 264.440) = 202.629$, $p = .000$, partial $\eta 2 = .676$). As such, children's dwell time on faces showed gradual increase from window 1 to window 4 (Fig. 4.3A).

For happy-neutral comparisons, a significant main effect of emotion ($F (1,97) = 20.984$, $p = .000$, partial $\eta 2 = .178$) and time ($F (2.719, 263.766) = 185.021$, $p = .000$, partial $\eta 2 = .656$) emerged. Also, interaction effect of time and emotion was found ($F (2.813, 272.848) = 6.920$, $p = .000$, partial $\eta 2 = .067$). To follow up the interaction, paired samples t-tests with emotion type on each level of time window were carried out. Accordingly, children dwelled on happy faces longer on window 2 ($t(97) = 5.600$, $p = .000$) and window 4 ($t(97) = 2.448$, $p = .014$) (Fig. 4.3B).

Separate independent t-tests were carried out to test for gender related variations in all eye movement indices of AB. No significant gender differences were found on all bias scores (all p’s > .05). None of the bias scores were found to be significantly associated with age, accept dwelling on happy faces at window 1 (r = .211, p = .036).

Panel A



Panel B

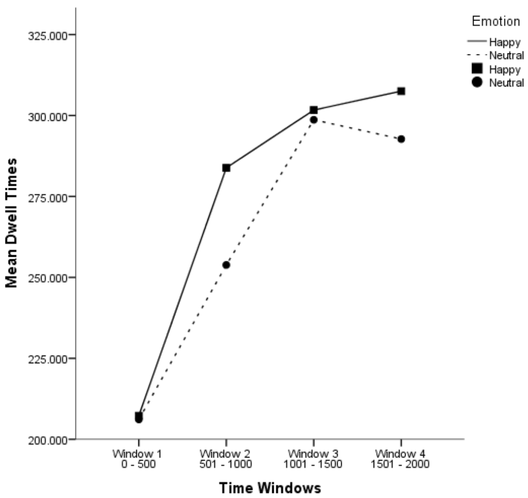


Figure 4.3. Absolute dwell times in each time window for each emotion type. Panel A: Angry trials. Panel B: Happy trials

4.3.3. Analysis of Simon Task Data

Table 4.3. Descriptive statistics of Simon Task Data

	Children N = 98	
	Mean	SD
CONTROL PHASE		
Discarded Data (%)	4.923	4.862
Performance Accuracy (%)	96.556	4.389
Reaction Time (msec)	477.650	142.425
INHIBITION PHASE		
Discarded Data (%)	8.571	9.436
Performance Accuracy (%)		
Overall	92.449	9.517
Congruent	95.92	8.134
Incongruent	88.98	12.842
Reaction Time (msec)		
Overall	719.074	190.548
Congruent Trials	705.160	192.267
Incongruent Trials	742.561	198.272
SWITCHING PHASE		
Discarded Data (%)	42.346	6.257
Performance Accuracy (%)		
Overall	57.985	6.347
Switch Trials	59.395	9.962
Non-Switch Trials	56.498	8.954
Reaction Time (msec)		
Overall	902.774	330.406
Switch Trials	976.339	395.559
Non-Switch Trials	835.735	284.304
ATTENTIONAL CONTROL INDICES		
Simon Index (%)	-6.94	9.991
Simon Index (msec)	37.401	80.001
Switch Cost (%)	2.897	13.750
Switch Cost (msec)	140.604	211.537
Mix Cost – Control (%)	40.058	9.260
Mix Cost – Control (msec)	-358.085	230.173
Mix Cost – Inhibition (%)	35.950	13.132
Mix Cost – Inhibition (msec)	-116.661	189.412

Note. Presented Simon data is raw data prior to log transformation. Discarded data percentage involves total percentage of error trials, inattentive trials, and outlier trials

To examine whether children's attentional control performance varied as a function of task phase, repeated measures ANOVA with phase (control, inhibition, switching) as independent variables were carried out on children's performance accuracy. Greenhouse-Geisser correction was applied for violation of the assumption of sphericity when required.

The analysis revealed that task phase had significant impact on children's percentage of accurate trials ($F(1.527, 148.108) = 836.793$, $p = .000$, partial $\eta2 = .896$). Accordingly, children had significantly lower number of correct trials on switching phase (*M* = 57.985, *SE* =.641) compared to control phase (*M* = 96.607, *SE* = .442, p = .000) and inhibition phase (*M* = 92.423, *SE* = .962, p = .000). Also, children's performance accuracy was significantly lower on switching phase compared to inhibition phase (p = .000).

Same analysis was repeated for reaction times. Reaction time data yielded similar results. It took children to respond significantly longer on switching phase (*M* = 6.744, *SE* = .035) compared to control phase (*M* = 6.132, *SE* = .027, p = .000) and inhibition phase (*M* = 6.541, *SE* = .026, p = .000). Also, children responded significantly late on inhibition phase compared to control phase (p = .000).

To test for the impact of age and gender differences, correlations and t-tests were carried out. Age had a significant impact on children's performance. Performance accuracy in inhibition phase correlated significantly with age (r_t = .161, $p < .05$) suggesting that older children had greater number of accurate responses on inhibition task. Age also showed significant negative correlation with reaction times in all phases (r_t = -.425, r_t =-.438, r_t = -.366 in control, inhibition, and switching phases respectively, all p's < .01).

Interestingly, gender also had an impact on children's performance on reaction time performance. Accordingly, boys' responses were significantly faster than girls in control phase (t(96) = -2.110, p = .038), inhibition phase (t(96) = -3.492, p = .001), and switching phase (t(96) = -3.906, p = .000).

To explore congruency effect on Inhibition phase, performance accuracy and reaction times were compared on congruent and incongruent trials of inhibition phase. Children had significantly lower accuracy rates on incongruent trials compared to congruent trials (t(97) = 6.827, p = .000). Reaction time data yielded similar results in that children responded faster on congruent trials compared to incongruent trials (t(97) = -5.738, p = .000) suggesting that children were influenced by response conflict.

Age showed significant negative correlation with reaction times on both congruent (r = -.533, p < .01) and incongruent trials (r = -.635, p < .01). Accordingly, older children responded significantly faster than younger children, thus showed better inhibitory control.

Also, gender had an impact on children's reaction time performances. Although no differences were observed on performance accuracy, boys responded significantly faster than girls on both congruent (t(96) = -3.755p = .000) and incongruent (t(96) = -2.997, p = .003) trials of inhibition phase.

4.3.4. Correlations

A series of t-tests and correlations were carried out on critical variables (See Appendix 10 for the variable correlogram) to identify potential predictors and covariates for a regression model that tests whether attentional control moderates the association between children's bias and anxiety symptomatology.

Accordingly, none of the attention bias indices were significantly correlated with anxiety or depression scores (all p's > .05).

The impact of age and gender on Simon task performance were also observed on attentional control related indices. Age showed significant positive correlation with performance accuracy Mix Cost Inhibition ($r_t = .145$, $p < .05$) and reaction time Mix Cost Control ($r_t = .242$, $p < .01$), and negative association with reaction time Simon Index ($r_t = -.173$, $p < .05$) and reaction time Switch Cost ($r_t = -.180$, $p < .01$).

Regarding gender, although boys were found to be faster than girls when comparing absolute reaction times, girls appear to be affected less by undertaking mixed tasks on Mix Cost Control (Girls *Mdn* = 7.021, Boys *Mdn* = 7.128, *U* = 705.00, p = .001) and Mix Cost Inhibition scores (Girls *Mdn* = 6.800, Boys *Mdn* = 6.869, *U* = 868.00, p = .022).

None of the Simon indices, switch cost indices, and mix cost indices were found to be significantly associated with anxiety or depression symptomatology in children (all p's > .05).

As for the association between attention biases and attention control, none of the attentional control indices were found to be significantly associated with vigilance scores for either emotion. Interestingly, however, Mix Cost Control performance accuracy score showed negative association with participant disengagement from angry faces (r_t = -.151, p = .028), suggesting that poor switching ability is associated with delayed disengagement from angry faces. The same association was also observed for participant disengagement from happy faces (r_t = -.169, p = .014).

Correlation analyses between attention control indices and the length of stimuli observation in each time window were also carried out. In order to reduce the number of analyses, the observation lengths for emotional stimuli were adjusted to reflect the function of dwell time on neutral pair by dividing the absolute emotion dwell time by that of neutral stimulus for each emotion type in each time window (Seefeldt et al., 2014).

Accordingly, only performance accuracy Mix Cost Inhibition showed significant association with dwell time on angry faces in window 1 (r_t = .150, p = .029). For happy faces, reaction time Switch Cost was negatively correlated with dwell time on happy faces in window 1 (r_t = -143, p = .037). Also, performance accuracy Simon index showed significant negative correlation with dwell time on happy faces on window 2 (r_t = -.158, p = .031).

4.3.5. Regression Analyses

Based on the significant correlations between Mix Cost Control performance accuracy as index of switching ability and participant disengagement indices, two hierarchical linear multiple regression analyses were carried out to test whether switching ability would moderate the association between anxiety symptomatology and disengagement bias for each emotion. So, anxiety scores and Mix Cost Control accuracy scores were treated as predictors and disengagement bias for the respective emotion as outcome variable.

While developing the regression model, other variables that might influence independent and dependent variables were controlled. So, depression scores were taken as covariate since the literature previously showed that depression symptomatology in addition to anxiety might be implicated in children's biased processing of emotional information (McCrory et al., 2013; Reinholdt-Dunne et al., 2012; Waters, Mogg, et al., 2008; Waters, Kokkoris, et al., 2010). In addition, age and gender were also treated as covariates due to their significant associations with attentional control variables.

Assumptions of multiple regression relevant to linearity, normal distribution of residuals, and heteroscedasticity were met. To reduce multicollinearity between the predictor variables, all the continuous variables were centred around each variable's means. The interaction term (Anxiety x Switching) was obtained by multiplying these two centred variables.

In the first step, age, gender, and depression were entered. In the second step, anxiety score and performance accuracy Mix Cost Control were entered. In the final step, the interaction term of anxiety and Mix Cost was entered (Table 4.3).

None of the steps accounted significantly for model variance. In Step 1, R^2 was estimated at .015, indicating that age, gender, and depression symptomatology account for 2% of the variance in disengagement difficulty from angry faces ($F(3, 94) = .478$, $p = .699$). When anxiety symptomatology and switching ability were respectively entered in Step 2, adjusted R^2 was estimated at .040, yielding an additional explained variance of 4% in disengagement difficulty from angry faces ($F(5, 92) = 1.801$, $p = .120$). Although Step 2 did not significantly improve the variance in the model, switching ability as measured by Mix Cost Control performance accuracy uniquely accounted for significant variance in angry disengagement difficulty (β= -4.509, $p = .015$) at this step. The inclusion of interaction term of anxiety and switching revealed an additional variance of 0.9% in the final step, which was not significant ($F(6, 91) = 1.656$, $p = .141$).

Table 4.4. Summary of hierarchical regression model predicting disengagement difficulty from angry faces

Predictor	r	r^2	Adjusted r^2	F-value (df)	B	SE B	β	t-value	Δr2	ΔF (df)
Step 1	.123	.015	-.016	.478 (3, 94)					.015	.478 (3, 94)
Constant					557.622	56.559		9.858		
Age					-5.730	7.689	-0.076	-0.745		
Gender					-19.927	34.723	-0.058	-0.573		
Depression					1.575	2.063	0.076	0.763		
Step 2	.299	.089	.040	1.801 (5, 92)					.074	**3.743**** (2, 92)
Constant					529.463	56.586		9.356		
Age					-4.010	7.576	-0.053	-0.529		
Gender					-1.797	34.831	-0.004	-0.051		
Depression					3.541	3.051	0.178	1.160		
Anxiety					-2.213	2.045	-0.169	-1.082		
Switching					-4.509	1.813	-0.252	**-2.486***		
Step 3	.314	.098	.039	1.656 (6, 91)					.009	.938 (1, 91)
Constant					529.371	56.609		9.351		
Age					-5.583	7.755	-0.074	-0.719		
Gender					-2.423	34.851	-0.006	-0.069		
Depression					3.729	3.057	0.187	1.219		
Anxiety					-2.660	2.098	-0.202	-1.268		
Switching					-4.946	1.870	-0.277	**-2.644****		
Anxiety X Switching					-0.160	0.167	-0.105	-0.958		

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

Therefore, switching ability appears to be a significant determinant of attention bias such that poorer performance accuracy in Mix Cost Control is associated with greater difficulty in disengaging from angry faces. However, no interactions were manifested between anxiety and switching score, suggesting that switching ability did not moderate the association between anxiety and angry disengagement bias in the current sample.

The same model was tested on disengagement difficulty from happy faces. Similarly, none of the steps accounted significant variance in the model (all p's > .05). Following the significant correlation between performance accuracy Mix Cost Control and disengagement difficulty from happy faces, switching ability explained a significant variance in disengagement difficulty from happy faces by 8% associated with a β of -.234 ($p = .024$). Accordingly, although poor switching ability was associated with increased disengagement difficulty from happy faces, it did not manifest interaction with anxiety scores to predict the bias.

4.3.6. Exploratory Analyses with Dot-probe Data

Table 4.5. Descriptive statistics of dot-probe task data (Study 2)

	Children N = 98	
	Mean	SD
Error Trials (%)	0.867	1.429
Total Discarded Data (%)	3.163	2.462
Mean RT (msec)		
Angry Congruent	648.036	136.281
Angry Incongruent	654.604	148.962
Happy Congruent	648.476	141.006
Happy Incongruent	656.802	135.611
Neutral - Neutral	657.445	148.806
VA Bias Scores		
Angry	6.568	61.122
Happy	8.325	46.287
Engagement Bias Scores		
Angry	9.408	53.939
Happy	8.968	52.924
Disengagement Bias Scores		
Angry	-2.840	51.045
Happy	-.643	54.200

Note. Presented Dot-Probe data is raw data prior to winsorization.

To compare our results with previous literature, we also investigated the associations between attentional control and attention bias indices obtained from dot-probe reaction time data.

To explore attention bias in dot-probe task, a 2 x 2 repeated measures ANOVA with emotion (angry, happy) and congruency (congruent, incongruent) was carried out on children's reaction times. No main or interaction effects were observed (all p values > .05). In alignment with this, one-sample t-tests revealed that neither angry vigilance-avoidance score (t(97) = .920, p = .360) nor happy vigilance-avoidance score (t(97) = 1.793, p = .076) reached significance, suggesting that neither of the biases differed significantly than zero.

Mean reaction times in emotion congruent and incongruent trials were also compared with mean reaction times in neutral-neutral trials for each emotion type, as suggested by Koster and colleagues (2004). For angry faces, no significant differences were observed between threat congruent, threat incongruent and neutral-neutral trials (all p's > .05). Accordingly, threat engagement and disengagement scores were also not significantly different than zero. Same analyses were carried out on reaction times, engagement and disengagement scores for happy faces, and results were the same.

None of the attention bias indices were significantly correlated with anxiety or depression symptomatology (all p's for r_t's > .05 for both emotions). Age was not significantly associated with attention bias indices. Only group differences were observed for threat engagement scores based on gender, such that girls (*M* = 15.500, *SD*= 47.23) were significantly more vigilant for angry faces than boys (*M* = -3.287, *SD* = 40.30) (t(96) = -2.090, p = .039).

Correlation analyses exploring the links between dot-probe threat bias indices and attentional control did not reveal significant associations, except the negative associations between threat vigilance-avoidance score and Switch

Cost performance accuracy (r = -.341, p = .001) and Mix Cost Control performance accuracy (r = -.220, p = .030) (See Appendix 11 for the variable correlogram). Also, threat engagement score showed significant negative associations with performance accuracy Switch Cost (r = -.226, p = .025) and Mix Cost Control (r = -.221, p = .029). The significant associations indicate that children with poor switching ability showed greater vigilance for angry faces.

Based on the above significant correlations, four hierarchical multiple regression analyses testing the same model in section 3.5. were performed on threat vigilance-avoidance scores and threat engagement scores separately.

Test of moderating role of performance accuracy Switch Cost as a measure of switching ability on the association between anxiety and threat vigilance avoidance revealed that only step 2 added significant variance to the model by 11% ($F(2, 92) = 5.961$, $p = .004$), and the only significant predictor in this step was Switch cost [$\beta = -.336$, $p = .001$). No moderation effect of anxiety and switching on attention bias was observed. Test of moderator role of performance accuracy Mix Cost Control on the association between anxiety and threat vigilance avoidance revealed that yielded similar results. Although Mix Cost Control uniquely contributed to the variance in attention bias ($\beta = -.226$, $p = .031$), no interaction between anxiety and was Mix Cost Control to predict threat vigilance-avoidance score was observed.

Test of moderator role of performance accuracy Mix Cost Control on the association between anxiety and threat engagement revealed that adding Mix Cost Control ($\beta = -.256$, $p =.024$) in step 2 accounted significantly for model variance by 7% ($F(2, 92) = 3.678$, $p = .029$). The overall variance added to the model in Step 3 was also significant ($F(6, 91) = 2.361$, $p = .036$), however, its unique contribution of .01% variance was minor and not significant ($F(91,1) = .096$, $p = .758$). No interaction effect of anxiety and switching on threat bias was observed. Test of moderator role of performance accuracy Mix Cost Control on the association between anxiety and threat engagement yielded same results in that while Mix Cost Control was a significant predictor of threat engagement ($\beta = -.247$, $p = .026$), no interaction between Mix Cost Control and anxiety to predict threat engagement was observed.

4.4. DISCUSSION

The current study explored the association between children's attentional control and attention biases and tested whether attentional control moderates the children's AB-anxiety associations. Based on the calls from previous empirical studies (Helzer et al., 2009; Pergamin-Hight et al., 2016; Susa et al., 2012, 2014), the current study overcame methodological limitations of previous research by using behavioural measurement of attentional control and eye movement measurement of attention bias with relatively longer stimuli presentation duration.

This study involved greater number of children compared to the study in Chapter 3 since no removal of child data was necessary based on parental data. Inclusion of ten more children in the current study had children's vigilance scores for angry faces approach towards a marginal significance. However, children's vigilance towards angry faces was not statistically greater than chance in Chapter 3. Given that the mean anxiety scores and the number of initial fixations on angry faces were almost identical across both studies (see Tables 3.1, 4.1 and 3.2, 4.2 respectively), the greater sample size in the current chapter might be responsible for the nearly significant difference. Since children were also vigilant for happy faces, current results suggest that children's vigilance is not specific to threat, but it may instead be underlined by a general saliency of emotion compared to neutral information (Gamble & Rapee, 2009; Ho et al., 2016; Waters et al., 2008; Waters et al., 2010).

However, longer disengaging times for neutral faces in angry trials compared to happy trials somewhat suggest the role of contextual factors in determining stimuli saliency. Although using a different disengagement index, Schofield and colleagues (2012) also commented on participants' tendency to have longer dwell times on neutral faces before disengaging from them. As discussed in Chapter 3, greater difficulty in disengaging from neutral faces when paired with angry faces is unlikely to reflect avoidance from threat since the number of initial fixations on angry faces before neutral faces was not significantly greater than chance and the average disengagement times from angry faces until the first shift away were longer than neutral faces paired with angry faces. Instead, it could be that children may have found the information signalled by neutral faces more ambiguous compared to clearer saliency of angry faces (Cooper & Langton, 2006; Fani et al., 2011; Pergamin-Hight, Bitton, et al., 2016; Schofield et al., 2013) and have taken longer time to disengage from them for further appraisal.

Regarding involvement of attentional control on attention bias, Eysenck and colleagues' (2007) Attentional Control Theory predicted that attention bias is a result of either impaired inhibition function such that individuals cannot resist allocating their attention on threat information or impaired switching function such that attention cannot be allocated flexibly to remain focused on task relevant stimulus. The significant association between poor switching ability and enhanced disengagement difficulty from angry faces confirms one component of Attentional Control Theory. However, the lack of associations between anxiety and attentional control indices limits the scope of the interpretations in this sample such that they cannot be extended to the debilitating role of anxiety on attentional control.

By measuring attentional control indices for both inhibition ability and switching ability, this study has generated novel findings regarding the individual roles of inhibition and switching ability on children's attention bias. Accordingly, no association between vigilance and either inhibition or switching was observed. However, the significant association between poor switching ability and enhanced disengagement difficulty from angry faces is in line with Pergamin-Hight et al (2016).

In addition, how elements of attentional control were involved in maintained attention over emotional stimuli was also investigated through correlation analyses. For angry faces, attentional control was involved in the first window capturing the first 500 milliseconds such that greater inhibition ability was linked with longer fixation times on angry faces. As previously proposed (Mogg & Bradley, 1998; Öhman & Wiens, 2004), attention to threatening information compared to other stimuli can signal an adaptive appraisal in non-anxious individuals. So, better inhibition ability might have served to keep attention focused on the threat-relevant stimuli, not on neutral stimuli, for initial appraisal of threat value in this case.

However, children's average disengagement from angry faces following their initial fixation on them is 532 msec, which encapsulates initial engagement in the first 500 msec. Given that poor switching ability was a significant associate of disengaging from angry faces, one explanation could be that following inhibiting attention to neutral faces, children might have had difficulty to switch their attention from angry faces to neutral faces.

Exploratory moderation analyses were performed based on the critical significant association between poor attentional control and greater disengagement difficulty from angry faces to test whether shifting ability would also interact with trait anxiety to predict disengagement difficulty. Despite the main effect of switching ability on predicting threat bias, no moderation effect was observed in the current sample. So, the lack of moderation between attentional control and anxiety on disengagement bias also restricts full support of the theory. However, the finding regarding the lack of interaction with anxiety is not completely surprising given that the current sample had low trait anxiety.

Failure of our regression model to predict significant moderation based on eye movement data is contrary to Lonigan and Vasey (2009) and Susa et al., (2012; 2014) studies. Since these studies were carried out with reaction time-based paradigms to measure attention bias such as dot-probe, associations between bias indices extracted from dot-probe data and attentional control were also tested to ease the comparison with previous literature.

Although weak switching ability was a significant predictor of enhanced attentional engagement with threat in the current study, the overall model with dot-probe data did not reveal significant switching moderation on anxiety and attentional engagement either. Nevertheless, the significant association between greater vigilance and poor attentional control in dot-probe data partially replicates results in Susa et al (2012; 2014).

The current analyses on happy biases were carried out for exploratory purposes since no previous study or account of attention bias clearly articulated the role of attentional control in the presence of positive information. In Vervoort et al. (2011) and Helzer et al. (2009) studies, no positive stimulus was used. In Pergamin-Hight et al. (2016) study, scores from positive stimuli were not involved in the analysis. Susa et al (2012; 2014) and Ho et al (2016) reported no significant associations between attentional control and bias for happy faces. In contrast, we found that weak attentional control was also involved in regulation of attention towards positive information as the significant association between greater disengagement difficulty from happy faces and poor switching ability implies. This means that attentional control might be operating in regulating attention biases not only for threatening information but also for positive information in normative populations.

The limitations of this study and suggestions for future research should be noted. First, the children and adolescents in our sample were almost symptom-free and had low trait anxiety, which was not representative of mild or high trait anxious children in the community. So, the results provide only partial support to Attentional Control Theory (Eysenck et al., 2007) and cannot be generalized to trait anxious children in community samples. Future studies investigating the role of attention control in community samples would therefore benefit from having a more heterogenous youth sample regarding trait anxiety levels.

Second, although sample size in this study was relatively robust compared to the sample sizes of many previous attention bias studies with children, a number of participants were excluded due to their high rate of invalid gaze data. Compounded with high number of covariates, the regression models may have been under powered. Therefore, predictors with small effect sizes may not have been identified as significant. So, it would be worthwhile for future research to replicate the current study in a larger youth sample.

Third, valence ratings of emotional stimuli were not recorded. This could have helped explain why the current sample showed vigilance for both happy and angry faces and longer dwell times on neutral faces when paired with angry faces. It could be that children might not have found angry faces as threatening enough to display relatively stronger attention biases compared to happy faces.

Fourth, the current study was cross-sectional so no conclusions regarding causality can be drawn. Therefore, a longitudinal approach may be adopted in the future studies to delineate whether anxiety impairs attentional control and threat AB occurs or impaired attentional control leads to greater anxiety through threat AB in developmental populations.

Overall, our key finding is that poor attentional control contributes to greater attention bias for threatening information in children with low trait anxiety as well as anxious cohorts. Although the results cannot be generalized to anxious children, good attentional control ability appears to be an important factor in adaptive appraisal of information in the environment in also typically developing children. So, our results appear to have important implications for practice such that educational programmes for developing executive control over attention and emotion can be useful as a preventative approach against cognitive biases, associated with emotional difficulties, in children and adolescents.

5. CHAPTER FIVE: EXPLORING CHILDREN'S HABITUAL EMOTION REGULATION STRATEGY USE and THEIR THREAT RELATED ATTENTION BIAS

5.1. LITERATURE REVIEW

5.1.1. A Brief Overview of Emotion Regulation and Childhood Anxiety

Emotional competence through emotion regulation is a significant developmental task from infancy to adolescence for intact psychosocial functioning (Cole, Mitchell, & Teti, 1994; Thompson, 1991; Zeman, Cassano, Perry-Parish, & Stegall, 2006). The developmental trajectory of emotion regulation shows a continuum from relying on caregiver for down regulation of basic negative emotions via physical mediums for being soothed to self-reliant, internalized, and person specific strategies in complex social settings (Thompson, 1991; Young, Sandman, & Craske, 2019). Together with cognitive and social development, children's emotion regulation skills get more sophisticated since understanding and recognizing emotions in self or others and reflecting on emotion laiden thoughts and behaviours in various social interactions require cognitive maturation (Cole et al., 1994; Thompson, 1994).

Empirical research points out that preschool children, aged between 3 to 6, are capable of recognising basic emotions from facial/ posture expressions and greater recognition ability predicts higher socio-emotional competence (Parker, Mathis, & Kupersmidt, 2013), they can match emotions with context-wise appropriate regulatory strategies (Cole, Dennis, Smith-Simon, & Cohen, 2009; Dennis & Kelemen, 2009), variety in their suggestions for emotion regulatory strategies increase with age (Sala, Pons, & Molina, 2014), and use of cognitive strategies to regulate emotions starts to emerge at around age of 5 (Davis, Levine, Lench, & Quas, 2010; Sala et al., 2014). Throughout middle and late childhood, children can differentiate between effective and ineffective emotion regulation strategies based on emotion type (Waters & Thompson, 2014), and they agree that emotions are manageable and can be changed while older participants also acknowledging that it could be difficult to regulate emotions (Brandone & Klimek, 2018). During adolescence, planned problem solving, behavioural and cognitive distraction, recognizing and reflecting on own internal emotional state, self reliant cognitive strategies in the face of a stressor, and intention to regulate emotions are common features of emotion regulation (Zimmer-Gembeck & Skinner, 2011). However, because adolescence is an exquisite developmental period that involves tendency towards autonomy and increasing role of other social contexts in addition to familial environment (Riediger & Klipker, 2014), challenges in regulating stress responses and relatively lower skills in doing so could be characteristic to this period (Zimmer-Gembeck & Skinner, 2011).

On the other hand, persistent failure to exert adaptive emotion regulation strategies is deemed as a transdiagnostic feature of childhood psychopathology, including anxiety linked behaviours/disorders (Campbell-Sills, Ellard, & Barlow, 2014; Esbjørn, Bender, Reinholdt-Dunne, Munk, & Ollendick, 2012; Hannesdottir & Ollendick, 2007; Weems & Silverman, 2006). Indeed, anxious children experience more intense reactivity of negative emotions that interferes with various developmental domains (Hannesdottir &

Ollendick, 2007) and show poor competence in managing these negative emotions (Compas et al., 2017; Mathews, Koehn, Abtahi, & Kerns, 2016).

Accordingly, anxious children typically show more use of maladaptive strategies such as rumination, withdrawal, negative self-talk, acting on negative emotions and attempt or use adaptive strategies less such as being oriented to problem solving, reappraisal, and acceptance compared to non-anxious children (Hughes, Gullone, Dudley, & Tonge 2010; Keil, Asbrand, Tuschen-Caffier, & Schmitz, 2017; Suveg & Zeman, 2004) albeit they can recognize and understand multiple types of emotions (Southam-Gerow & Kendall, 2000). The same ineffective emotion regulation patterns are also present in anxious adolescents (Eastabrook, Flynn, & Hollenstein, 2014; Henry, Castellini, Moses, & Scott, 2016; Riediger & Klipker, 2014; Sackl-Pammer et al., 2019). In fact, longitudinal studies reveal that poor emotion regulation skills during early childhood predict anxiety during middle/late childhood and adolescence in later years (Bosquet & Egeland, 2006; Schneider, Arch, Landy, & Hankin, 2018).

Taken together, emotion regulation difficulty is now seen as an important correlate of anxiety development (Aldao & Mennin, 2014; Cole et al., 1994; Huberty, 2012b; Southam-Gerow & Kendall, 2000; Weems, 2008). Accordingly, many suggest that emotion regulation difficulties should be an explicit focus in treatment of anxiety disorders (Berking et al., 2008; Hannesdottir & Ollendick, 2007; Huberty, 2012b; Southam-Gerow & Kendall, 2000; Young et al., 2019).

5.1.2. Conceptual Foundations: The Process Model of Emotion Regulation

Zeman and colleagues argue that it is important to delineate "….mechanisms and processes by which emotion regulation and other emotion processes assist in … exacerbation of childhood psychosocial maladaptation" (Zeman et al., 2006, p.165). So, considering that distorted processing of emotional information leads to greater experience of anxiety-linked emotions in children, it is important to recognize the potential association between anxious children's cognitive biases and how they attempt to regulate their negative emotions. Given that control over attention to change its focus (i.e., attentional deployment) is one of the emotion regulatory steps in Gross' Process Model of Emotion Regulation (1998), especially the emotion (dys)regulatory role of attention bias and its potential association with emotion regulation strategies deserve further empirical interest.

In alignment with this, Gross' definition of emotion regulation and his information processing model of emotion regulation (Gross, 1998) provides a well organized conceptual foundation for the underpinnings of emotion regulatory outcomes associated with temporal emotion regulatory processes. Therefore, the theoretical rationale of this chapter is mainly based on Gross' contributions to the emotion literature by situating them in a developmental context.

However, it should be noted that numerous conceptual definitions of emotion and emotion regulation have been made based on discrepancies across different perspectives in the field of psychology (Gross, 1999), each of which formulated various emotion regulation related concepts such as coping, affect regulation, mood regulation, and psychological defence. It is beyond the scope of this chapter to discuss the discrepancies or similarities between these definitions or the perspectives from where these definitions emerged (for some extensive reviews, see Cole, 2004; Gross, 1998; Gross & Barret, 2011; Jazaieri, Urry, & Gross, 2013; Koole, 2009; Skinner & Zimmer-Gembeck, 2007).

Gross defines emotion regulation as “the processes by which the individuals influence which emotions they have, when they have them, and how they experience and express these emotions” (Gross, 1998, p. 275). Other theorists with a developmental perspective have also proposed similar conceptualizations of emotion regulation by also noting reliance on others and self for emotion management through development (Thompson, 1991) and the importance of social contexts when handling emotions (Cole et al., 1994).

Reflecting his definition of emotion regulation, the process model encompasses five sequential emotion regulatory steps, each of which has a role in emotion generation (Gross, 1998). The first step is *situation selection*, where one attempts to increase or decrease the likelihood of emotion generation by choosing whether or not to be present in a respective situation. The following step is *situation modification,* which refers to tailoring physical features of the environment to alter its emotional impact. *Attentional deployment* step involves directing the focus of attention in a particular way in a given situation. The *cognitive change* step refers to selection of a specific meaning to be attributed to a particular situation to change its emotional impact. Clarification of the meaning elicits response tendencies in physiological, experiential, and behavioural domains. The final step *response modulation* involves alterations of these response tendencies.

Notably, the model has been criticised on the grounds that it does not account for automatic fear or aggression related behaviours as the model requires time for processing (Hofmann, 2014) and the temporal order between those emotion regulatory steps may vary and not follow the consecutive pattern and, thus, applicability of the model on emotional responses may be restricted (Koole, 2009).

Correspondingly, Gross and Thompson (2007) view responses related to hunger, sex, aggression, and pain as motivational impulses, which belong to affect family and only linked to emotions due to the context in which these impulses occur can also elicit emotions. But they distinguish impulses from emotions in that emotional eliciting situations has a much broader range (Gross & Thompson, 2007). In addition, Gyurak, Gross, and Etkin (2011) add that emotion regulation could be viewed as a spectrum from explicit and effortful emotion regulation to implicit one, which is evoked automatically and is executed without monitoring and awareness. So, emotion regulation can take place at one or more points in the process model and alter emotions based on an individual's current implicit or explicit goals (Gyurak et al., 2011). Thus, appropriate use of implicit/explicit regulation based on the context is a marker of mental health (Gyurak, et al., 2011). Regarding Koole's arguments (2009), Gross and Thompson (2007) acknowledge the dynamic nature of the interaction between emotion generation and regulation processes and posit that the model is recursive and emotional response could feedback any of these emotion regulatory steps as shown by the feedback arrow in figure 5.1, which in turn alters the emotional response.

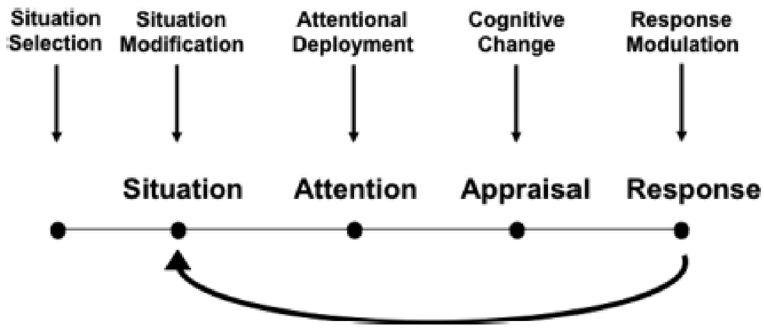


Figure 5.1. The Process Model of Emotion Regulation (Gross, 2013)

5.1.3. Reappraisal and Suppression in Anxious Children

The strategies to regulate emotions can take many individual specific forms (Thompson, 1991) in individual specific contexts (Gross, 1999). Here, Gross' (1998) information processing model of emotion regulation has been highly influential as it proposes a conceptual framework to organize many different emotion regulation strategies along with the temporal continuum of emotional response process (Gross, 2002).

The model distinguishes two broad emotion regulation strategies based on the timing of their exertion, whether before the full activation of emotion response tendencies or after. The first is referred as antecedent-focused while the latter is called as response-focused strategies (Gross, 1998). Gross proposes that situation selection, modification, attention deployment, and appraisal steps nest in the antecedent-focused emotion regulation strategy while response modulation is a response-focused strategy (Gross, 1998).

Cognitive reappraisal and expressive suppression, henceforth will be referred as reappraisal and suppression in short, are two well established examples for antecedent and response focused emotion regulation strategies, respectively (Fig. 5.2). Reappraisal is defined as "a form of cognitive change that involves construing a potentially emotion eliciting situation in a way that changes its emotional impact" (Lazarus & Alfert, 1962, cited in John & Gross, 2004, p. 1304). On the other hand, suppression refers to "a form of response modulation that involves inhibiting ongoing emotion expressive behaviour" (Gross & Levenson, 1993, cited in John & Gross, 2004, p. 1304).

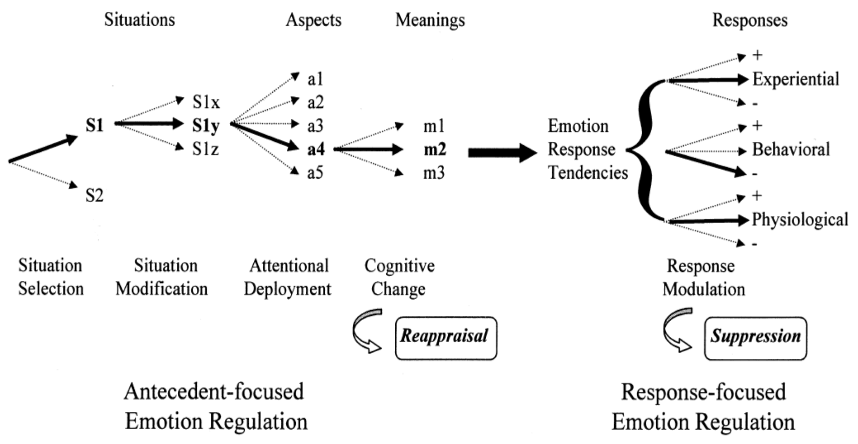


Figure 5.2. The Process Model of Emotion Regulation distinguishing antecedent–response focused strategies (Gross, 2002)

Gross notes that no emotion regulation strategy is inherently good or bad (2002); nevertheless, reappraisal and suppression have differences in the way they impact ongoing emotional experience and responding during the regulation process (Gross & John, 2003). More specifically, suppression of expressing negative emotions could be seen as a rapid emotional adjustment to the requirements of a specific social context. However, in their set of preliminary studies with adults, Gross and John (2003) found that habitual use of suppression is linked with experiencing greater negative emotion in contrast to reappraisal. This could be due to reappraisal being an antecedent focused strategy that alters both intensity of negative emotion and subsequent responding style in contrast to suppression (Gross & John, 2003). Moreover, Gross and John (2003) also reported that greater reappraisal is associated with greater interpersonal functioning and well-being while greater suppression is associated with poor interpersonal functioning and well-being.

A similar categorization is also present in youth literature such that suppression has been part of maladaptive emotion regulation strategy family whereas reappraisal is accepted as an adaptive emotion regulation strategy (Hannesdottir & Ollendick, 2007; Schäfer, Naumann, Holmes, Tuschen-Caffier, & Samson, 2017; Young et al., 2019; Zeman et al., 2006).

In line with this, empirical literature points out that anxious children and adolescents engage in reappraisal less frequently in everyday life (Carthy, Horesh, Apter, Edge, & Gross, 2010; Hughes et al., 2010; Keil et al., 2017; Lougheed & Hollenstein, 2012; Sackl-Pammer et al., 2019) and are less successful to use reappraisal in stress eliciting situations even when cued compared to non-anxious counterparts (Carthy, Horesh, Apter, & Gross, 2010), with an effect size of r = -.29 (Schäfer et al., 2017). Correspondingly, greater use of suppression is associated with greater anxiety symptomatology in children (Eastabrook et al., 2014; Hughes et al., 2010; Lanteigne et al., 2014) with an effect size of r = .21 (Schäfer et al., 2017).

5.1.4. The Association Between Attention Bias and Emotion Regulation

As explained above, attentional deployment broadly refers to a collection of processes to selectively attend certain aspects of the stimuli and to alter emotional experiences (Gross, 2015; Wadlinger & Isaacowitz, 2011). So, attentional deployment encompasses distinct emotion regulation strategies (Wadlinger & Isaacowitz, 2011) based on physical withdrawal of attention such as shifts in gazing behaviour or cognitive shifts in one's internal focus (Gross, 2015; Gross & Thompson, 2007). Attentional deployment on cognitive level could be distraction (i.e., non – emotional aspect of the situation or thinking about a situation that is irrelevant to the concurrent situation), concentration (i.e., intensely focusing on a particular topic), and rumination (i.e., repetitive focus on the situation and its emotional aspects) (Gross, 1999; Gross, 2002; Gross, 2015; Gross & Thompson, 2007; Wadlinger & Isaacowitz, 2011).

One specific form of attentional deployment that is especially relevant to this chapter is shifts in gazing behaviour. Emotion regulation through attentional mechanisms has been frequently observed in developmental populations. In fact, according to gaze aversion studies with infants, attentional deployment through gaze shifting could be one of the earliest forms of emotion regulation (Gross & Thompson, 2007).

Attention to positive images in lab settings is associated with positive mood in individuals (Wadlinger & Isaacowitz, 2011) while robust attention bias literature clearly shows that attention to threatening images is associated with increased anxiety (Bar-Haim et al., 2007; Dudeney et al., 2015). Although the link between attention bias for threat and greater experience of anxious emotion has been shown, whether attention bias interacts with emotion regulatory processes to produce or maintain anxiety is yet to be understood.

Attention bias studies where anxious children were given the need to regulate their emotions through stress induction appears to implicitly suggest an association between attention bias for threat and poor emotion regulation in children. For example, Eldar and colleagues (2008) explored whether training children to display attention bias towards and away from angry faces would make them more susceptible to stress. Accordingly, children who were in the attend to angry face group rated themselves with higher anxiety compared to children in the attend to neutral face group after stress induction, which suggests that habitual deployment of attention on threatening aspects of stimuli makes children's ability to deal with anxiety weaker. Similar results were reported by Bar-Haim and colleagues' study (2011), where they trained one group of high anxious children to disengage from angry faces while the other high anxious group was in the placebo condition. As a result, the group that learned to disengage from angry faces reported less anxiety compared to the placebo group following stress induction.

Seefeldt and colleagues (2014) measured attention bias for threat after stress induction instead of measuring anxiety levels after bias towards threat induction, and reported that only children with social phobia showed increased bias for angry faces following stress induction compared to healthy controls, which suggests that the association between failure to decrease the impact of negative emotions and attention to negative information could be bi-directional.

Romens and Pollak (2012) study explored the association between attention bias and emotion regulation strategy more explicitly in maltreated children. They measured attention bias before, right after, and 8-minute after negative mood induction. The delay period was allocated to the study design on purpose to allow children time to regulate their negative emotions following negative mood induction. Accordingly, children with maltreatment history coupled with frequent use of rumination showed greater bias for sad faces after the delay period compared to healthy controls.

Price and colleagues' study (Price, Allen et al., 2016) is another study where emotion regulation strategies were explicitly measured and their association with attention bias for threat was explored. They assessed whether the participating adolescents experienced a negative event eliciting negative emotions in the past one hour and whether they behaviourally distracted themselves or suppressed their thoughts on the negative events through phone calls twice a day. Their results revealed that even after controlling for anxiety status, both healthy and anxious children's behavioural distraction and thought suppression regulation scores were positively correlated with increased vigilance for threatening faces, suggesting that effort to regulate emotions on its own might be differentially linked to attention bias independent of anxiety.

Finally, Connel and colleagues (Connel, Patton, Klostermann, & Hughes-Scalise, 2013) explored the role of suppression and reappraisal on attention bias in depressed children and reported that higher levels of suppression predicted bias towards sad faces and low levels of suppression predicted bias away from sad faces in highly depressed children, while reappraisal was not a significant predictor of bias.

Taken together, given that one's emotions can determine saliency of stimuli and impact the scope of attention in relation to that stimuli or, the other way around, the features of stimuli under attentional focus can impact emotional experience, attention bias and attention deployment through gazing behaviour appear to have common characteristics to shape emotional experience. In fact, Todd and colleagues (Todd, Cunningham, Anderson, & Thompson, 2012) argue that attention bias for threat is a maladaptive emotion regulation strategy on its own, which lays the foundation for further processing of stimuli through selective attentional filtering and modulates emotional responses.

In addition, Wadlinger and Isaacowitz (2011) argue that attentional deployment as one of the earlier emotion regulation process can impact efficiency of the forthcoming regulatory processes and because it can also be automatic and require minimum cognitive effort in such cases, the desired emotional outcomes can be achieved with ease. More importantly, they further argue that attentional deployment could also work as a component of other emotion regulation strategies such as reappraisal or suppression, which would improve each other's efficiency (Wadlinger & Isaacowitz, 2011).

5.1.5. Current Study: Aims

Overall, emotion regulation difficulties are a well-known maintaining factor for childhood anxiety. So, literature demands examining the mechanisms that contribute to emotion (dys)regulation that leads psychopathology in children (Zeman et al., 2006). On the other hand, attention bias for threat has been a well established causal or maintaining factor in childhood anxiety (Bar-Haim et al., 2007; Dudeney et al., 2015) and emotion regulation patterns have been suggested to be a potential correlate of attention bias (Cisler & Koster, 2010).

In that regard, whether attention bias modulates or is modulated by children's habitual emotion regulation strategy use requires further attention. So, to investigate the links between children's attention biases and emotion regulation strategy uses, Gross' Process Model of Emotion Regulation was chosen to be the conceptual framework to this study based on the operational similarities between attention bias and the process of attention deployment in the model. Furthermore, the model provides a framework for conceptualizing several different emotion regulatory processes including cognitive change and response modulation. Because reappraisal and suppression strategies are situated in cognitive change and response modulation processes that follow attentional deployment process in the model, reappraisal and suppression were chosen to be investigated in relation to attention bias in this study.

To the best of our knowledge, only three studies so far directly examined how attention bias might be related to children's emotion regulation strategies to contribute their psychopathology. But each of these studies examined these associations in different psychopathological contexts with measuring diverse emotion regulation strategies, which reduce comparisons and characterization of the link between attention bias and emotion regulation.

Romens and Pollak (2012) study explored trait rumination and provides support for the positive association between trait rumination and attention bias for sad faces in maltreated children. It is known that suppression is positively associated with depression symptomatology, and Connell et al. (2013) study provides further evidence regarding the diverse impact of expressive suppression levels on attention bias for sad faces in depressed children. These two studies were specific to bias for sad faces within the context of mood disorders. Price, Allen et al. 2016 study, on the other hand, is the only study that provides preliminary evidence for the effect of habitual use of thought suppression and distraction on greater attention bias for threatening faces in anxious children.

Therefore, it appears that no study so far explored the role of reappraisal and expressive suppression in children’s attention biases for threat within the context of anxiety. Yet, considering that how reappraisal and suppression are involved in childhood anxiety has been recognized (Carthy, Horesh, Apter, Edge et al., 2010; Eastabrook et al., 2014; Hughes et al., 2010; Keil et al., 2017; Lougheed & Hollenstein, 2012; Lanteigne, Flynn, Eastabrook, & Hollenstein, 2014; Sackl-Pammer et al., 2019; Schäfer et al., 2017) and the presence of the association between attention bias for threat and anxiety in children has been well established (Bar-Haim et al., 2007; Dudeney et al., 2015), exploring how attention bias for threat and the frequency of using reappraisal and suppression operate together to contribute anxiety has important implications for anxiety treatment in children.

Therefore, the first aim of this chapter is to examine the association between children's habitual use of reappraisal and suppression to regulate their emotions and their attention biases. Because attentional deployment comes before cognitive change and response modulation steps in Gross' process model of emotion regulation (Fig 1.3), and likely to impact the efficiency of the following emotion regulation strategies (Wadlinger & Isaacowitz, 2011), we also aimed to test whether attention bias for threat mediates the association between children's anxiety symptomatology and their reappraisal and suppression frequency.

Based on the previous literature pointing out that reappraisal is associated with less psychological symptoms in contrast to suppression (Schäfer et al., 2017), it could be expected that children with greater reappraisal skills would show less attention bias for threatening faces in contrast to greater use of suppression. However, because the association between emotion regulation strategy use and attention bias in anxious children has not been characterised yet due to the scarcity of previous studies, the current study stands out as an exploratory study; hence, we did not formulate specific hypotheses and the statistical significance of the tests was evaluated as two-sided.

5.2. METHODOLOGY

5.2.1. Participants

The total sample consists of 99 children, which is nearly identical to that of Chapter 5 with the inclusion of one more child, who was excluded due to data pre-processing in Simon task. Please refer to Chapter 5 for details of sample characteristics.

5.2.2. Measurement Tools Specific to Chapter 5

Symptom measures were SCAS-C and MFQ. Eye movement indices and reaction-time based indices from dot-probe task were used as measures of attention bias.

ERQ-C was used to measure children's emotion regulation strategy use. Total scores of cognitive reappraisal and expressive suppression subscales were entered separately into the analyses as each of them reflect a different aspect of emotion regulation strategy.

Descriptive statistics for sample characteristics and eye movement data were summarized in Table 5.1 and Table 5.2, respectively.

5.2.3. Data Integrity Check and Preparation

Data pre-processing of attentional bias data and questionnaire data was identical to Chapter 3. So, missing data in ERQ-C scores as well as SCAS-C and MFQ were replaced with linear regression multiple imputation (n = 5).

5.2.4. Outliers and Normality Check

Data testing procedure for the assumptions and requirements of parametric tests were identical to Chapter 2.

Both non-parametric and parametric tests were carried out in the investigations involving non-normally distributed variables, which were denoted with an asterisk in the respective descriptives tables. If the results were the same, estimates based on parametric tests were reported. If there was no non-parametric equivalent of parametric tests such as repeated measures ANOVA, parametric tests were conducted. In such cases, the results should be interpreted with caution.

5.3. RESULTS

5.3.1. Sample Characteristics

Table 5.1. Descriptive statistics of demographic variables and questionnaires (Study 3)

	Children N = 99	
	Mean / N	SD / %
Gender		
Male	45	45.5
Female	54	54.5
Age (year)	10.78*	2.24
Ethnicity		
Caucasian	86	86.9
Asian	5	5.1
Arabian	1	1
Mixed	7	7.1
Questionnaires		
SCAS-C	24.35*	12.62
MFQ-C	11.51*	8.62
ERQ-C Cognitive Reappraisal	19.21*	3.77
ERQ-C Expressive Suppression	10.42*	2.70

Note. SCAS-C = Spence Children's Anxiety Scale-Child Version, MFQ-C = Mood and Feelings Questionnaire – Child: Long Version. ERQ-C Cognitive Reappraisal = Emotion Regulation Questionnaire: Child Version, Cognitive Reappraisal subscale, ERQ-C Expressive Suppression = ERQ-C Cognitive Reappraisal = Emotion Regulation Questionnaire: Child Version, Expressive Suppression subscale.
Presented questionnaire data is raw data prior to winsorization and imputation, so participants whose missing data to be imputed were not reflected in the respective sample.
Variables with * superscript indicates non-normal distribution after winsorization.

Reliability of SCAS-C and MFQ were excellent, with Cronbach's α = .888 and α = .896, respectively. Mean SCAS-C (*M* = 24.35, *SD* = 12.62) and MFQ (*M* = 11.51, *SD* = 8.62) scores were within the non-clinical range in our sample, meaning that the overall sample is not trait anxious or depressed. No effect of gender or ethnicity found in either scale. Age was not associated with the scores.

ERQ-Cognitive Reappraisal and ERQ-Expressive Suppression subscales show satisfactory reliability with Cronbach's α = .771 and α = .660, respectively. The children in the current sample have slightly lower scores on reappraisal (*M* = 19.21, *SD* = 3.77) and suppression (*M* = 10.42, *SD* = 2.70) scales compared to the community sample in the standardization study (Gullone et al., 2012), which reported *M* = 21.53, *SD* = 4.11 for reappraisal and *M* = 11.44, *SD* = 3.14 for suppression for 10-year-olds. Age was neither associated with ERQ-Suppression (r_t = -.018) nor ERQ-Reappraisal (r_t = -.013). No gender differences were observed for reappraisal subscale; however boys resort to expressive suppression (*M* = 11.24, *SD* = 2.797) significantly more than girls (*M* = 9.74, *SD* = 2.443) (t(97) = 2.810, p = .005). Suppression scores were also found to be affected by ethnicity such that Asian children (*M* = 13.20, *SD* = 1.789) use suppression to regulate their emotions more than other children (F(2, 95) = 3.11, p = .041). No impact of ethnicity was found on reappraisal scores.

The associations between symptom measures and emotion regulation strategy use revealed that SCAS and MFQ were positively correlated (r = .740, p = .01). SCAS was not associated with neither emotion regulation scales.

However, MFQ showed positive correlation with the suppression subscale (r = .343, p = .01) suggesting that children with greater depression scores use expressive suppression to regulate their emotions more.

5.3.2. Analysis of Attention Bias with Gaze Data

Table 5.2. Descriptive statistics for eye movement data (Study 3)

	Children N = 99	
	Mean	SD
Missing Data (%)	7.085	12.941
Total Discarded Data (%)	8.867	13.204
Vigilance Index Score		
Angry	.513	.06
Happy	.561	.09
Disengagement (msec)		
Angry Trials - Angry	530.765*	183.519
Angry Trials - Neutral	505.070*	226.705
Happy Trials - Happy	529.100*	176.124
Happy Trials - Neutral	452.855*	155.599
AngryTrials – Angry Dwell (msec)		
Window 1	207.394	39.661
Window 2	274.909*	40.725
Window 3	301.470	48.380
Window 4	304.774	61.010

Table 5.2. Descriptive statistics for eye movement data (Study 3) (Continued)

AngryTrials – Neutral Dwell (msec)		
Window 1	208.077	44.838
Window 2	264.723	44.083
Window 3	297.301	47.834
Window 4	297.834	62.294
Angry Trials – Adjusted Dwell		
Window 1	1.020	.190
Window 2	1.059	.200
Window 3	1.033	1.197
Window 4	1.049*	.245
Happy Trials – Happy Dwell (msec)		
Window 1	206.562	36.196
Window 2	284.266	41.092
Window 3	301.538	54.595
Window 4	306.207	61.030
Happy Trials – Neutral Dwell (msec)		
Window 1	205.997	40.684
Window 2	254.577	41.482
Window 3	298.948	50.401
Window 4	292.516	64.831
Happy Trials – Adjusted Dwell		
Window 1	1.012	.177
Window 2	1.142*	.237
Window 3	1.023*	.205
Window 4	1.076	.236

Note. Presented EM data is raw data prior to winsorization. Variables with * superscript indicates non-normal distribution after winsorization.

5.3.2.1. Initial Vigilance

One sample t-tests were carried out to test whether children's probability of first fixating on emotional faces were significantly different from chance (50%). Accordingly, children displayed significant vigilance towards both angry ($t(98) = 74.067$, $p = .000$) and happy faces ($t(98) = 60.403$, $p = .000$) (Fig. 5.3).

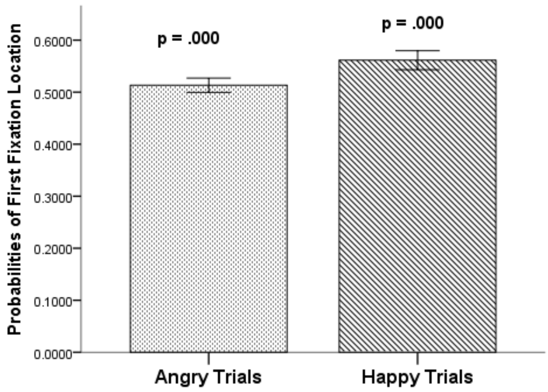


Figure 5.3. Probabilities of first fixation location for each emotion compared to neutral faces, Error Bars 95% CI

5.3.2.2. Disengagement Difficulty

To test the effect of emotion on children's disengagement lengths, 2 x 2 repeated measures ANOVA with trial type (angry, happy) and disengagement type (emotion, neutral) was carried out on children's disengagement duration.

Accordingly, main effects of disengagement type ($F(1, 98) = 37.864$, $p = .000$, partial $\eta 2 = .279$) and trial type were found ($F(1, 98) = 6.225$, $p = .014$, partial $\eta 2 = .060$). Interaction effect of trial type and disengagement type also emerged ($F(1, 98) = 5.004$, $p = .028$, partial $\eta 2 = .049$). To follow up the interaction, paired samples t-tests with trial type on each level of disengagement type were carried out. Accordingly, children had shorter disengagement latencies for neutral faces on happy trials compared to neutral faces on angry trials (t(99) = 3.331, p = .001) (Fig. 5.4). So, when neutral faces were paired with angry faces, disengaging period from neutral faces following initial vigilance on them increases.

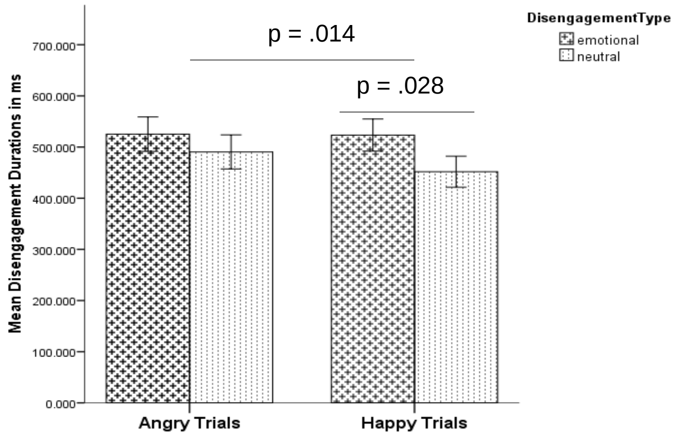


Figure 5.4. Mean disengagement durations across trial types for each emotion. Error Bars 95% CI.

5.3.2.3. Attentional Maintenance

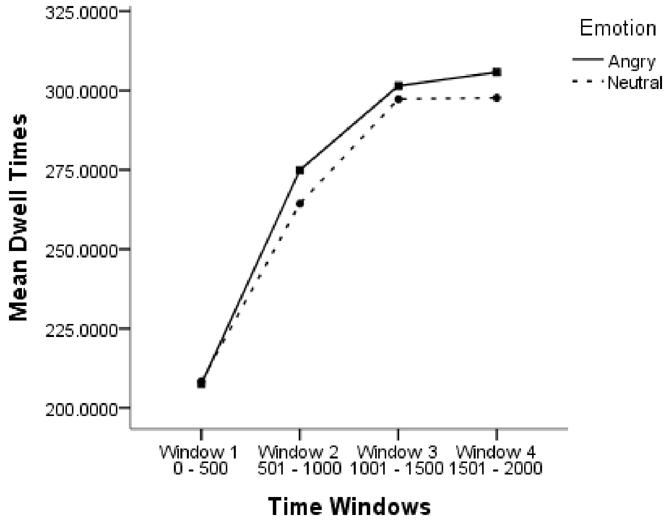
To test maintained attention, two 2x4 repeated measures ANOVA with emotional valence (emotion, neutral) and time window (0-500, 501-1000, 1001-1500, 1501-2000 milliseconds) as independent variables were carried out on children's absolute average dwell times for each emotion type. Greenhouse-Geisser correction was applied for violation of the assumption of sphericity when required.

For angry-neutral comparisons, a significant main effect for emotion emerged ($F(1,98) = 4.375$, $p = .039$, partial $\eta 2 = .043$). Also, significant effect of time was found ($F(2.729, 267.487) = 207.379$, $p = .000$, partial $\eta 2 = .679$). Accordingly, children dwelled on angry faces longer than neutral faces throughout the entire observation period and dwell times on faces increased as time evolves except the final time window. Although children showed a tendency to dwell more on angry faces compared to neutral faces during the last three windows, the difference did not reach significance since no significant time x emotion interaction emerged (Fig. 5.5A).

For happy-neutral comparisons, a significant main effect for emotion ($F(1,98) = 19.899$, $p = .000$, partial $\eta 2 = .169$) and time ($F(2.731, 267.591) = 186.226$, $p = .000$, partial $\eta 2 = .655$) emerged. Also, interaction effect of time and emotion was found ($F(3, 294) = 7.128$, $p = .000$, partial $\eta 2 = .068$). To follow up the interaction, paired samples t-tests with emotion type on each level of time window were carried out. Accordingly, children dwelled on happy faces longer on window 2 ($t(97) = 5.639$, $p = .000$) (Fig. 5.5B).

Separate independent t-tests and set of correlation analyses were carried out to test for gender related variations and age associations in bias scores. No significant gender differences or age associations were found on neither of the bias scores (all p's > .05).

Panel A



Panel B

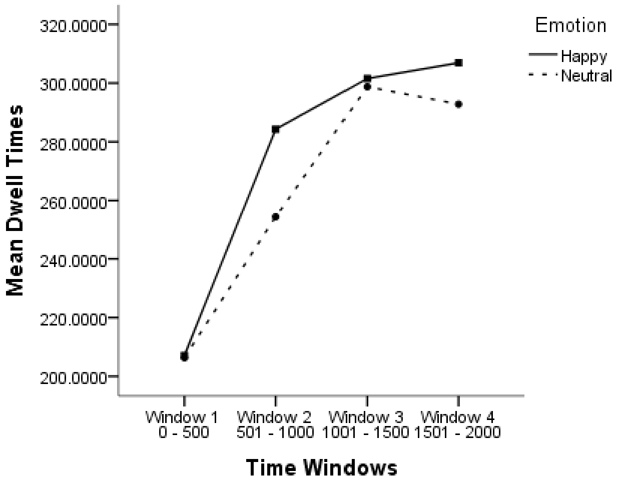


Figure 5.5. Absolute dwell times in each time window for each emotion. Panel A: Angry Trials. Panel B: Happy Trials

5.3.3. Correlations

According to Baron and Kenny's three-variable mediation model (1986) significant associations should exist between a) independent variable and mediator variable; b) mediator variable and dependent variable; and c) independent variable and dependent variable to test a mediator effect. So, in order to identify significant associations and potential covariates, and hence to establish our mediation model, we ran a series of bivariate correlations (See Appendix 12 for the variable correlogram).

Our data revealed no significant associations between anxiety scores and emotion regulation strategies (a); emotion regulation strategies and attention biases (b); and anxiety scores and attention biases (c).

Accordingly, our data failed to meet the pre-requisites of mediation model; hence, testing mediator role of attention bias on the association between anxiety symptomatology and reappraisal and suppression was not possible.

5.3.4. Exploratory Analyses

Failure to find significant correlations between critical variables could be due to small variance in the questionnaire scores as SCAS-C and ERQ- C Reappraisal scores were positively skewed and ERQ-C Suppression scores were leptikurtotic. Thus, further post-hoc exploratory analyses were carried out in order to determine the link between emotion strategy use in children and their attention biases. Accordingly, children were divided into groups as high and low based on emotion regulation strategy use scores and potential group differences were tested on their attention bias patterns.

The scores at 25th percentile and below were used to determine low scoring groups while 75th percentile and above were used to determine high scoring groups for each subscale. For reappraisal scale (25th percentile score = 17, 75th percentile score = 22), the sample consisted of 61 children with n(reappraisal – low) = 29 and n(reappraisal high) = 32. For suppression scale (25th percentile score = 9, 75th percentile score = 12), the sample consisted of 74 children with n(suppression – low) = 40 and n(suppression – high) = 34.

5.3.4.1. Examining Reappraisal

Initial Vigilance

One sample t-tests yielded that low reappraisal group showed vigilance towards angry faces significantly greater than chance (t(28) = 3.020, p = .005) while high reappraisal group did not show significant angry vigilance. Furthermore, between-groups difference was marginally significant (t(59) = 1.889, p = .059) such that low reappraisal children showed greater vigilance for angry faces compared to high reappraisal children (Fig. 5.6).

For happy faces, both reappraisal-low (t(28) = 2.634, p = .014) and reappraisal-high groups (t(31) = 4.717, p = .000) showed significant vigilance; however, there was no significant between-groups difference.

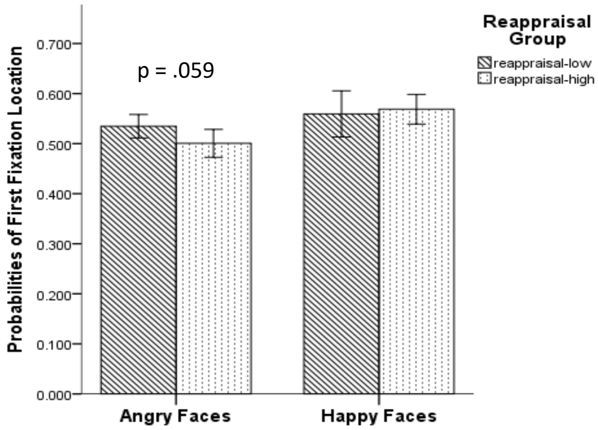


Figure 5.6. Probabilities of first fixation location for each emotion compared to neutral faces across high vs low reappraisal groups, Error Bars 95% CI

Disengagement Difficulty

2 x 2 x 2 mixed design ANOVA with trial type (angry, happy) and disengagement type (emotion, neutral) as within subjects and group (reappraisal high vs low) as between groups factors were carried out on participants' disengagement reaction times.

Main effect of disengagement type was found (F(1, 59) = 24.144, p = .000, partial η2 = .290) such that disengaging attention from emotional faces took longer than disengaging from neutral faces in the entire group. There was also main effect of trial type (F(1, 59) = 5.398, p = .024, partial η2 = .084) which was qualified by marginally significant trial type x group interaction (F(1, 59) = 3.925, p = .051, partial η2 = .063). Accordingly, reappraisal-low children showed greater disengagement difficulties on angry trials compared to reappraisal-high children (Fig. 5.7). No other main or interaction effects emerged.

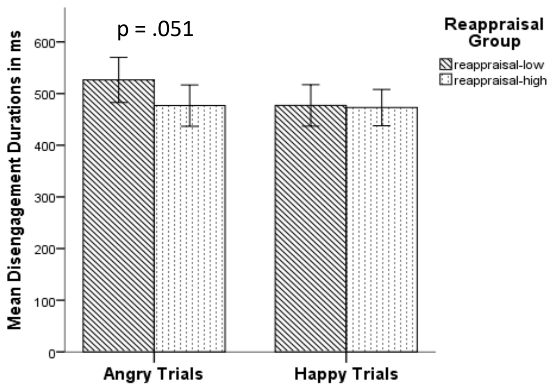


Figure 5.7. Mean disengagement durations across trial types for each emotion across high vs low reappraisal groups. Error Bars 95% CI.

Maintained Attention

To test maintained attention, 2 x 4 mixed design ANOVA with time window (0-500, 501-1000, 1001-1500, 1501-2000 milliseconds) as within-subjects and group (reappraisal high vs low) as between groups factors were tested on children's dwell scores each emotion type.

For angry trials, no significant main or interaction effects emerged (all p's > .05) (Fig. 5.8A).

For happy trials, only main effect of time window was significant ($F(3, 177) = 8.548$, $p = .000$, partial $\eta 2 = .127$) such that dwelling on happy faces was greater on window 2 compared to window 1 and window 3 (Fig. 5.8B).

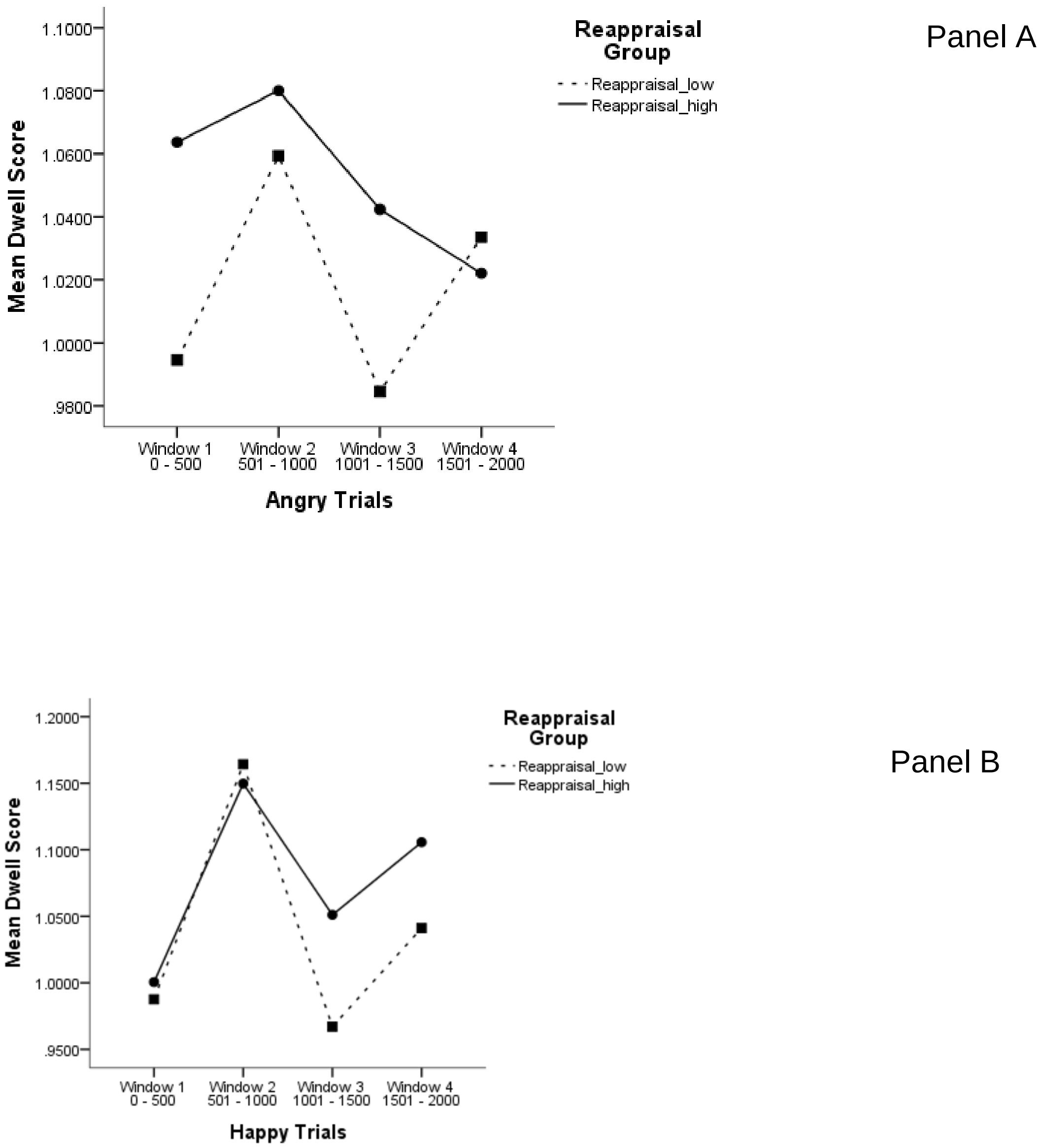


Figure 5.8. Mean dwell scores in each time window across high vs low reappraisal groups. Panel A: Angry Trials. Panel B: Happy Trials

5.3.4.2. Examining Suppression

Initial Vigilance

High suppression children's vigilance towards angry faces was not significant while low suppression children's vigilance was marginally significant from chance (t(39) = 1.813, p = .078). No between-groups difference emerged (p > .05) (Fig. 5.9).

Vigilance towards happy faces was significant in both low suppression (t(39) = 4.454, p = .000) and high suppression groups (t(33) = 3.871, p = .000) and no between-groups difference emerged (p > .05).

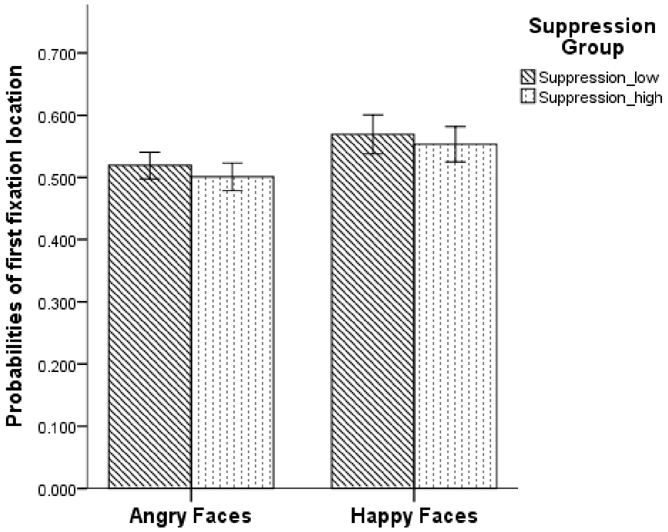


Figure 5.9. Probabilities of first fixation location for each emotion compared to neutral faces across high vs low suppression groups, Error Bars 95% CI

Disengagement Difficulty

2 x 2 x 2 mixed design ANOVA with trial type (angry, happy) and disengagement type (emotion, neutral) as within subjects and group (suppression high vs low) as between groups factors were carried out on participants' disengagement reaction times. Because MFQ scores were significantly correlated with suppression scores, it was added to the analysis as a covariate.

There was a significant main effect of disengagement type ($F(1, 71) = 11.687$, $p = .001$, partial $\eta^2 = .141$) and a marginally significant main effect of trial type ($F(1, 71) = 3.685$, $p = .059$, partial $\eta^2 = .049$) (Fig. 5.10). No other main or interaction effects were significant. So, overall children showed greater disengagement difficulty for emotional faces compared to neutral faces and their disengagement times on angry trials were longer than happy trials independent of suppression scores.

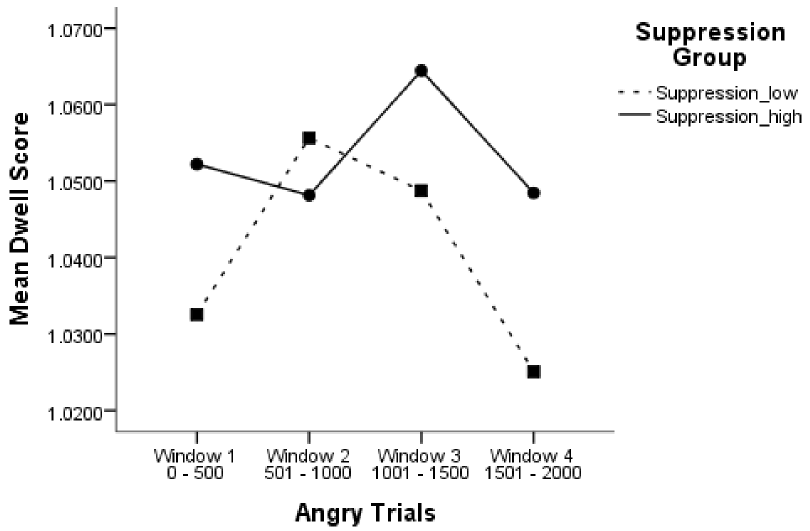
Figure 5.10. Mean disengagement durations across trial types for each emotion across high vs low suppression groups. Error Bars 95% CI.

Maintained Attention

2 x 4 mixed design ANOVA with time window (0-500, 501-1000, 1001-1500, 1501-2000 milliseconds) as within-subjects and group (suppression high vs low) as between groups factors, and MFQ as covariate were tested on children's dwell scores each emotion type.

For angry trials, no significant main or interaction effects emerged (all p's > .05) (Fig. 5.11A).

For happy trials, only main effect of time window was significant ($F(3, 213) = 5.999$, $p = .001$, partial $\eta2 = .078$) (Fig. 5.11B). Accordingly, dwelling on happy faces during window 2 was significantly greater than window 1 and window 3.



Panel A

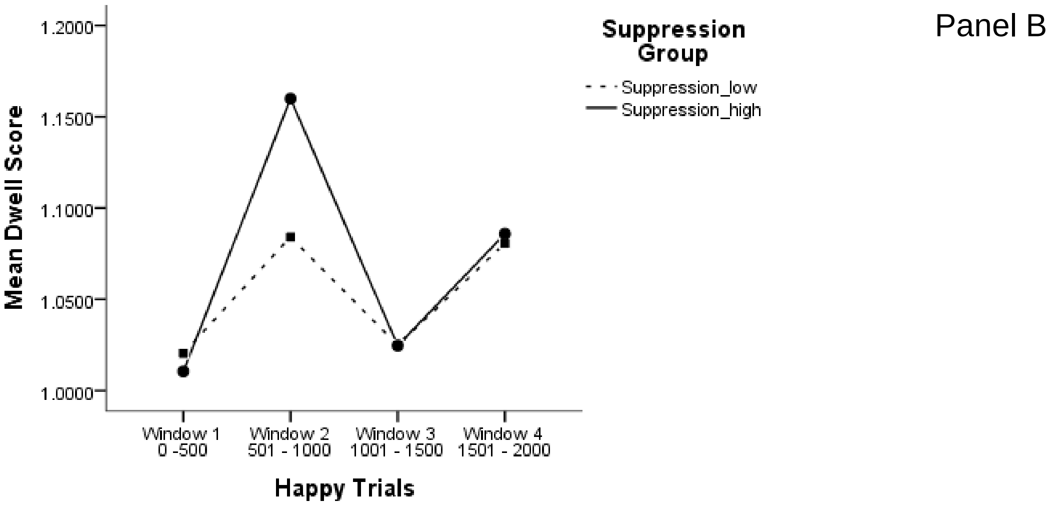


***Figure 5.11*.** Mean dwell scores in each time window across high vs low suppression groups. Panel A: Angry Trials. Panel B: Happy Trials

5.4. DISCUSSION

The aim of the current study was to examine the association between children's reappraisal and suppression use frequency to regulate their emotions and their attention biases. This chapter also aimed to examine whether attention bias would mediate the association between children's anxiety symptomatology and their reappraisal and suppression based on the Process Model (Gross, 1998b).

The sample in the current study was nearly identical to the sample in Chapter 4 with the addition of one more child. A detailed explanation of stimuli appraisal during vigilance, disengagement, and overall attentional maintenance patterns can be found in the discussion section of Chapter 4; hence will not be repeated here.

The key variables involved in this chapter were frequency of children's reappraisal and suppression use to regulate their emotions. Age and gender have been suggested to be developmental moderators of suppression and reappraisal use in children (Gullone et al., 2010) in that use of both strategies diminishes as children gets older and males use more suppression than females. Although the directionality of the correlations in this study indicated a decrease in the use of both strategies as age increases, the associations did not reach statistical significance despite the wide age range. Because age was positively skewed in the current sample and tend to cluster towards the age of 10, adolescents might have been underrepresented. Future research with a sample of more homogenous distribution of age might statistically detect the decrease trend emerging in the current sample.

However, gender related differences emerged in suppression scale such that boys reported to use more suppression than girls, which replicates previous research which found boys to be less expressive (Gullone et al., 2010). In addition, suppression was also affected by ethnicity in our sample in that Asian children were found to use suppression significantly more than other children. Cultural differences have been a recognised factor in shaping the habitual use of emotion regulation strategy patterns and the appropriate ways of expressing emotion in children (Huberty, 2012). So, Asian children's frequent use of suppression in the current sample appears to be supported by previous literature (Butler, Lee, & Gross, 2007; Gross & John, 2003). However, the disproportionately low number of Asian children in the current sample does not facilitate a well rounded conclusion.

The current findings yielded no significant associations between anxiety symptomatology and reappraisal and suppression scores, hence failed to replicate the previously documented low reappraisal-high anxiety (Carthy et al., 2010a; Carthy et al., 2010b; Keil et al., 2017; Sackl-Pammer et al., 2019) and high suppression-high anxiety (Estabrook et al., 2014; Lanteigne et al., 2014) associations. However, it is noteworthy that the youth in this thesis did not have elevated levels of trait anxiety in contrast to the samples of the previous studies, where clinically diagnosed or highly symptomatic children were tested. The current results therefore might suggest that where anxiety levels are low to average, anxiety and emotion regulation strategies are not particularly associated. Alternatively, the lack of associations could be due to the relatively narrow range of anxiety scores which limit statistical ability to detect correlations.

Children's suppression scores, on the other hand, showed a positive significant correlation with depression scores, which replicates Estabrook et al. (2014) and Lanteigne et al. (2014) studies. Despite that the children in the current sample were not depressed, the suppression scores being associated with such narrow range of depression scores may suggest that suppression could be a particular regulation style that is characteristic to distinguish depressed individuals.

The associations between attention biases and reappraisal and suppression were also not significant in the current study. Hence, the non-significant associations between the critical variables did not meet Baron and Kenny's (1986) associational pre-requisites to test the potential mediatory role of attention bias on the association between anxiety and reappraisal and suppression.

The lack of significant associations could be due to the scores derived from questionnaire measures not being normally distributed. SCAS-C and ERQ-C Reappraisal scores were positively skewed and ERQ-C Suppression score was leptikurtotic. So, the resulting variance in these scores were considerably small. Therefore, we grouped children as high and low based on their emotion regulation strategy use frequency and conducted several post-hoc exploratory analyses to investigate whether these children would differ in their attention biases.

Exploring reappraisal use and multiple types of attention bias patterns for threatening stimuli in children provides preliminary results to the literature, which limits the extent of comparisons with past research regarding how exactly cognitive reappraising frequency is associated with assessment of emotional stimuli through gazing behaviour. Nevertheless, Gross and John's (2003) account of how reappraisal functions to regulate emotions offers few possible explanations for divergent attentional biases to anxiety evoking information in children with low reappraising skills.

Accordingly, Gross and John (2003) have argued that greater use of reappraisal reduces negative emotions since it allows one to work on the situations that elicit negative emotional state to reduce psychological discomfort. In that regard, vigilance of children with low reappraisal skills might be due to being less experienced in evaluating the emotional value of negative environmental stimuli in contrast to the children with high reappraisal skills. Moreover, longer angry face disengagement times of children with low reappraisal skills might further signal their increased effort to understand the true threat value of angry faces compared to neutral faces.

Also, when children's attentional maintenance patterns are examined, a noteworthy difference emerges between high-low reappraisal groups specific to viewing of angry faces in the second half of the observation time. Accordingly, children with high reappraisal skills showed efficient disengagement from angry faces and continuous decrease in contrast to the children with low reappraisal skills.

Although this difference was not statistically significant, it resonates the vigilance-avoidance patterns of non-anxious individuals. As addressed before, the vigilance–avoidance model of attention bias (Mogg et al., 2004) predicts that non-anxious individuals' avoidance from threat reflects their reduced interest due to threat stimuli not being as salient as it was in the initial vigilance stage, which functions for threat appraisal.

In that regard, current findings can be extended to suggest that reappraisal skills could be a specific factor that underlie threat appraisal process in vigilance-avoidance hypothesis (Mogg & Bradley, 1998). As such, children with high reappraisal skills might have evaluated threat value of angry faces more efficiently than low reappraiser children during the vigilance state so that they might not have the need to turn back to angry faces again in the later stages of processing. So, low reappraiser children's return of interest on angry faces in the final time window could be an extension of their initial disengagement difficulty, such that they might have needed more time to look at angry faces for further evaluation.

In contrast, the divergence between the high and low reappraisal groups disappears regarding attention biases and maintenance for happy faces, suggesting that reappraising frequency specifically impacts gaze patterns on angry faces in children.

Examination of group differences based on suppression frequency, on the other hand, did not reveal any group differences in children's attention bias or maintenance patterns for neither angry nor happy faces. Therefore, when compared to suppression, frequency of reappraisal use in children appears to be particularly relevant to their attention bias for threat.

What is more striking is that the group differences in attention bias for threat in the current study were based on reappraisal scores and independent of anxiety as the current sample did not have high trait anxiety. So, this finding provides further support to Price and colleagues' study (2016), where behavioural distraction and thought suppression were still significantly associated with vigilance towards threat after controlling for anxiety status. Correspondingly, this implies that there might be a unique association between individual differences in children's use of reappraisal and their bias for threat above and beyond anxiety symptomatology.

Several limitations of this preliminary study need to be addressed. First of all, this study intended to examine emotion regulation – attention bias associations within the context of trait anxiety. However, the relatively small number of high trait anxious children did not allow examination of the mediatory role of attention bias on the association between children's anxiety and use of reappraisal and suppression. Future studies might find it beneficial to explore this potential modulatory role of attention bias with a youth sample with elevated levels of trait anxiety.

Secondly, albeit our results regarding group differences based on reappraisal use frequency are promising, it is important to note that the significance of the vigilance difference was only marginal, which requires caution in interpretation. The mean suppression and reappraisal scores were slightly lower than the ones reported by the standardization study (Gullone et al., 2010). So, the scores for high reappraiser children in this sample may not have been high enough to elicit greater threat attention bias divergence to be statistically significant.

Third, the attentional maintenance patterns discussed do not reflect statistically significant group difference, but rather underscore a qualitative difference. However, it is important to note that these differences were chosen for investigation as they resemblance vigilance-avoidance patterns in non-anxious individuals suggested by Mogg and Bradley (1998). Therefore, this qualitative difference can inform future studies to test the role of reappraising in threat processing with a more representative sample of anxious children.

Fourth, the cross-sectional design of this study renders it difficult to determine causality regarding attention bias and reappraisal. However, delineation of whether one causes the other has important implications for anxiety treatment. So, future longitudinal examinations can reveal whether it is hindered development of reappraisal skills that elicit greater attention bias for threat, or it is habitual attention bias that prevents children using efficient reappraisal.

Overall, our preliminary results highlight that especially reappraisal use is a critical emotion regulation strategy that is involved in attentional processing of threatening stimuli in children. So, psychoeducation programmes aiming to improve adaptive emotion regulation strategies in community sample children might benefit from having a specific focus on children's reappraisal skills, which might prevent children from developing attention biases for threat.

Additionally, our results warrant replication in anxious children as the association found in this study could be even stronger in anxious cohorts. If indeed anxious children with low reappraisal skills show stronger attention bias for threat, having a particular focus on improving emotion regulation skills in children in therapeutic settings would be a worthwhile endeavour in addition to promoting attention bias modification techniques.

6. CHAPTER SIX: GENERAL DISCUSSION

6.1. Introduction

The overarching aim of this thesis was to investigate developmental correlates of threat related attention bias in community sample children and adolescents. A systematic literature search identified three potential factors that warrant further investigation. These are: parental attention bias, children's attention control ability, and emotion regulation strategy use. So, one specific factor was explored in each of the empirical chapters in relation to children's attention biases.

In this final chapter, the following sections will reflect on the findings reported in Chapters Three to Five, address the limitations, offer suggestions for future research, and discuss the implication of the results for application and practice.

6.2. Summary of the Findings

6.2.1. An Overview of Children's Eye Movement Data

Attention bias is a complex concept consisting of components as vigilance, disengagement difficulty, and avoidance, which reflects Posner and colleagues (1987) postulation on components of attention orienting as shifting, engaging with new target, and disengaging. Although earlier accounts of attention bias attempted to specify which component of attention bias in the presence of threatening information especially characterizes anxious individuals, recent models by Bar-Haim et al. (2007) and Cisler and Koster (2010) acknowledge that attention bias can be manifested in either form.

Yet, majority of empirical evidence comes from reaction time paradigms, which have been subjected to many criticisms regarding their reliability and validity in mirroring components of attention bias (Brown et al., 2014; Clarke et al., 2013; Reinholdt-Dunne et al., 2012; Von Bockstaele et al, 2014). Especially probe detection paradigms have been highly preferred since they aid extracting out visuo-spatial components of attention by providing a gauge of whereabouts of attention before the probe occurs. The key task property here is the stimuli presentation duration that is usually at least several hundreds of milliseconds, which is long enough for multiple attentional shifts in eye gaze during the observation before the probe (Weierich et al., 2008). Therefore, reaction time tasks do not seem to have the power to accommodate continuous nature of attention and to capture the ongoing attentional behaviour, which do not allow extensive examination of attention bias throughout the entire stimuli observation.

Another issue is related to delineating whether automatic or strategic attentional processes underlie occurrence of vigilance, disengagement difficulty, and avoidance. Automatic and strategic attentional control may differ in their timeline of operation such that automatic/stimuli driven attention is rapid while strategic attention may require longer period of time (Chica et al., 2013). This is inherently linked to the stimuli presentation time in attention bias paradigms. In reaction time tasks keeping presentation time short may prevent operation of strategic attention, which limits examining how attention would unfold. If the task is kept long enough for strategic attention to operate, then encapsulating automatic vigilance is compromised.

Therefore, one of the key strengths of this thesis was to take eye movement data to obtain an uninterrupted measure of attention bias during a relatively long stimuli observation time, which was designed to allow strategic attentional processes to operate (Armstrong & Olatunji, 2012; Bar-Haim et al., 2007; Cisler & Koster, 2010; Lisk et al., 2020).

We also employed dot-probe task along with eye tracking since it does not compromise gazing behaviour. This was to keep the participants focused on the stimuli in contrast to free-viewing paradigm, and to compare dot-probe results with previous literature. So, eye movement data has been the primary data set and this thesis presents several different attention bias indices derived from eye movement data as initial vigilance, disengagement difficulty, and overall attentional maintenance.

This thesis involved a single large group of children and adolescents with varying levels of trait anxiety; hence their attention bias patterns for threat can only be compared against neutral faces as within-subjects bias. Accordingly, vigilance patterns of youth participants, as indexed by the proportion of initial fixations towards angry faces, do not suggest automatic attention capture by angry faces. Given that the youth sample had low levels of trait anxiety in this thesis, this is not unexpected and replicates the results of healthy control groups in previous eye tracking studies where threat-neutral biases were compared (Shechner et al., 2013; Seefeldt et al., 2014; Stevens, Rist, & Gerlach, 2011).

Their vigilance for happy bias, on the other hand, was significantly greater than neutral faces. This is contradictory to Shechner et al. (2013), where no happy vigilance was evidenced in their non-anxious youth sample. However, increased vigilance for happy faces when paired with neutral faces is not uncommon in children and adolescents with low trait anxiety as some dot-probe studies suggest (Joorman et al., 2007; Ho et al., 2017; Stirling et al., 2006; Waters, Henry et al., 2010; Waters et al., 2014). Considering that initial vigilance is thought to be underlined by stimulus driven attentional system (Armstrong & Olatunji, 2012) and operation of stimulus driven attention is dependent on stimuli saliency such as emotionality (Corbetta & Shulman, 2002), it is possible that children's happy vigilance reflects greater emotional saliency of happy faces compared to neutral faces.

Children's disengagement periods reflected the very first disengagement behaviour following the onset of encounter with stimuli as indicated by the time between their initial fixation on a face until their first gaze shift away from that face. Overall, youth participants looked at both angry and happy faces longer than neutral faces during the first disengagement period, which were around 532 msec for angry faces and 529 msec for happy faces. One interesting result that was specific to angry faces was that children disengaged from neutral faces paired with angry faces after a longer time compared to the neutral faces paired with happy faces.

Given that their initial engagement with angry stimuli was not more often than neutral stimuli, and the average disengagement time on angry faces was longer than neutral faces, longer dwell times on neutral faces on angry trials in comparison to happy trials is unlikely to signal avoidance from angry faces.

Instead, this seems to underscore the role of the context in determining stimuli saliency. Previous research highlighted ambiguity of neutral faces in comparison to angry faces such that angry faces clearly signal threat (Öhman, 1996, cited in Cisler & Koster, 2010) while emotionless depictions of neutral faces may require more time for valence evaluation (Cooper & Langton, 2006; Fani et al., 2011; Pergamin-Hight et al., 2016; Schofield et al., 2013). So, longer disengagement periods for neutral faces paired with angry faces might be due to children needing more time to appraise the meaning of neutral faces when paired with angry faces.

Analyses of attentional maintenance patterns within the entire stimuli observation period revealed that prioritized processing of emotional stimuli is not restricted to initial vigilance or the following disengagement period until the first shift away from the respective stimulus. The attentional maintenance patterns based on absolute dwell times revealed sustained increase in attention on emotional faces (see Fig. 4.3A). This indicates a clear preference to look at emotional faces compared to neutral faces in each time window of 500 msec, which is beyond the initial stages of observation.

Because obvious selection of emotional stimuli for attentional processing was not restricted to the first stages of viewing and was continuous towards the later stages, where strategic attention is assumed to operate (Armstrong & Olatunji, 2012; Lisk et al., 2020), the results support the postulations of Bar-

Haim et al. (2007) and Cisler and Koster (2010) attention bias models, each of which posit that top-down, effortful processing also has a role in manifestation of attention bias.

Adjusting the absolute dwell times for angry faces based on the time to dwell on the paired neutral faces allowed examination of how attention bias unfolds in each time window singly for angry faces (see Fig. 3.4B). Accordingly, children looked at angry faces with increase during the first 1000 msec, then following a brief decrease during 1000-1500 msec, their attention turned back to the angry faces in the final time window.

Distinct from other attention bias models, the vigilance-avoidance model (Mogg & Bradley, 1998) considers attention spanning from vigilance to avoidance and offers explanation on the role of attention orienting in experiencing anxiety. Accordingly, anxious individuals first show vigilance towards threat, which is then followed by avoidance away from threat to reduce the anxious arousal caused by the initial vigilance (Mogg & Bradley, 1998). Some eye tracking studies have provided evidence in support of vigilance-avoidance patterns in anxious children (In-Albon et al., 2010). However, the attentional patterns of the youth in the current thesis suggest that the proposed pattern is not displayed by children and adolescents with low trait anxiety. Instead, their returned attention on angry faces in the final time window might indicate further need to elaborate on the meaning of angry faces.

6.2.2. Parental Origins of Attention Bias

Parental environment is a risk factor for developing anxiety in children and adolescents (McLeod et al., 2007). There is a growing literature examining the mechanisms by which anxiety is transferred from parents to their children. Transference of cognitive biases can be a potential medium for children to be more sensitive to threatening stimuli and become more anxious.

Chapter Three of this thesis focused on parental data with the aim to examine whether attention bias for threat would be transferred from parents to their children, which would be indicated by significant associations between parent and child attention bias scores. So, parental attention bias as well as parental anxiety levels were tested in relation to their children's attention bias.

Regarding the role of parental anxiety, eye movement data did not suggest an association between parental anxiety and their children's threat bias. But dot-probe data revealed the contrary, such that greater parental anxiety was associated with greater vigilance for threat. This seems to support parental anxiety–child threat vigilance associations found in previous studies with dot-probe task (Mogg et al., 2012; Montagner et al., 2016). This might suggest that parental anxiety also has a role in formation of attention biases for threat even in low trait anxious, typically developing children.

However, it is important to note that the dot-probe vigilance scores that showed positive correlation with parental anxiety levels were obtained using the traditional formula (e.g., Mogg & Bradley, 1999), which requires subtracting the average reaction times on threat congruent trials from the average reaction times on threat incongruent trials. But, when Koster and colleagues' (2004) formula was used to disentangle children's initial engagement from the following disengagement period, which requires consideration of both emotion congruency and baseline measure of visuo-spatial attention for neutral stimuli, neither engagement nor disengagement scores showed significant association with parental anxiety. Therefore, this result require caution for interpretation.

This thesis' results on the associations between parents' own and their children's attention biases replicated findings of the previous literature with parents with clinical levels of anxiety (Mogg et al., 2012; Waters et al., 2017) in parents with low trait anxiety, suggesting that parental attention bias is not a significant correlate of their children's attention bias. Therefore, it seems unlikely that attention bias is one of the cognitive biases that low trait anxious youth acquire through modelling their parents.

However, it is important to note that there could be other mechanisms of attention bias transmission within parental environment, which we did not assess in this thesis. Although one's orientation of eye gaze could be informative for the others regarding the information in the environment, modelling of parental attention bias could be a relatively indirect mechanism to acquire attention bias for threat. Other mechanisms that facilitate interactions and conversations between parents and children about anxiogenic information such as parental anxiety and parenting styles might have a more straightforward association with children's attention biases for threat.

The key finding of Chapter Three comes from comparison of parents and children's attentional maintenance patterns. Both groups showed an initial interest on angry faces during the first half of the observation. But there was a divergence specific to viewing of angry faces in the second half of the observation time, where strategic attentional processes were assumed to operate. Accordingly, parents' attention on angry faces showed a gradual decrease while children's attention came back to angry faces in the final time window.

Parents' initial interest on angry faces followed by sustained avoidance resonates the threat appraisal process of non-anxious individuals in the vigilance-avoidance model (Mogg & Bradley, 1998). Accordingly, non-anxious individuals' avoidance following initial threat appraisal stem from allocating attentional resources on more important or novel stimuli once threat value of stimulus is determined to be minor.

However, although children were non-anxious as well, same avoidance was not observed in them. So, their persistent attention on angry faces during the strategic stage of processing implies that they needed further time to elaborate on the meaning of angry faces. Given that this observation pattern was independent of anxiety, there should be factors such as attentional control and emotion regulation strategies involved in children's threat appraisal during strategic processing (Cisler & Koster, 2010), efficiency of both of which are dependent on cognitive maturation. Accordingly, children might have had relatively lower attentional control skills or habituation of reallocating attention through emotion regulation to disengage efficiently from threatening information compared to their parents.

6.2.3. Attentional Control

The impact of children's cognitive development and skills on their cognitive biases have been a long standing interest for cognitive bias researchers (Ehrenreich & Gross, 2002; Puliafico & Kendall, 2006). Especially attentional control ability has been proposed to be an underlying mechanism of attention bias (Cisler & Koster, 2010; Nightingale et al., 2010). Specifically, Eysenck's attentional control theory (2007) and Lonigan and colleagues' (2010) temperamental model predict that the interaction of low attentional control and high trait anxiety/negative affectivity is associated with greater attention bias for threat. Empirical evidence indeed highlights the role of poor attentional control ability in attention bias for threat in children with elevated levels of anxiety (Helzer et al., 2009; Lonigan et al., 2010; Pergamin-Hight et al., 2016; Susa et al., 2012; Susa et al., 2014).

However, the design of most of these studies was not adequate to examine on which stage of attentional processing attention bias emerges and the underlying attentional control related constructs responsible for the location and duration of attentional focus in the presence of threat stimuli. Therefore, the focus of Chapter Four was to examine the association between children's attentional control ability and their attention biases by bringing together a computerised measurement of attention control that differentiates executive inhibition and switching abilities and AB indices obtained from gaze data.

The key finding of Chapter Four was the significant negative correlation between children's executive switching ability and their threat bias, such that low switching ability was associated with greater difficulty in disengaging from angry faces. These results support findings of Pergamin-Hight et al. (2016). Because the children and adolescents had low trait anxiety in the current thesis, attentional control was not found to be a significant moderator on the association between trait anxiety and disengagement AB. However, switching ability remained as a significant predictor of threat bias and explained a unique variance on disengagement period from angry faces in the regression model.

Dot-probe data also revealed similar associations between low switching ability and attention bias for threat; however, low switching ability was associated with increased vigilance towards angry faces in contrast to disengagement difficulty as eye movement data indicated. Given that participants responded to the location of the probe after 2000 msec, dot-probe data vigilance scores are unlikely to reflect true initial vigilance (Fox, 2004; Richards et al., 2014; Weierich et al., 2008; Yiend, 2010) but may rather indicate attentional maintenance on angry faces just before responding to the probe and requires caution in interpretation.

Examining involvement of inhibition and shifting abilities in smaller time segments during the entire stimuli presentation time produced novel findings by complementing predictions of Attentional Control Theory (Eysenck et al., 2007). Accordingly, greater inhibition ability was associated with longer dwell time on angry faces in youth during the first 500 msec. This seems to signal an initial adaptive threat appraisal since many attention bias theories accept that low anxious individuals' vigilance towards threatening information reflect adaptation to the requirements of the environment for survival (Mogg & Bradley, 1998; Öhman & Wiens, 2004). In this case, better inhibition ability might have functioned to inhibit attention to be allocated on less salient stimuli and thus keep attention focused on threatening faces.

In addition, shifting ability was found to be associated with children's initial disengagement from angry faces, which on average was 532 msec. Interestingly, longer angry disengagement times were associated with lower shifting ability. This might indicate that low switching ability might have prevented children's attentional engagement on angry faces to shift to neutral faces, which resulted in longer disengagement times.

So, the associational results of this thesis may suggest that inhibition ability has a particular role on initial vigilance during automatic stages of attention while switching ability is involved in strategic attention during later stages of processing. However, because these findings are novel, to reliably overlap the associational contingency between elements of inhibition and shifting and stages of attention bias along the stimuli presentation continuum requires replication of this study.

The age range of the youth sample in the current thesis was considerably wide, ranging from 8 to 16. This requires consideration of the impact of developmental stage on their attentional control abilities and how this possibly influences children's attention biases.

Results of the meta-analysis studies regarding the age related effects on children's attention bias is mixed. Dudeney et al. (2015) suggests that anxious children display greater attention bias for threat compared to non-anxious children as they get older. This resonates cognitive-inhibition hypothesis (Nightingale et al., 2010). Accordingly, non-anxious children are proposed to acquire better inhibition skills as they get older and therefore do not show bias for threat in contrast to anxious children. On the other hand, Lisk et al. (2020) analysis, which exclusively involved only eye movement studies of attention bias in youth, suggests that age does not have a moderator effect on attention bias for threat in neither anxious nor non anxious youth samples when age was taken as a continuous moderator.

Although the Simon task data in this thesis revealed significant associations with age in the current thesis, age was not a significant predictor of children's attention biases either on its own or in moderation with attentional control abilities. In other words, although older children performed better in Simon task reflecting better cognitive abilities, there was no effect of age on their attention biases. This seems to support the results of Lisk et al. (2020).

However, it is important to note that adolescents may have been underrepresented in the current youth sample, which may have hindered the analyses to statistically detect age related variances in attention bias scores. Therefore, future research can benefit from replicating this study to examine the impact of age on the association between attention bias for threat and executive switching and inhibition abilities in high trait anxious youth sample with a balanced representation of age groups.

6.2.4. Use of Emotion Regulation Strategy

Maladaptive emotion regulation skills are an acknowledged risk factor for childhood anxiety disorders (Campbell-Sills et al., 2014; Esbjørn et al., 2012; Hannesdottir & Ollendick, 2007). Because children's attention biases for threat are underlined by enhanced and exaggerated appraisal of threatening information leading to anxious emotion, there could be an association between children's attention bias for threat and how they manage their emotional experiences and reactions.

Therefore, the focus of Chapter Five was exploring the role of children's habitual emotion regulation strategy use, as another developmental factor, on their threat biases since only a handful of studies have examined this. Following Cisler and Koster (2010) model and situating the association between children's eye movement data and two well established emotion regulation strategies in anxiety in Process Model of Emotion Regulation (Gross, 1998), this study was the first, to the best of my knowledge, to explore how cognitive reappraisal and expressive suppression could be linked to threat bias within the context of anxiety.

In part due to the limited variance in our critical symptom and emotion regulation variables, our data did not reveal significant associations between children's attention biases and the frequency of the strategies they use for emotion regulation. However, the key finding of Chapter Five emerged when children were divided into groups based on the degree of skill use.

As such, children with low reappraisal skills looked at angry faces before neutral faces at stimuli onset significantly more than chance and showed greater disengagement difficulty on angry trials compared to children with high reappraisal skills. So, our results suggest that reappraising skills are critical for evaluation of the meaning of stimuli in the environment and impacts the motivation for threat appraisal underlying attention bias.

Furthermore, attentional maintenance patterns of youth groups based on reappraisal skills point out a qualitative divergence. Accordingly, children with high reappraising skills showed a gradually reduced interest on angry faces during the second half of the observation in contrast to children with low reappraising skills, whose attention was relocated on angry faces at the final time window. This suggests that high reappraiser children might have evaluated the true threat value of angry faces more efficiently at the beginning and preferred looking at them less during strategic processing while low reappraiser children needed to look at them again for further evaluation. However, because our findings are novel, further studies warranted to draw firm conclusions.

On the other hand, children's attention biases did not differ based on suppression ability. Considering that our conceptualization of suppression functions to inhibit behavioural manifestation of emotion rather than altering the emotion itself (Gross & Levenson, 1993, cited in John & Gross, 2004), it may not have a specific role on the ongoing threat appraisal.

Because age can be a developmental moderator in the efficiency of employing emotion regulation skills (Gullone et al., 2010), chances can be expected in children's attention biases through joint effect of age and employment of emotion regulation strategies. Attention bias data did not reveal any age related associations; however, the emotion regulation results did suggest a decrease trend, albeit nonsignificant, in the use of both appraisal and suppression skills, which is in line with previous literature (Gullone et al., 2010). However, lack of significant associations between children's attention bias for threat and emotion regulation strategy use prevented us to take the analyses further to examine the moderation between age and emotion regulation in predicting attention bias for threat. Therefore, future studies might benefit from examining the impact of varying levels of emotion regulation strategy use underlined by age related differences on attention bias by replicating this study with a more heterogenous representation of age groups in youth.

6.2.5. A Synthesis of the Empirical Results

Comparisons of the parent-child data in Chapter Three revealed interesting results. Accordingly, children's attention turned back to angry faces in the final time window while parental attention showed steady decrease in attentional maintenance on angry faces. Because these divergent attentional maintenance patterns are independent of anxiety, this points out consideration of other factors that modulate attention bias, which are prone to be affected by stage of development.

In that regard, the results of the empirical studies in Chapter Four and Five appear to suggest explanations for the attentional maintenance difference while presumably strategic attentional processes were in operation (Armstrong & Olatunji, 2012).

Examination of the role of attentional control ability revealed that poor executive switching ability predicts greater difficulty in disengaging attention away from angry faces. Hence, the parent-child bias divergence during strategic stages of processing could be underlined by the level of attentional control ability. As such, children and adolescents might have had lower levels of attentional control ability in comparison to their parents as adults, which may have hindered attention to disengage from threat.

Likewise, examination of emotion regulation skills also revealed that children with low levels of reappraising skills showed greater difficulty in disengaging their attention from angry faces compared to the children with high level of reappraisal skills. Furthermore, the was a divergent pattern between high and low reappraisal groups during the later stages of observation. As such, children with high reappraisal skills showed gradual decrease in their interest on angry faces while children with low reappraisal skills turned attention back to angry faces for further evaluation, which bears striking resemblance with the divergence in the attentional maintenance pattens of parent and offspring groups.

Therefore, the results implicate that the degree of reappraisal skills can determine attentional orientation in the presence of threatening information, which might explain differences in parent-child attentional maintenance scores. Accordingly, children and adolescents might have had lower levels of reappraising skills in comparison to their parents, which may have impacted attentional engagement from threat in youth negatively.

Overall, the results of Chapter Four and Five complement the results of Chapter Three, which imply that attentional control and emotion regulation strategy use have a role in attentional processing of threatening information during later stages of processing. Also, from a developmental perspective, specifically low levels of switching and reappraisal skills appear to be a vulnerability factor for development and maintenance of threat related attention biases in youth populations.

6.3. Limitations and Future Directions

Limitations specific to each empirical study were addressed in discussion sections of each respective chapter. While this thesis provides preliminary results regarding the role of attentional control and emotion regulation abilities in children's vulnerability to threat related attention bias, one significant limitation of this thesis is that our participants did not have high levels of trait anxiety. This is reflected in symptom scores being positively skewed towards the low end of the anxiety and depression spectrum for nearly 80% of the sample.

Therefore, the results of this thesis cannot be generalized to high trait anxious children and adolescents. So, considering that having greater symptoms of anxiety also causes significant psychological disturbances in children and adolescents' everyday life (Huberty, 2008 cited in Huberty, 2012a), results of the current thesis should be interpreted with caution until further replication. It would be beneficial for future studies to adopt a similar eye tracking design in a community sample of parent/youth who display a wider representation of trait anxiety spectrum, which would allow to pin down how trait anxiety is involved in parental origins of threat bias, operations of attentional control, and habitual use of emotion regulation strategy.

The second limitation that is common to all empirical studies in this thesis comes from the cross-sectional nature of the studies. Although the age range was wide to represent both children and adolescents in the sample, the distribution of age was skewed positively and the mean age of the youth sample was ten, which suggests that adolescence might have been underrepresented in the sample. So, not finding any age-related associations with critical variables except attentional control related measures in the overall sample may actually be due to the low proportion of adolescents in the sample. However, the variables and mechanisms of associations investigated in this thesis could be susceptible to change through time provided that cognitive maturation and the extent of emotional experiences through environmental interactions increase with time in normative populations. Therefore, longitudinal studies are better suited to track down the impact of potential age-related within-subject changes in parent-child associations, habitual emotion regulation strategy use, and executive attentional control abilities on youth attention bias.

Another limitation of this thesis due to its cross-sectional design is that causality cannot be inferred. If follow up studies are carried out with children and adolescents with elevated levels of trait anxiety, a robust disambiguation would be possible as to whether a) parental trait anxiety and attention bias is also a risk factor on their children's anxiety as well as their attention biases; b) it is anxiety that leads to low attentional control and greater attention bias or vice versa; and c) it is poor emotion appraisal skills to regulate emotion that lead to attention bias and anxiety or it is anxiety that leads to repetitive attention bias, which hinder developing effective reappraisal skills.

6.4. Implications for Practice

Since our participants did not have high levels of anxiety, the findings regarding attention bias patterns cannot be situated within that of anxious children's attention biases. So, the capacity of this thesis is limited to offer suggestions for developing more efficient attention bias modification techniques. Nevertheless, coupled with the findings of previous research and recent models of attention bias (Bar-Haim et al., 2007; Cisler & Koster, 2010), our results imply that attention bias is not restricted to initial, effortless, and automatic threat processing and spans through more strategic processing. Therefore, it could be a worthwhile effort to focus on developing attention bias modification techniques that aim to alter attention biases emerging during strategic processing.

Current results regarding involvement of executive switching ability in predicting prolonged time to disengage from threat complements the findings of previous research and supports that attentional control is the cognitive mechanism that underlines attention bias in non-anxious children. In addition, current findings related to emotion regulation strategy use implies that the focus of cognitive reappraisal underlies the habitual motivational patterns to evaluate threat meaning in non-anxious children. More importantly, these two correlates had their own impact on children's attention biases for threat independent of anxiety. Therefore, psychoeducational programmes aiming to improve better executive control and use of more efficient emotion regulation strategies in community sample children can be beneficial as a preventative approach against developing or maintaining cognitive biases that lead to emotional difficulties.

6.5. Conclusion

Models of attention bias and emerging research suggest that children and adolescents' attention bias for threat is susceptible to the impact of developmental factors other than anxiety. Previous research focusing on this issue was scarce, have used disputed measurement tools, and thus far from being conclusive. This thesis presented three empirical studies with novel measurement techniques in community sample youth, collectively examining the role of parental attention bias, attentional control, and habitual emotion regulation strategy use on their threat related attention biases.

The key findings suggest that parental attention bias is not a significant associate of their children's attention bias. However, we found that executive switching ability as an element of attentional control and cognitive reappraisal ability as an aspect of emotion regulation strategy are important associates of threat related attention biases independent of anxiety in community sample children and adolescents. This suggests that youth with low levels of anxiety could also be susceptible to develop or maintain prioritized threat processing linked with these mediums.

Future studies should replicate these studies in trait anxious children/families since the current data is not adequate to reflect on how these mechanisms are involved in threat bias coupled with trait anxiety due to our sampling composition. This endeavour can hold promising clinical relevance regarding treatment of childhood anxiety. Nevertheless, our results have important implications for practice concerning community sample youth. As such, programmes aiming to improve attentional control and use of emotion regulation strategies in children and adolescents can be beneficial to prevent developing or maintaining cognitive biases, which could lead to clinically significant emotional difficulties if not intervened.

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Appendices

Appendix 1

Appendix 1. Ethics Approval

PSYCHOLOGY RESEARCH ETHICS COMMITTEE
SCHOOL of PHILOSOPHY, PSYCHOLOGY and LANGUAGE SCIENCES
The University of Edinburgh
7 George Square
Edinburgh EH8 9JZ
Telephone +44 (0) 131 651 5002
Email Lynsey.Buchanan@ed.ac.uk

22 September 2016

Ethics proposal 212-1516/2, entitled Understanding parental, cognitive, and emotional underpinnings of threat related attention bias in developmental populations and submitted by Ilayda Turk, Nicolas Chevalier, Stella Chan and Matthias Schwannauer has been approved by the Psychology Research Ethics Committee per the Department's ethics regulations.

The following files were uploaded with the application:

Filename: Information sheet & Consent form _Ilayda.docx
Date: 29 Jul 2016 04:31 PM
Purpose: Information/Consent Sheet

Filename: ReviewComments-212-1516_1.pdf
Date: 08 Aug 2016 04:19 PM
Purpose: (Reply to)/PREC Review
Note: Comments from reviewer in response to your submission.

Filename: Participant information sheet & Consent form_Second Submission.docx
Date: 03 Sep 2016 02:31 PM
Purpose: (Reply to)/PREC Review
Note: The uploaded participant information sheet and consent forms have been revised by taking into consideration the reviewer's comments. I moved the 'eligibility for participation' section to the end of the parent information sheet and I wrote the student information sheet in a simpler language.

Appendix 2

Appendix 2. A copy of invitation emails for participation in the study

Dear Parent,

I am Ilayda Turk, a PhD Student at the University of Edinburgh. As part of Wee Science Research Group based in psychology department, I am running studies with parent-child or parent-adolescent pairs (typically developing youth aged between 8 and 17). I am currently looking for participants living in Edinburgh. Previously you took part in my colleague Claire Ann Banga's study and indicated that you would be happy to be contacted in the future for participation in other studies. So, this is an invitation to take part in my research study with your child(ren).

The study takes place in our cosy and friendly Child Development Lab, 7 George Square and lasts around an hour. You will play computer games to measure attentional abilities and fill out questionnaires on your emotional wellbeing. While you play one of my games, and a device called eye tracker will track and record your eye movements to give me information about where you have looked at on the screen. While I am with one of the pairs in the eye tracking room, my assistant will be with the other pair to guide them through completing questionnaires.

The study involves nothing to make you feel physically or emotionally uncomfortable. The eye tracker is non-intrusive and embedded on the screen. All you need to do is to play the game. However, if you or your child happen to feel uncomfortable, you can stop taking part at any time. All the information I will obtain from you will be kept confidential and anonymous.

Your and your child's participation is entirely voluntary. However, I will compensate your invaluable time and effort, so I will give you £10 cash, and your child £5 worth of Amazon voucher as a little thank you. If you participate with more than one child, each kid will receive a voucher.

I attached participant information form in this email. So, if you are interested in taking part, please read it. If you are happy to participate, you can go to the Doodle Poll using the link below to pick your preferred dates & times.

https://doodle.com/poll/tsqpfhami6fmurwz

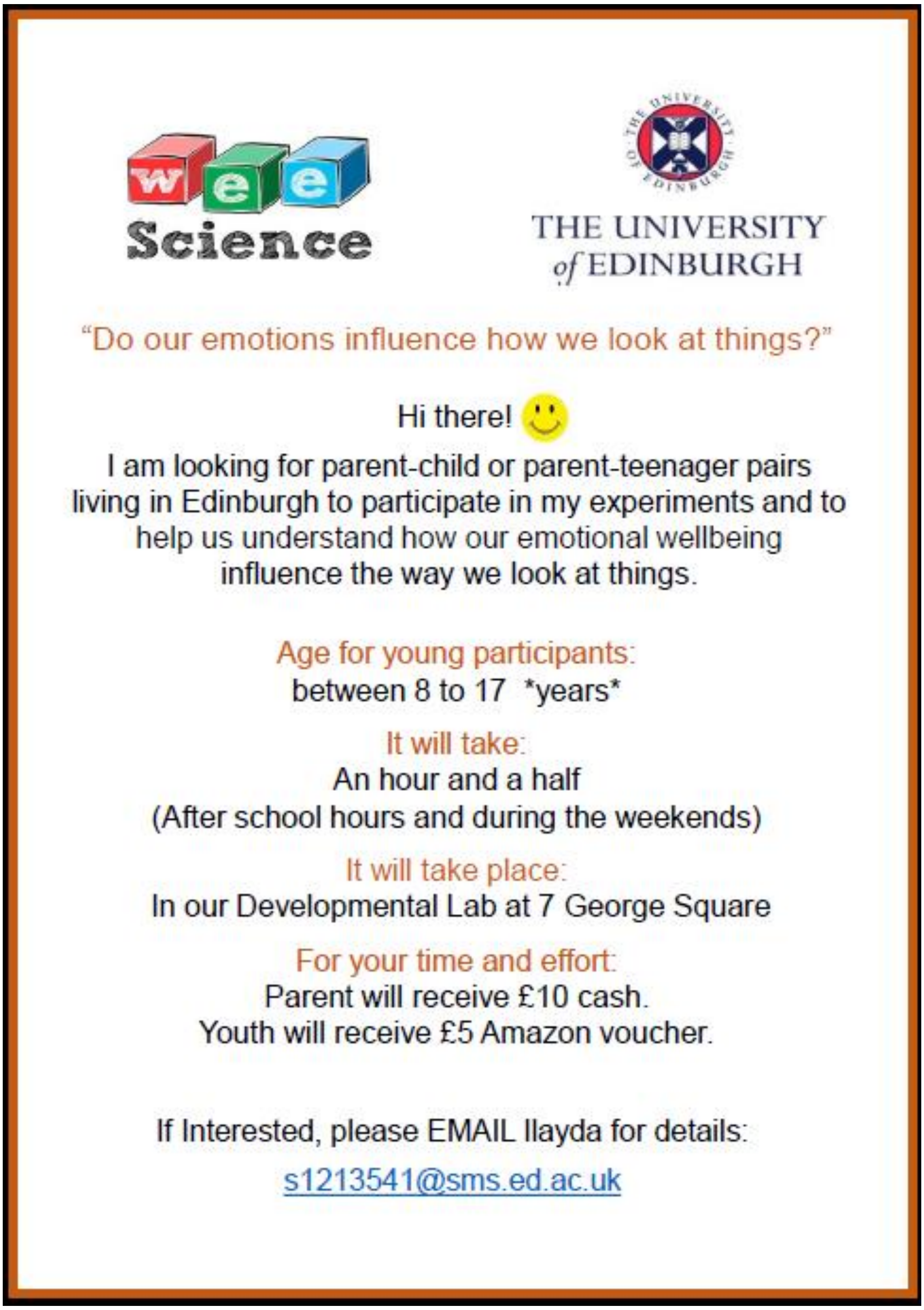
In case you need direct contact, my mobile is: 07438221640.

I am looking forward to hearing from you,
Best wishes,

Ilayda Turk
PhD Student
Clinical Psychology
School of Health in Social Science
The University of Edinburgh
Email: s1213541@sms.ed.ac.uk

Appendix 3

Appendix 3. An example advertisement poster on Facebook for recruitment



Appendix 4

Appendix 4. Participant information sheet

Study on Emotions and Attentional Abilities

Parent Information Pack

Information Sheet

WHAT IS THE AIM OF THE PROJECT?

The aim is to investigate how your and your child's emotional wellbeing as well as general attentional abilities influence what information you pay attention to.

WHAT WILL HAPPEN? HOW WILL THE DATA BE COLLECTED? WHAT KIND OF DATA WILL BE COLLECTED?

The study takes place in our child development laboratory, based in the University of Edinburgh, Psychology Department. Once you arrive, I will introduce our child-friendly laboratory environment to you and answer any questions you may have about the study.

Data collection involves completion of short computerised games that measure attention and questionnaires that measure emotional wellbeing. You and your child will both complete computerised games and the questionnaires.

While you and your child are completing the games, your eye movements will be recorded remotely to measure your visual attention, with a device called eye tracker. Eye-tracker is simply a device that uses small cameras to remotely record eye gaze position. It is completely safe and non-intrusive.

The questionnaires that are administered in this study are used as preliminary screens for clinical conditions. They might unveil some psychological problems of which you might be unaware. However, they are not sufficient for diagnostic purposes on their own, nor they will be used in this manner in this study. This study has no therapeutic purposes and I cannot give personal feedback regarding your questionnaire scores and task performances. You do not have to fill out parts or all of these questionnaires if you do not want to.

The data collected will involve the scores that I obtain from the games and questionnaires. I will also ask you for demographic information (e.g., age, gender), but they will be kept anonymously.

Please note that only one parent's participation is sufficient.

DOES THIS STUDY INVOLVE ANY RISKS?

There are no known risks to you or to your child in this study.

WILL THIS STUDY BE CONFIDENTIAL?

Yes, the study will be strictly confidential. You and your child's personal information will be anonymised and all data will be kept securely in password protected computers within the university network as well as locked cabinets within the university premises. The data I obtain from you will only be seen by myself and my supervisors Dr. Chan, Dr. Chevalier, and Prof. Schwannauer. It will not be linked to any identifying information that you or your child has supplied. The data collected will be presented at conferences and in academic publications, however we will only present data averaged over many participants. Yours and your child's individual data will not be identifiable.

HOW LONG WILL IT TAKE?

It will take approximately an hour and a half in total within one session.

WHERE DO I NEED TO GO?

The study takes place in the Child Development Lab of the Psychology Department at the University of Edinburgh, 7 George Square, Edinburgh, EH8 9JZ.

WHAT IF I DON'T WANT TO TAKE PART OR DON'T WANT MY CHILD TO TAKE PART?

Participation in this study is entirely voluntary, however it will be compensated. If you or your child do not wish to participate, you do not need to respond to this invitation.

If you want to take part with your child, please respond my email so that we can arrange a date and time that is suitable for you.

WHAT IF I DON'T WANT TO CONTINUE AFTER JOINING IN?

You may decide to stop your own or your child's participation at any time during administration of the tasks or questionnaires. Your child can also choose to stop participation at any point. You and your child may decide not to complete or stop completing some or all of the activities related to this study at any time. You may skip any questionnaire items that you are not comfortable filling out.

You do not have to provide any justifications for stopping the participation completely or for partial completion of the activities. It will not be held against you by any means.

You have the right to ask that any data supplied from you or your child to be withdrawn/destroyed.

WILL PARTICIPATION BE COMPENSATED?

Yes, parents will be given £10 in return for their participation. Also, your child will be given an Amazon voucher as a little thank you worth £5 for their help. If you are participating with more than one child, each child will be given a voucher for their participation.

AM I SUITABLE TO PARTICIPATE AS A PARENT?

If you:

- have normal or corrected to normal vision,
- have no physical disability to use a computer,
- have no diagnosis of a current mental health difficulty,
- have no diagnosis of a neurodevelopmental disorder (e.g., reading/learning/language disabilities, autism spectrum disorders, attention deficit hyperactivity disorders, or tic disorders),
- are not receiving psychosocial treatment or relevant medication,
- are your child's caregiver and legally able to give consent for participation,

Then yes, you are suitable to participate in this study.

IS MY CHILD SUITABLE TO PARTICIPATE?

If your child:

- is between the ages of 8 to 18,
- has normal or corrected to normal vision,
- has no physical disability to use a computer,
- has no diagnosis of a current mental health difficulty,
- has no diagnosis of a neurodevelopmental disorder (e.g., reading/learning/language disabilities, autism spectrum disorders, attention deficit hyperactivity disorders, or tic disorders),
- is not receiving psychosocial treatment or relevant medication,

Then yes, your child is suitable to participate in this study.

IF HAVE A QUERY, WHO CAN I CONTACT?

This study has obtained ethics approval from the University of Edinburgh and the City of Edinburgh Council. Feel free to ask any questions. If you have any questions as a result of reading this information sheet, I will be glad to answer your questions at any time. You can also contact my supervisors for further information or complaints/concerns.

Contact details:

Ilayda Turk

e-mail: s1213541@sms.ed.ac.uk

mobile: 07438221640

address: Medical School, Doorway 6, 6

Teviot Place, Edinburgh

EH8 9AG

Dr. Stella Chan

e-mail: stella.chan@ed.ac.uk

phone: +44 (0)131 651 3935

address: Medical School, Doorway

Teviot Place, Edinburgh

EH8 9AG

Dr. Nicolas Chevalier

e-mail: nicolas.chevalier@ed.ac.uk

phone: +44 (0)131 650 4336

address: 7 George Square, Doorway 6,

Edinburgh

EH8 9JZ

Prof. Matthias Schwannauer

e-mail: m.schwannauer@ed.ac.uk

phone: +44 (0)131 651 3954

address: Medical School,

Teviot Place, Edinburgh,

EH8 9AG

Study on Emotions and Attentional Abilities

Youth Information Pack

Information Sheet

By joining in my study, you will help me to understand how children's/adolescents' feelings change the way they look at things. During the research, I will ask you and your parent to play computer games. While you are playing the games, the computer will record where you look on the computer screen with a tool called eye tracker. I will also ask you to fill out some questionnaires. This is all that you will need to do.

If you and your parent want to take part, you will come to my school together.

Before you decide if you want to join in, it's very important you read this booklet carefully and talk about it with your family if you would like.

Do I have to take part?

Not at all. It is up to you if you would like to join in. If you do, we would like you to sign the form at the end of this booklet - this is called a consent form. This form will let us know that you are okay to play the computer games and fill out the questionnaires. Taking part in our study is completely separate from your schoolwork.

What is the aim of the study?

I want to see if how your feelings influence the way you look at things.

Where do I need to go?

You and your parent come to the child/adolescents laboratory at my school, which is in the Psychology Department at the University of Edinburgh.

What do I have to do?

When you and your parent come, I will show you around and answer your questions. I will also tell you and your parent more about how we use eye tracker (the tool used during the computer games), how to play the games and how to fill out the questionnaires. First you and your parent will sign a form to let us know that you are okay to play the computer games and fill out the questionnaires. You will then complete computer games and then questionnaires.

The games and questions in this study aren't like school work and there are no right or wrong answers to the questions. So, you don't have to worry about giving the right answer! All you need to do is give honest information about yourself and do the games as best as you can 🙂 . You don't have to answer the questions that you don't want to answer in the questionnaires or play the parts of the games that you don't want to do.

What is eye tracker?

Eye tracker is a device that gives information about where you look and when you blink. It is safe to use and doesn't make you feel uncomfortable.

How long will it take?

You will only need to come to my school with your parent once and everything will take about an hour and a half.

What if I have a problem while I fill out the questionnaires or doing the tasks?

I will be there to answer any of your questions about them.

Will anyone know about how well I did?

No. Your scores in computer games and questionnaires will be kept in secret and I won't tell anyone your information. Only my teachers and I will know about the results, but your name will not be on any of the scores – so no one will know it was your score. Also, I won't use your real name and will give you a nickname when recording your scores. This is a good thing to keep your information private.

Will you tell me my scores?

I won't tell you your scores on questionnaires or the games. There will be many students joining in this research, and I will calculate everyone's scores altogether when I am done with the research.

What if I don't want to take part anymore?

You can skip any questionnaire items or parts of the games if you want. It is also okay if you don't want to keep going and you can quit the study at any time, for any reason. If you feel you don't want to continue any more, let me know. The answers you gave will be destroyed.

Who has given permission for this study?

It is important that every study is checked by a Research Ethics Committee. They make sure the research is fair and safe to do. This study has been checked by the University of Edinburgh Psychology Research Ethics Committee. I was also told that it was fine by the City of Edinburgh Council.

This study will not cause you to be upset or hurt at any point.

Will I receive a prize for taking part?

Yes. I will give you an Amazon voucher worth £5.

Appendix 5

Appendix 5. Consent Forms

Parent Consent Form

By signing below, you are agreeing that: (1) you have read and understood the Participant Information Sheet, (2) questions about your participation in this study have been answered satisfactorily, (3) you are taking part in this research study voluntarily (without coercion), and (4) anonymised data only may be shared in public research repositories.

____________________________	____________________________
Caregiver's Name (Printed)	Child's Name (Printed)
____________________________	____________________________
Caregiver's Signature	Child's signature
____________________________	____________________________
Child's Date of Birth	Today's Date
____________________________	____________________________
Person obtaining consent (Printed)	Signature of person obtaining consent

Parent Consent Form for Youth

By signing below, you are agreeing that: (1) you have read and understood the Participant Information Sheet, (2) questions about your child's participation in this study have been answered satisfactorily, (3) you are willing for your child to take part in this research study voluntarily, and (4) anonymised data may only be shared in public repositories.

____________________________	____________________________
Caregiver's Name (Printed)	Child's Name (Printed)
____________________________	
Caregiver's Signature	
____________________________	____________________________
Child's Date of Birth	Today's Date
____________________________	____________________________
Person obtaining consent (Printed)	Signature of person obtaining consent

Youth Consent Form

Please tick if you wish to join in this research.

☐ I agree to join in the research.

Please tick the following boxes if you agree with them:

☐ I have read about this research and I have had a chance to ask any questions that I have.

☐ I understand that I can choose to join in this research and I can decide to stop joining in at any time, without giving a reason.

☐ I understand that all the information I give will be kept private.

Your Name: _____________________ Date: _______________

Your Parent's Name: __________________________________

Appendix 6

Appendix 6. A sample of facial expression pictures used as stimuli in Dot-Probe task

Appendix 7

Appendix 7. Questionnaires

Socio-Demographics Questionnaire

DEMOGRAPHICS FORM

The form involves some demographic questions about you and your child, just so we can have a general idea of the demographic characteristics of our participants as a big group. This information will be kept confidential and anonymous and will not be linked to any questionnaire or game scores we obtain from you. Please do not write your or your child's name on this form.

For all the data obtained from you to be kept anonymously, please create a code number for yourself below using the day of the month you were born and the first three letters of your mothers' maiden name.

Example: 11SON

A. PARENT DEMOGRAPHICS

This part of the form asks information about yourself, please fill in accordingly.

1. **Age:** ____ **years** ____ **months**

2. **Gender:** female ○ male ○

3. **How would you describe your ethnicity?**
   - ○ White
   - ○ Asian (e.g., Indian, Bangladeshi, Pakistani, Chinese)
   - ○ Black (e.g., African, Caribbean)
   - ○ Arabian
   - ○ Mixed
   - ○ Other
   - ○ Prefer not to indicate

4. What is the highest education you have attained?

- No formal education
- Primary school education
- Secondary school education
- Tertiary education (e.g., college, university

B. <u>YOUTH DEMOGRAPHICS</u>

This part of the form asks information about your child, please fill in accordingly.

For all the data obtained from your child to be kept anonymously, please create a code number for your child below using the day of the month s/he was born and the first three letters of his/her mother's maiden name.

[ ]

1. Age: [ ] **years** [ ] **months**

2. Gender: female ○ male ○

3. How would you describe your child's ethnicity?

- White
- Asian (e.g., Indian, Bangladeshi, Pakistani, Chinese)
- Black (e.g., African, Caribbean)
- Arabian
- Mixed
- Other

4. Who does your child spent most of his/her the time with?

- Mainly mother
- Mainly father
- Both parents
- Other (e.g., grandparents, other relatives)

Would you like to be contacted in the future to hear about ongoing research in Wee Science Development Lab?

- ◯ **YES**
- ◯ **NO**

Spielberger State-Trait Anxiety Inventory – Form Y (STAI; Spielberger, 1983) – Not represented due to copyright restrictions.

Spence Children's Anxiety Scale-Child Version (SCAS-C; Spence, 1998)

SPENCE CHILDREN'S ANXIETY SCALE

Your Name: ____________________ **Date:** ________________

PLEASE PUT A CIRCLE AROUND THE WORD THAT SHOWS HOW OFTEN EACH OF THESE THINGS HAPPEN TO YOU. THERE ARE NO RIGHT OR WRONG ANSWERS.

1.	I worry about things..	Never	Sometimes	Often	Always
2.	I am scared of the dark...	Never	Sometimes	Often	Always
3.	When I have a problem, I get a funny feeling in my stomach...........	Never	Sometimes	Often	Always
4.	I feel afraid...	Never	Sometimes	Often	Always
5.	I would feel afraid of being on my own at home............................	Never	Sometimes	Often	Always
6.	I feel scared when I have to take a test......................................	Never	Sometimes	Often	Always
7.	I feel afraid if I have to use public toilets or bathrooms..................	Never	Sometimes	Often	Always
8.	I worry about being away from my parents..................................	Never	Sometimes	Often	Always
9.	I feel afraid that I will make a fool of myself in front of people..............	Never	Sometimes	Often	Always
10.	I worry that I will do badly at my school work..............................	Never	Sometimes	Often	Always
11.	I am popular amongst other kids my own age................................	Never	Sometimes	Often	Always
12.	I worry that something awful will happen to someone in my family........	Never	Sometimes	Often	Always
13.	I suddenly feel as if I can't breathe when there is no reason for this.....	Never	Sometimes	Often	Always
14.	I have to keep checking that I have done things right (like the switch is off, or the door is locked)..	Never	Sometimes	Often	Always
15.	I feel scared if I have to sleep on my own....................................	Never	Sometimes	Often	Always
16.	I have trouble going to school in the mornings because I feel nervous or afraid..	Never	Sometimes	Often	Always
17.	I am good at sports...	Never	Sometimes	Often	Always
18.	I am scared of dogs...	Never	Sometimes	Often	Always
19.	I can't seem to get bad or silly thoughts out of my head....................	Never	Sometimes	Often	Always
20.	When I have a problem, my heart beats really fast..........................	Never	Sometimes	Often	Always
21.	I suddenly start to tremble or shake when there is no reason for this...	Never	Sometimes	Often	Always
22.	I worry that something bad will happen to me................................	Never	Sometimes	Often	Always
23.	I am scared of going to the doctors or dentists...............................	Never	Sometimes	Often	Always
24.	When I have a problem, I feel shaky..	Never	Sometimes	Often	Always
25.	I am scared of being in high places or lifts (elevators)......................	Never	Sometimes	Often	Always

26.	I am a good person	Never	Sometimes	Often	Always
27.	I have to think of special thoughts to stop bad things from happening (like numbers or words)	Never	Sometimes	Often	Always
28	I feel scared if I have to travel in the car, or on a Bus or a train	Never	Sometimes	Often	Always
29.	I worry what other people think of me	Never	Sometimes	Often	Always
30.	I am afraid of being in crowded places (like shopping centres, the movies, buses, busy playgrounds)	Never	Sometimes	Often	Always
31.	I feel happy	Never	Sometimes	Often	Always
32.	All of a sudden I feel really scared for no reason at all	Never	Sometimes	Often	Always
33.	I am scared of insects or spiders	Never	Sometimes	Often	Always
34.	I suddenly become dizzy or faint when there is no reason for this	Never	Sometimes	Often	Always
35.	I feel afraid if I have to talk in front of my class	Never	Sometimes	Often	Always
36.	My heart suddenly starts to beat too quickly for no reason	Never	Sometimes	Often	Always
37.	I worry that I will suddenly get a scared feeling when there is nothing to be afraid of	Never	Sometimes	Often	Always
38.	I like myself	Never	Sometimes	Often	Always
39.	I am afraid of being in small closed places, like tunnels or small rooms.	Never	Sometimes	Often	Always
40.	I have to do some things over and over again (like washing my hands, cleaning or putting things in a certain order)	Never	Sometimes	Often	Always
41.	I get bothered by bad or silly thoughts or pictures in my mind	Never	Sometimes	Often	Always
42.	I have to do some things in just the right way to stop bad things happening	Never	Sometimes	Often	Always
43.	I am proud of my school work	Never	Sometimes	Often	Always
44.	I would feel scared if I had to stay away from home overnight	Never	Sometimes	Often	Always
45.	Is there something else that you are really afraid of?	YES	NO		
	Please write down what it is ______________________				
	How often are you afraid of this thing?	Never	Sometimes	Often	Always

Mood and Feelings Questionnaire – Child: Long Version (MFQ-C; Angold & Costello, 1987)

Child Self-Report

MOOD AND FEELINGS QUESTIONNAIRE: Long Version

This form is about how you might have been feeling or acting **recently**.

For each question, please check (✓) how you have been feeling or acting ***in the past two weeks***.

If a sentence was not true about you, check NOT TRUE.
If a sentence was only sometimes true, check SOMETIMES.
If a sentence was true about you most of the time, check TRUE.

Score the MFQ as follows:
NOT TRUE = 0
SOMETIMES = 1
TRUE = 2

To code, please use a checkmark (✓) for each statement.	NOT TRUE	SOME TIMES	TRUE
1. I felt miserable or unhappy.			
2. I didn't enjoy anything at all.			
3. I was less hungry than usual.			
4. I ate more than usual.			
5. I felt so tired I just sat around and did nothing.			
6. I was moving and walking more slowly than usual.			
7. I was very restless.			
8. I felt I was no good anymore.			
9. I blamed myself for things that weren't my fault.			
10. It was hard for me to make up my mind.			
11. I felt grumpy and cross with my parents.			
12. I felt like talking less than usual.			
13. I was talking more slowly than usual.			
14. I cried a lot.			

15. I thought there was nothing good for me in the future.			
16. I thought that life wasn't worth living.			
17. I thought about death or dying.			
18. I thought my family would be better off without me.			
19. I thought about killing myself.			
20. I didn't want to see my friends.			
21. I found it hard to think properly or concentrate.			
22. I thought bad things would happen to me.			
23. I hated myself.			
24. I felt I was a bad person.			
25. I thought I looked ugly.			
26. I worried about aches and pains.			
27. I felt lonely.			
28. I thought nobody really loved me.			
29. I didn't have any fun in school.			
30. I thought I could never be as good as other kids.			
31. I did everything wrong.			
32. I didn't sleep as well as I usually sleep.			
33. I slept a lot more than usual.			

Emotion Regulation Questionnaire – Youth (ERQ – CA; Gullone & Taffe, 2011)

Emotion Regulation Questionnaire (youth)

[Adapted from Gross, J.J., & John, O.P. (2003).]

These 10 questions are about how you feel inside, and how you show your emotions/feelings. Some of the questions may seem similar to one another, but they are different in important ways.

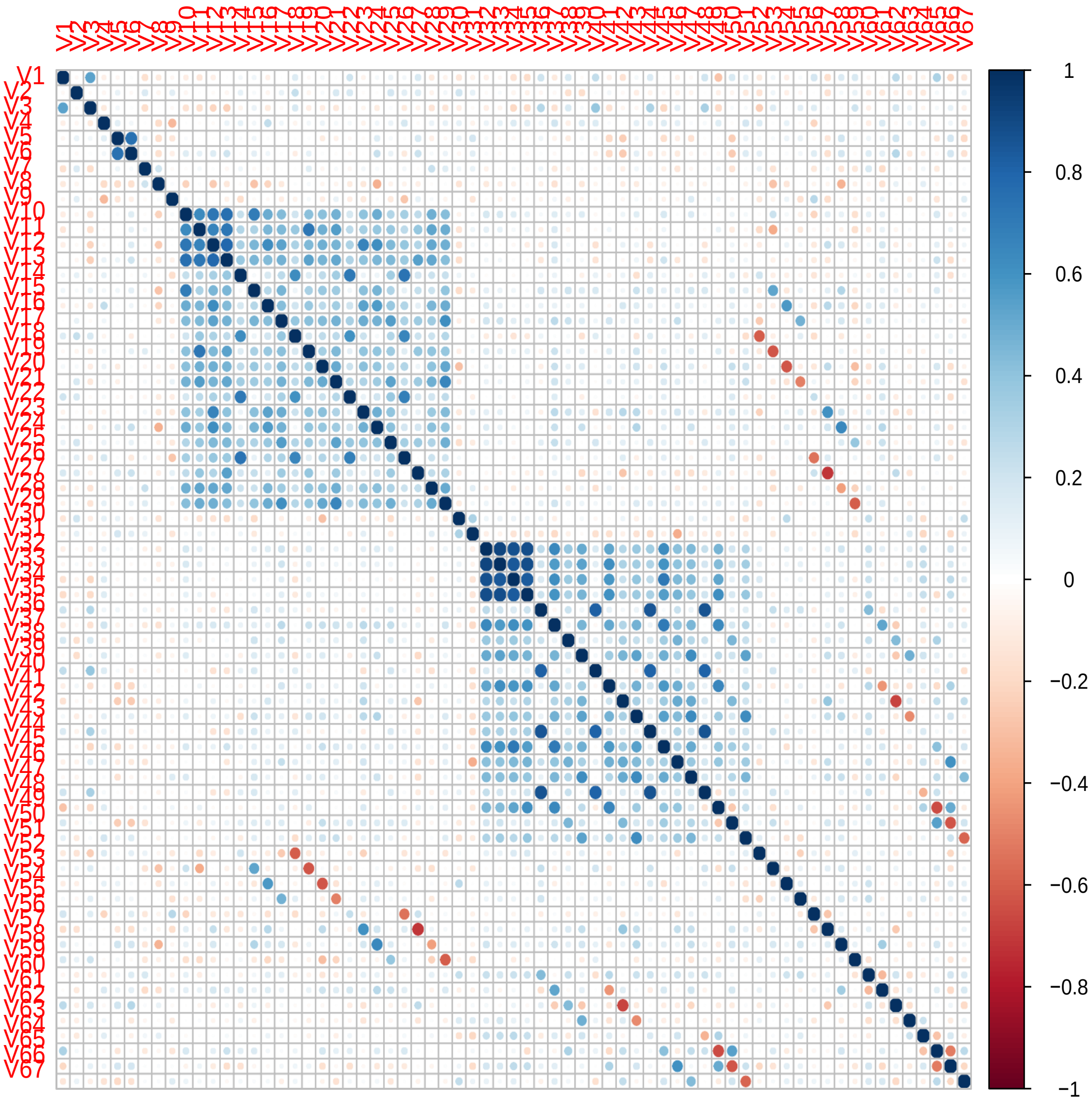
Please read each statement, and then **circle** the choice that seems **most true for you**. Do not spend too much time on any one item. Remember, this is not a test. There are no right or wrong answers. We really want to know what you think.

1. When I want to feel happier, I think about something different.	Strongly Disagree	Disagree	Half and half	Agree	Strongly Agree
2. I keep my feelings to myself	Strongly Disagree	Disagree	Half and half	Agree	Strongly Agree
3. When I want to feel less bad (e.g., sad, angry or worried), I think about something different.	Strongly Disagree	Disagree	Half and half	Agree	Strongly Agree
4. When I am feeling happy, I am careful not to show it.	Strongly Disagree	Disagree	Half and half	Agree	Strongly Agree
5. When I'm worried about something, I make myself think about it in a way that helps me feel better.	Strongly Disagree	Disagree	Half and half	Agree	Strongly Agree
6. I control my feelings by not showing them	Strongly Disagree	Disagree	Half and half	Agree	Strongly Agree
7. When I want to feel happier about something, I change the way I'm thinking about it.	Strongly Disagree	Disagree	Half and half	Agree	Strongly Agree
8. I control my feelings about things by changing the way I think about them.	Strongly Disagree	Disagree	Half and half	Agree	Strongly Agree
9. When I'm feeling bad (e.g., sad, angry, or worried), I'm careful not to show it.	Strongly Disagree	Disagree	Half and half	Agree	Strongly Agree
10. When I want to feel less bad (e.g., sad, angry, or worried) about something, I change the way I'm thinking about it.	Strongly Disagree	Disagree	Half and half	Agree	Strongly Agree

ERQ-Y Page 1 of 1

Appendix 8

Appendix 8. Strength of association correlogram depicting Pearson correlation between eye movement related variables for Parental Transmission Study in Chapter 3. Shades of blue indicate positive correlations (the darker shade the stronger is the positive correlation) and shades of red indicate negative correlations (the darker shade the stronger is the negative correlation). Variable names are noted as V1, V2 etc. in the correlogram for simplicity due to high number of variables. The full variable list is available below.



List of Variables for Appendix 8

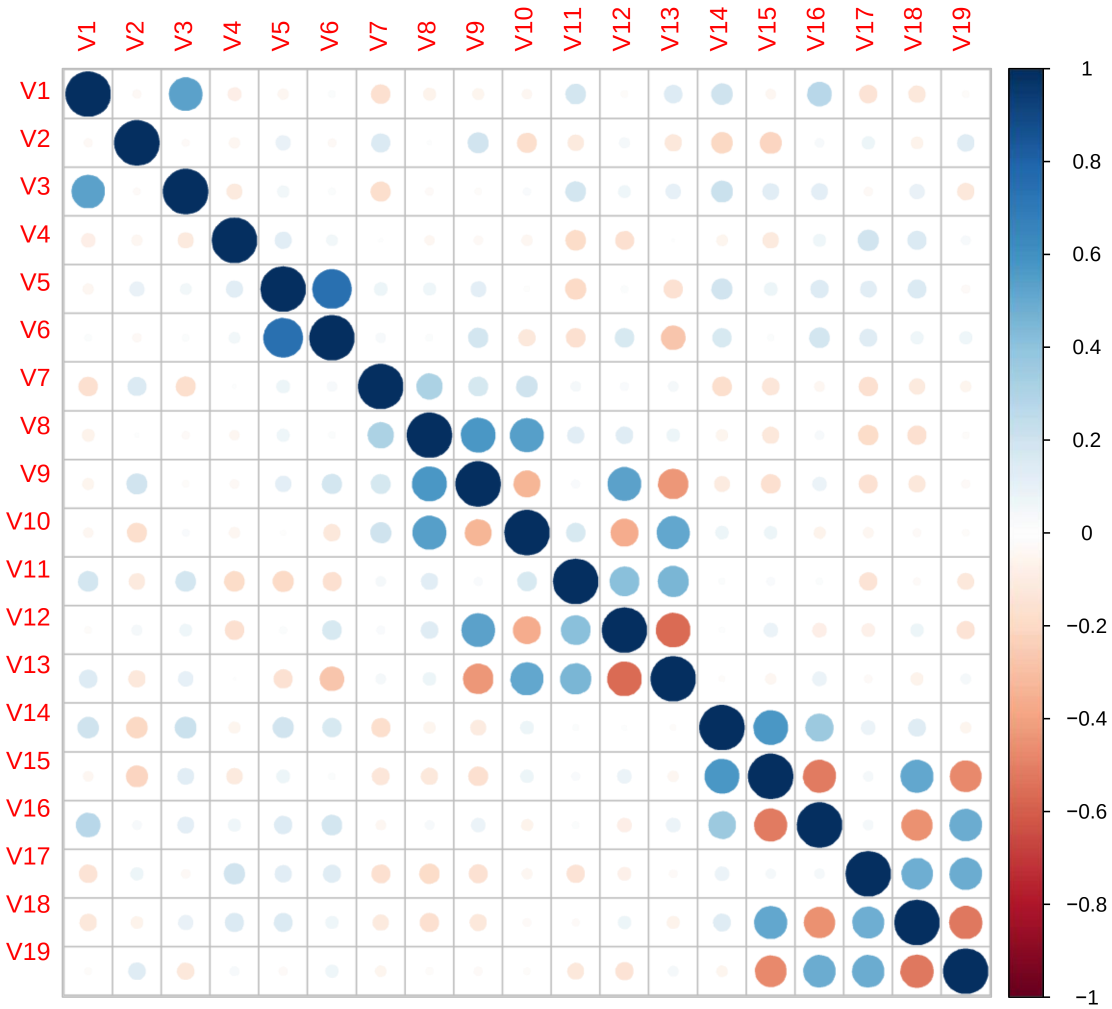
V1	Child_AgeYear
V2	Child_Gender
V3	Parent_AgeYear
V4	Parent_Gender
V5	SCAS_Total
V6	MFQ_Total
V7	STAIT_Total
V8	Child_AngryVigilance
V9	Child_HappyVigilance
V10	Child_AngryTrials_AngryDisengagement
V11	Child_AngryTrials_NeutralDisengagement
V12	Child_HappyTrials_HappyDisengagement
V13	Child_HappyTrials_NeutralDisengagement
V14	Child_AngryTrials_AngryDwell _Window1
V15	Child_AngryTrials_AngryDwell _Window2
V16	Child_AngryTrials_AngryDwell _Window3
V17	Child_AngryTrials_AngryDwell _Window4
V18	Child_AngryTrials_NeutralDwell_Window1
V19	Child_AngryTrials_NeutralDwell_Window2
V20	Child_AngryTrials_NeutralDwell_Window3
V21	Child_AngryTrials_NeutralDwell_Window4
V22	Child_HappyTrials_HappyDwell_Window1
V23	Child_HappyTrials_HappyDwell_Window2
V24	Child_HappyTrials_HappyDwell_Window3
V25	Child_HappyTrials_HappyDwell_Window4
V26	Child_HappyTrials_NeutralDwell_Window1
V27	Child_HappyTrials_NeutralDwell_Window2
V28	Child_HappyTrials_NeutralDwell_Window3
V29	Child_HappyTrials_NeutralDwell_Window4
V30	Parent_AngryVigilance
V31	Parent_HappyVigilance
V32	Parent_AngryTrials_AngryDisengagement
V33	Parent_AngryTrials_NeutralDisengagement
V34	Parent_HappyTrials_HappyDisengagement
V35	Parent_HappyTrials_NeutralDisengagement
V36	Parent_AngryTrials_AngryDwell _Window1
V37	Parent_AngryTrials_AngryDwell _Window2
V38	Parent_AngryTrials_AngryDwell _Window3
V39	Parent_AngryTrials_AngryDwell _Window4
V40	Parent_AngryTrials_NeutralDwell_Window1
V41	Parent_AngryTrials_NeutralDwell_Window2
V42	Parent_AngryTrials_NeutralDwell_Window3
V43	Parent_AngryTrials_NeutralDwell_Window4
V44	Parent_HappyTrials_HappyDwell_Window1

List of Variables for Appendix 8 (Continued)

V45	Parent_HappyTrials_HappyDwell_Window2
V46	Parent_HappyTrials_HappyDwell_Window3
V47	Parent_HappyTrials_HappyDwell_Window4
V48	Parent_HappyTrials_NeutralDwell_Window1
V49	Parent_HappyTrials_NeutralDwell_Window2
V50	Parent_HappyTrials_NeutralDwell_Window3
V51	Parent_HappyTrials_NeutralDwell_Window4
V52	Child_AngryTrials_AdjustedDwell_Window1
V53	Child_AngryTrials_AdjustedDwell_Window2
V54	Child_AngryTrials_AdjustedDwell_Window3
V55	Child_AngryTrials_AdjustedDwell_Window4
V56	Child_HappyTrials_AdjustedDwell_Window1
V57	Child_HappyTrials_AdjustedDwell_Window2
V58	Child_HappyTrials_AdjustedDwell_Window3
V59	Child_HappyTrials_AdjustedDwell_Window4
V60	Parent_AngryTrials_AdjustedDwell_Window1
V61	Parent_AngryTrials_AdjustedDwell_Window2
V62	Parent_AngryTrials_AdjustedDwell_Window3
V63	Parent_AngryTrials_AdjustedDwell_Window4
V64	Parent_HappyTrials_AdjustedDwell_Window1
V65	Parent_HappyTrials_AdjustedDwell_Window2
V66	Parent_HappyTrials_AdjustedDwell_Window3
V67	Parent_HappyTrials_AdjustedDwell_Window4

Appendix 9

Appendix 9. Strength of association correlogram depicting Pearson correlation between dot-probe data related variables for Parental Transmission Study in Chapter 3. Shades of blue indicate positive correlations (the darker shade the stronger is the positive correlation) and shades of red indicate negative correlations (the darker shade the stronger is the negative correlation). Variable names are noted as V1, V2 etc. in the correlogram for simplicity due to high number of variables. The full variable list is available below.

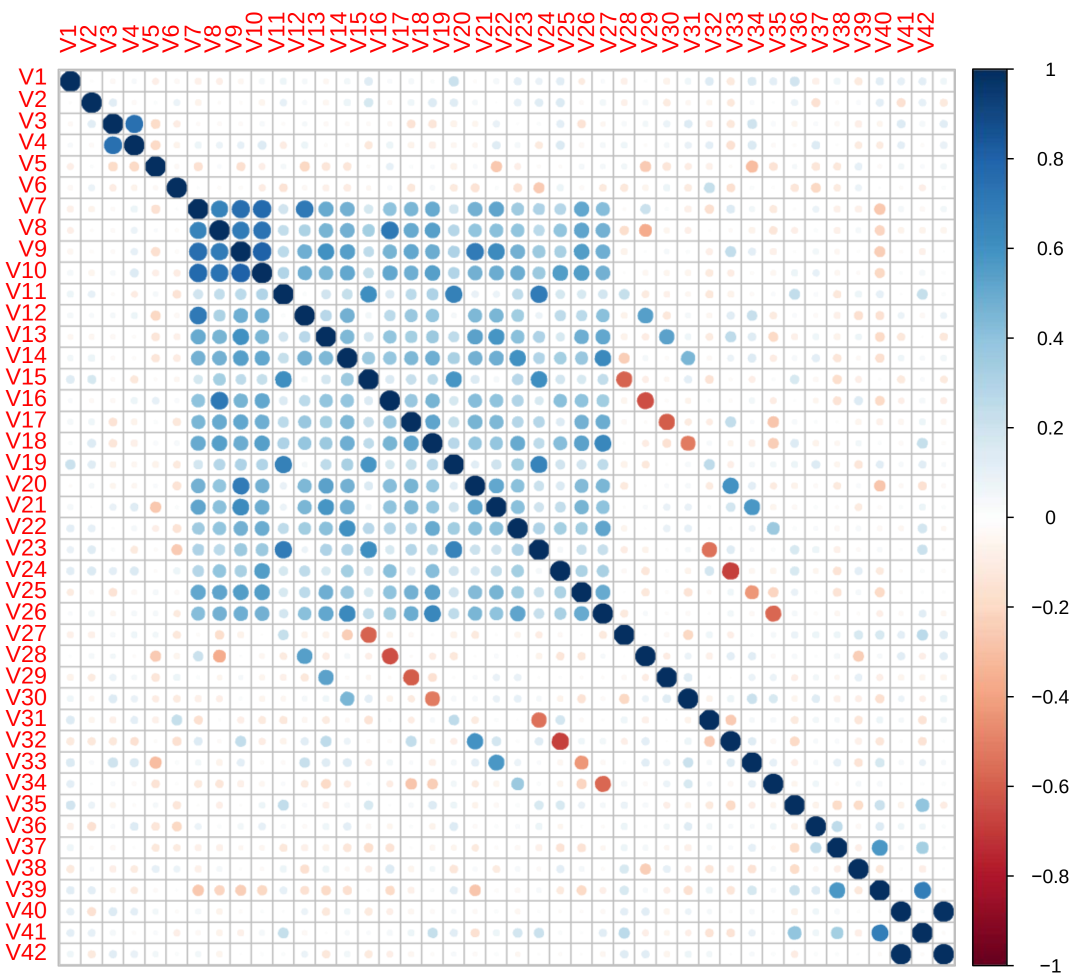


List of Variables for Appendix 9

V1	Child_AgeYear
V2	Child_Gender
V3	Parent_AgeYear
V4	Parent_Gender
V5	SCAS_Total
V6	MFQ_Total
V7	STAIT_Total
V8	Child_Vigilance-Avoidance_Angry
V9	Child_AngryEngagement
V10	Child_AngryDisengagement
V11	Child_Vigilance-Avoidance_Happy
V12	Child_ HappyEngagement
V13	Child_HappyDisengagement
V14	Parent_Vigilance-Avoidance_Angry
V15	Parent_AngryEngagement
V16	Parent_AngryDisengagement
V17	Parent_Vigilance-Avoidance_Happy
V18	Parent_HappyEngagement
V19	Parent_HappyDisengagement

Appendix 10

Appendix 10. Strength of association correlogram depicting Pearson correlation between eye movement data related variables for Attentional Control Study in Chapter 4. Shades of blue indicate positive correlations (the darker shade the stronger is the positive correlation) and shades of red indicate negative correlations (the darker shade the stronger is the negative correlation). Variable names are noted as V1, V2 etc. in the correlogram for simplicity due to high number of variables. The full variable list is available below.

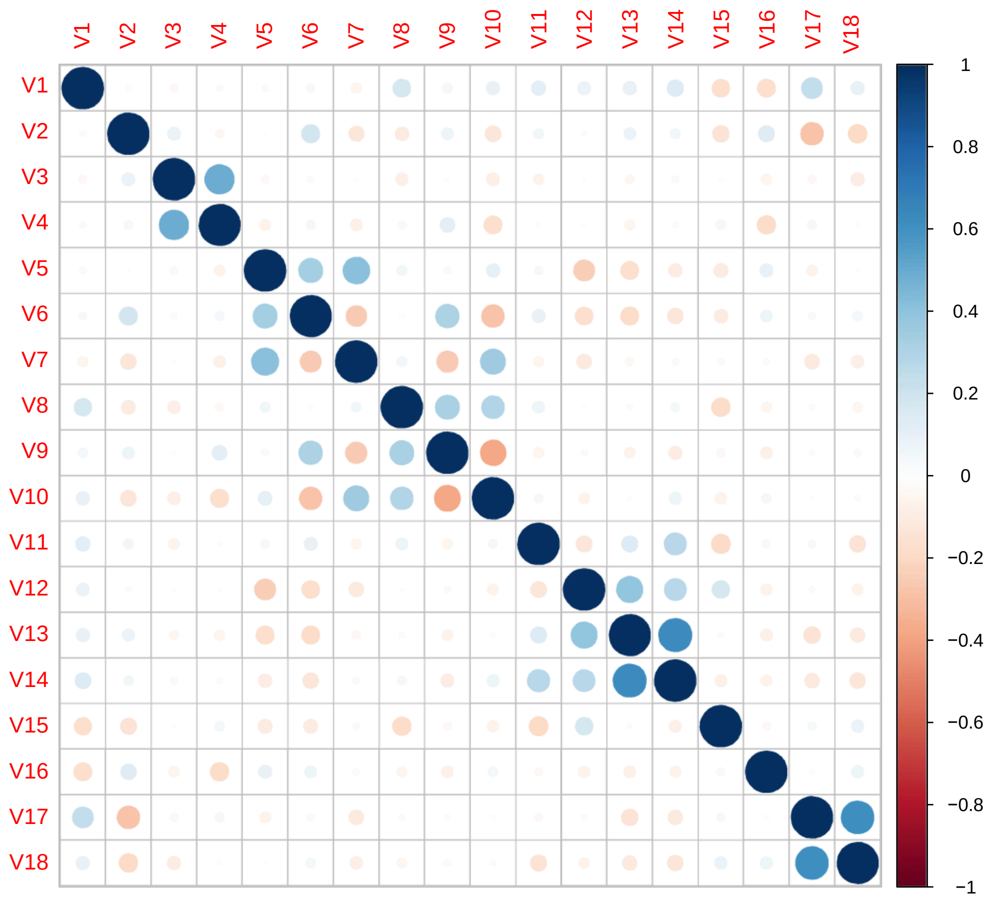


List of variables for Appendix 10

V1	Child_AgeYear
V2	Child_Gender
V3	Total_SCAS
V4	Total_MFQ
V5	Child_AngryVigilance
V6	Child_HappyVigilance
V7	Child_AngryTrials_AngryDisengagement
V8	Child_AngryTrials_NeutralDisengagement
V9	Child_HappyTrials_HappyDisengagement
V10	Child_HappyTrials_NeutralDisengagement
V11	Child_AngryTrials_AngryDwell _Window1
V12	Child_AngryTrials_AngryDwell _Window2
V13	Child_AngryTrials_AngryDwell _Window3
V14	Child_AngryTrials_AngryDwell _Window4
V15	Child_AngryTrials_NeutralDwell_Window1
V16	Child_AngryTrials_NeutralDwell_Window2
V17	Child_AngryTrials_NeutralDwell_Window3
V18	Child_AngryTrials_NeutralDwell_Window4
V19	Child_HappyTrials_HappyDwell_Window1
V20	Child_HappyTrials_HappyDwell_Window2
V21	Child_HappyTrials_HappyDwell_Window3
V22	Child_HappyTrials_HappyDwell_Window4
V23	Child_HappyTrials_NeutralDwell_Window1
V24	Child_HappyTrials_NeutralDwell_Window2
V25	Child_HappyTrials_NeutralDwell_Window3
V26	Child_HappyTrials_NeutralDwell_Window4
V27	Child_AngryTrials_AdjustedDwell_Window1
V28	Child_AngryTrials_AdjustedDwell_Window2
V29	Child_AngryTrials_AdjustedDwell_Window3
V30	Child_AngryTrials_AdjustedDwell_Window4
V31	Child_HappyTrials_AdjustedDwell_Window1
V32	Child_HappyTrials_AdjustedDwell_Window2
V33	Child_HappyTrials_AdjustedDwell_Window3
V34	Child_HappyTrials_AdjustedDwell_Window4
V35	Child_Simon_Index_ACC
V36	Child_Simon_Index_RT
V37	Child_SwitchCost_ACC
V38	Child_SwitchCost_RT
V39	Child_MixCost_Control_ACC
V40	Child_MixCost_Control_RT
V41	Child_MixCost_Inhibition_ACC
V42	Child_MixCost_Inhibition_RT

Appendix 11

Appendix 11. Strength of association correlogram depicting Pearson correlation between dot-probe data related variables for Attentional Control Study in Chapter 4. Shades of blue indicate positive correlations (the darker shade the stronger is the positive correlation) and shades of red indicate negative correlations (the darker shade the stronger is the negative correlation). Variable names are noted as V1, V2 etc. in the correlogram for simplicity due to high number of variables. The full variable list is available below.

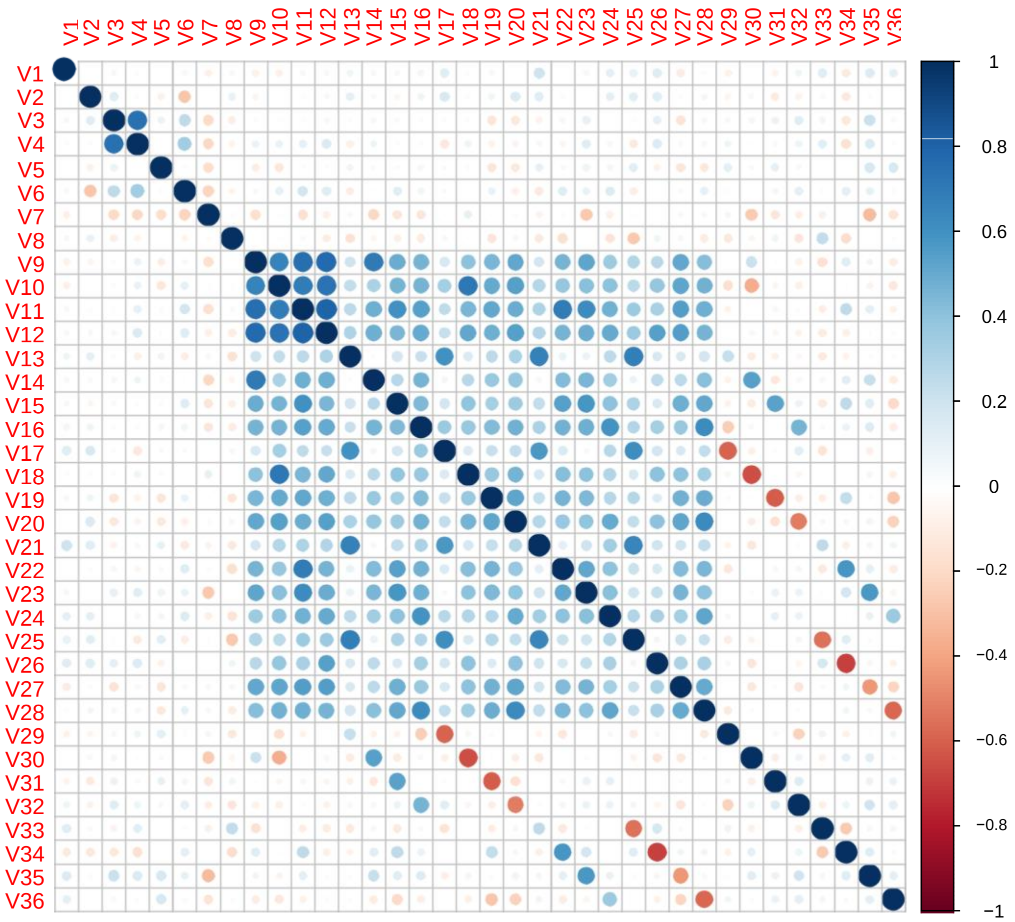


List of variables for Appendix 11

V1	Child_AgeYear
V2	Child_Gender
V3	Total_SCAS
V4	Total_MFQ
V5	Child_Vigilance-Avoidance_Angry
V6	Child_AngryEngagement
V7	Child_AngryDisengagement
V8	Child_Vigilance-Avoidance_Happy
V9	Child_ HappyEngagement
V10	Child_HappyDisengagement
V11	Child_Simon_Index_ACC
V12	Child_SwitchCost_ACC
V13	Child_MixCost_Control_ACC
V14	Child_MixCost_Inhibition_ACC
V15	Child_Simon_Index_RT
V16	Child_SwitchCost_RT
V17	Child_MixCost_Control_RT
V18	Child_MixCost_Inhibition_RT

Appendix 12

Appendix 12. Strength of association correlogram depicting Pearson correlation between eye movement data related variables for Emotion Regulation Study in Chapter 5. Shades of blue indicate positive correlations (the darker shade the stronger is the positive correlation) and shades of red indicate negative correlations (the darker shade the stronger is the negative correlation). Variable names are noted as V1, V2 etc. in the correlogram for simplicity due to high number of variables. The full variable list is available below.



List of Variables for Appendix 12

V1	Child_AgeYear
V2	Child_Gender
V3	SCAS_Total
V4	MFQ_Total
V5	ERQ_Reappraisal_Total
V6	ERQ_Suppression_Total
V7	Child_AngryVigilance
V8	Child_HappyVigilance
V9	Child_AngryTrials_AngryDisengagement
V10	Child_AngryTrials_NeutralDisengagement
V11	Child_HappyTrials_HappyDisengagement
V12	Child_HappyTrials_NeutralDisengagement
V13	Child_AngryTrials_AngryDwell _Window1
V14	Child_AngryTrials_AngryDwell _Window2
V15	Child_AngryTrials_AngryDwell _Window3
V16	Child_AngryTrials_AngryDwell _Window4
V17	Child_AngryTrials_NeutralDwell_Window1
V18	Child_AngryTrials_NeutralDwell_Window2
V19	Child_AngryTrials_NeutralDwell_Window3
V20	Child_AngryTrials_NeutralDwell_Window4
V21	Child_HappyTrials_HappyDwell_Window1
V22	Child_HappyTrials_HappyDwell_Window2
V23	Child_HappyTrials_HappyDwell_Window3
V24	Child_HappyTrials_HappyDwell_Window4
V25	Child_HappyTrials_NeutralDwell_Window1
V26	Child_HappyTrials_NeutralDwell_Window2
V27	Child_HappyTrials_NeutralDwell_Window3
V28	Child_HappyTrials_NeutralDwell_Window4
V29	Child_AngryTrials_AdjustedDwell_Window1
V30	Child_AngryTrials_AdjustedDwell_Window2
V31	Child_AngryTrials_AdjustedDwell_Window3
V32	Child_AngryTrials_AdjustedDwell_Window4
V33	Child_HappyTrials_AdjustedDwell_Window1
V34	Child_HappyTrials_AdjustedDwell_Window2
V35	Child_HappyTrials_AdjustedDwell_Window3
V36	Child_HappyTrials_AdjustedDwell_Window4