Falling Through the Cracks:

A Cognitive Profile of Primary School Children with Additional Health and Developmental Needs

Submitted by Alana Cross

BPsySc (Hons)

A thesis submitted in partial fulfilment

of the requirements for the degree of

Doctor of Clinical Psychology

School of Psychology and Public Health

College of Science, Health and Engineering

La Trobe University

Victoria, Australia

October 2020

This thesis is dedicated to my parents, and my grandparents. I never take it for granted how much you have sacrificed to ensure that I have always had the opportunity to pursue education.

Table of Contents

List of Tables

List of Figures

Statement of Authorship

Except where reference is made in the text of the thesis, this thesis contains no material published elsewhere or extracted in whole or in part from a thesis submitted for the award of any other degree or diploma. No other person's work has been used without due acknowledgement in the main text of the thesis. This thesis has not been submitted for the award of any degree or diploma in any other tertiary institution.

Where this thesis includes manuscripts, which are published or have been accepted for publication in peer-reviewed journals, the inclusion of co-authors reflects work that acknowledges input into team-based research. However, the theoretical framework, experimental data, data analyses and written material presented in these manuscripts were the principal responsibility of the candidate under the supervision of Professor Sheila Crewther.

This research was reviewed and approved by the La Trobe University Human Ethics Committee (UHEC Approval Number: HEC16-121/HEC18139), the Victorian Department of Education (Approval Number: 2017_003294) and the Victorian Catholic Schools Ethics Committee (Approval Number: CEM00889). All participants within this thesis provided written informed consent in accordance with the Declaration of Helsinki (see Appendix B - D). This work was supported by the Australian Postgraduate Award.

Alana Cross

5 October 2020

Acknowledgements

Thank you to my supervisors, Professor Sheila Crewther, Dr Robin Laycock and Dr Nahal Goharpey for their guidance and encouragement with this research project. My gratitude extends to the Crewther lab for their assistance, particularly with data collection. More broadly, the clinical staff of La Trobe University have been incredibly influential in my development as a psychologist and as a researcher.

This thesis would not have been possible without the enthusiastic involvement of the students, parents and staff of the SHINE program and St Margaret Mary's Primary School. I would like to sincerely thank those who so generously participated, and I hope that this thesis contributes to the advocacy of educational equality and recognition of mental health for all children experiencing difficulties at school.

I cannot put into words how much the support of so many friends, peers and colleagues has meant throughout the duration of this thesis. I'm not sure that I would have made it through without my dear friends, Charlotte, Liss and Emma.

I have been especially lucky to have Troy by my side, experiencing the highs and lows of this degree with me, and supporting me in every way. I am also so grateful for the endless love and support of my family- Mum, Dad, Julian, Uncle Peter and Uncle Alex. Finally, to my beloved Nan, it is in the memory of your resilience, empathy and kindness that I continue to strive.

Publications and Manuscripts Related to this Thesis

Chapter 2 (Manuscript Under Review)

Cross, A.J, Laycock, R., Goharpey, N., Crewther, S. G. (2020). Anxiety, Stress and Fear as Potential Core Traits of Children with Additional Health and Developmental Needs. *Manuscript submitted for publication.*.

Chapter 4 (Published Journal Article)

Cross, A. J., Goharpey, N., Laycock, R., & Crewther, S. G. (2019). Anxiety as a Common Biomarker for School Children with Additional Health and Developmental Needs Irrespective of Diagnosis. *Front Psychol, 10*, 1420.

Appendix A (Manuscript Under Review- Editorial Paper of Key Thesis Outcomes)

Cross, A.J, Laycock, R., Goharpey, N., Crewther, S. G. (2020). Falling Through the Cracks-Considerations for Psychologists Working with Children with Additional Health and Developmental Needs in Australian Schools**.** *Manuscript submitted for publication to InPsych for the Australian Psychological Society*.

Presentations Related to this Thesis

Cross, A. J., Laycock, R., & Crewther, S. G. (2017, July). *Visual Attention Differences in the Broader Autism Phenotype*. Poster session presented at the Asia Pacific Conference on Vision, Tainan, Taiwan.

Cross, A. J. (2017, July). *The Biopsychosocial Model of Childhood Anxiety: A 21st Century Update.* Oral Presentation presented at the La Trobe University Higher Degree by Research Seminar, La Trobe University, Melbourne, Australia.

Cross, A. J, Laycock, R., Peters, J., & Crewther, S. G. (2016, July). *The Contribution of Attention and Anxiety to the Neurodevelopmental Phenotype*. Poster session presented at the Asia Pacific Conference on Vision, Freemantle, Western Australia, Australia.

Abstract

Anxiety is a fundamental human experience that is usually adaptive but when chronic in adults can interfere with social interactions, and general behaviours including visual perception, visual attention and learning. However, less is known about the role chronic anxiety plays in children especially during school years. Thus, this thesis sought to investigate the role of chronic anxiety on visual perception and attention in school age children who require additional support at school. Research was conducted at a specialist school holiday program for children experiencing social, emotional and academic difficulties, i.e., children with Additional Health and Developmental Needs (AHDN), and at a general primary school (Typically Developing [TD] children) in Melbourne, Australia. The first study aimed to explore the behavioural profile of children with AHDN and the relationships between anxiety, autism-like traits and sleep behaviours as measured by parent-rated questionnaires- the Spence Children's Anxiety Scale- Parent version (SCAS-P), Autism Spectrum Quotient- Child (AQ-Child) questionnaire, and the Sleep Disturbance Scale for Children (SDSC). The results highlighted chronic anxiety as a common biomarker in this population, regardless of clinical diagnosis. The second study examined visual perceptual bias using a Navon global/local task but found no significant bias in children with AHDN compared to TD children suggesting that although chronic anxiety is commonly experienced in children with AHDN, it does not necessarily affect acute short duration transient attention. The third study investigated the contribution of chronic anxiety to performance on Posner's Attention Network Task (ANT) in children with AHDN, finding that a less efficient alerting network is associated with higher levels of anxiety in these children, while children with ADHN tended to show greater impairment in executive control when compared with TD peers. Overall our results suggest that anxiety is an endemic problem in many school age children especially those classified as having AHDN, and as such warrants more extensive consideration by clinical psychologists and educationalists, with further research needed to understand the relationship between anxiety and sustained attention in school age children.

List of Abbreviations

ADHD	Attention Deficit Hyperactivity Disorder
AHDN	Additional Health and Developmental Needs
ANT	Attention Network Task
APA	American Psychiatric Association
ASD	Autism Spectrum Disorder
AQ-Child	Autism Spectrum Quotient- Child Version
DSM	Diagnostic and Statistical Manual for Mental Disorders
GAD	Generalised Anxiety Disorder
ICD	International Classification of Diseases
RDoC	Research Domain Criteria
SCAS-P	Spence Children's Anxiety Scale- Parent Report
SDSC	Sleep Disturbance Scale for Children
TD	Typically Developing
WHO	World Health Organisation

Chapter 1- General Introduction to Topic and Thesis Overview

At least 1 in 5 children in Australia require extra support at school due to various diagnosed and undiagnosed developmental, behavioural and emotional difficulties (Goldfeld, O'Connor, Sayers, Moore, & Oberklaid, 2012). Hence the earliest possible identification of the specific nature of potential educational and/or mental health difficulties and the need for developmentally appropriate early interventions for such children is crucial (Atkins, Cappella, Shernoff, Mehta, & Gustafson, 2017; Noam & Hermann, 2002). These children may be characterised as having 'Special Health Care Needs', or as this group has more recently been classified in Australia, as *Additional Health and Developmental Needs* (AHDN) (McPherson et al., 1998). Children with AHDN include "those who have, or are at increased risk for a chronic physical, developmental, behavioural, or emotional condition and who also require health and related services of a type or amount beyond that required by children generally" (McPherson et al., 1998, p. 138). AHDN is a broad term that includes children with both diagnosed and undiagnosed needs (Goldfeld, O'Connor, Quach, Tarasuik, & Kvalsvig, 2015). The detection of such difficulties often first occurs at school, emphasising the importance of the education system in supporting young people with AHDN (Lawrence et al., 2015). Children who struggle at school are more likely to experience anxiety, poor sleep and social difficulties (Rzepecka, McKenzie, McClure, & Murphy, 2011), and their families often sustain significant emotional and financial stressors (Elkins, Van Kraayenoord, & Jobling, 2003; Looman, O'Conner-Von, Ferski, & Hildenbrand, 2009; Mattson & Kuo, 2019; Van Dyck, Kogan, McPherson, Weissman, & Newacheck, 2004). Thus psychological input is also often necessary for children with AHDN who require additional support (Cavanagh, 2017), given that they are at a greater risk of being bullied, having poorer academic outcomes and displaying more disruptive behaviour (Forrest, Bevans, Riley, Crespo, & Louis, 2011).

To date, there is limited research on Australian or any other country's school children with AHDN [rationale for choice of the terminology of AHDN is discussed further under Methodological Issues in Chapter 3] meaning that potential shared characteristics of a cognitive profile (e.g., atypical attention), biological processes (e.g., sleep quality and eating patterns) and mental health co-morbidities (e.g., anxiety) are largely unknown. Thus there is an urgency to expand the evidence base associated with this population to ensure that assessment of difficulties can shift beyond the single focus of access to funding and support services, towards prioritising the earliest identification of children requiring support and early intervention for educational success (O'Connor, O'Connor, Quach, Vashishtha, & Goldfeld, 2019).

Although inclusion and valuing of the diverse needs of students is a key principle for the Victorian State Government Education Department (State of Victoria, 2016), there appears to be a substantial portion of children who 'fall through the cracks' and do not receive adequate support (Macaulay, Deppeler, & Agbenyega, 2016; Walker et al., 2018). Such neglect is also evident in the allocation of funding and support in Australia, which is often restricted to children who fit within strict diagnostic criteria, and who meet a particular level of severity (McDowell & O'Keeffe, 2012). In fact, the educational and social outcomes for children who have additional needs in Australia are currently unknown as they are often excluded from standardised testing such as the National Assessment Program- Literacy and Numeracy (NAPLAN) (Dempsey & Davies, 2013). Where academic literature and government policies have included AHDN, severe disabilities have been targeted meaning that children with undiagnosed or mild-moderate challenges have been largely overlooked, even though these children still appear to experience poor outcomes (Goldfeld et al., 2015; Newacheck et al., 1998). Furthermore the allocation of resources even for the same diagnosis is known to be highly variable under the National Disability Insurance Scheme (NDIS)

federal funding initiative (Mavromaras, Moskos, & Mahuteau, 2016), with a child's problems sometimes being overstated by parents, schools and professionals in order to receive a severe enough diagnosis to access services (Skellern, Schluter, & McDowell, 2005).

Contrary to current system limitations, a non-categorical approach that focuses on the individual needs of the child along with parent involvement has been recommended (O'Connor et al., 2015). For instance, research has shown that an emphasis on the functioning of the child, referred to as the ability or limitation to engage and participate in meaningful activities, rather than diagnosis has improved outcomes for the child and their families (Miller, Shen, & Mâsse, 2016; World Health Organisation [WHO], 2001). Children who struggle at school experience difficulties that are also highly likely to be psychologically stressful, and induce persistent fear and anxiety, that in turn may negatively affect social interactions, visual perception, attention and learning in the school environment (Eysenck, Derakshan, Santos, & Calvo, 2007; Fox, Russo, Bowles, & Dutton, 2001; Reimherr, Marchant, Gift, & Steans, 2017).

Whilst it is also acknowledged educationally that children with AHDN need recognition, psychological support is seldom forthcoming clinically, as behaviourally obvious 'anxiety' is often overlooked in children given 'anxiety' *per se* is not recognised as a core component of the latest Diagnostic and Statistical Manual of Mental Disorders (DSM-5) (American Psychiatric Association [APA], 2013) or International Classification of Diseases, 11th Revision (ICD-11) (WHO, 2018) disorder categorisation of neurodevelopmental disorders. This may be because anxiety is looked at as a response to academic underachievement rather than as a part of the problem. Thus, this thesis set out to investigate the role of anxiety in the school experience of children categorised as having AHDN and in terms of their ability to attend rapidly and appropriately to short duration visual stimuli, and how they preferentially perceive a dynamic environment.

Although anxiety is not clinically associated with neurodevelopmental anomalies by DSM-5, it is a common descriptive term associated with normal and abnormal responses to threat or a fearful emotional state. Acute anxiety is experienced by all children during development and is usually adaptive in safeguarding a child from potential immediate danger. Acute anxiety is often first observed in closely aligned fears, for example infants commonly fear caregiver separation and preschool aged children may be scared of animals (Gullone, 2000). More persistent anxiety in adults and children is characterised by excessive worry about a particular issue across different areas of life, leading to poor concentration, and physical symptoms such as difficulty sleeping, feeling on edge, irritability, muscle tension and fatigue beyond developmentally appropriate periods (APA, 2013). As a biopsychological term anxiety is associated with systemic neurophysiological, psychological and behavioural changes in response to a threatening situation (Steimer, 2002). However anxiety is predominantly used as a behavioural description of 'nervous actions' such as pacing or wringing by clinical psychologists (Beidel & Alfano, 2011; Fonseca & Perrin, 2011). When such behaviours become frequent and persistent they tend to interfere with daily functioning and if not responded to appropriately in childhood (Beesdo, Knappe, & Pine, 2009) may lead to a lifelong trajectory of pathological levels of fearfulness. Hence, the term 'anxiety' in this thesis is used to encompass anxiety as a spectrum that includes symptoms and behaviours that do not necessarily reach the threshold of a clinical diagnosis.

Currently DSM-5 has no category to cover the vast heterogenous group of children with AHDN who experience school difficulties of one sort or another and for which the complexity and level of functional impairment exists along a continuum (Bramlett, Read, Bethell, & Blumberg, 2009). In fact, it is the heterogeneity of this large group that has led to there being little research regarding the identification of shared characteristics of this population (Garvey, O'Connor, Quach, & Goldfeld, 2020; O'Connor et al., 2019). As alluded

to above, this situation has been exacerbated in Australia where school support and intervention funding is often tied to clinical diagnosis of a specific neurodevelopmental disorder (Skellern et al., 2005).

What remains to be investigated more comprehensively is the impact that likely ongoing anxiety may have on persistent school difficulties on the current behaviour and future potential of any child struggling at school. In particular for these children, if chronic anxiety is a common occurrence then it is likely to be intimately linked to their current and future academic and/or social behaviours since the physical responses of fear and anxiety are closely aligned to autonomic nervous system and endocrine system 'fight and flight' behaviours. Whilst psychologists and teachers alike often think that a child's anxiety is reactionary to their situation and subsides when the child has academic and social success, the developmental trajectory of anxiety is often not adequately considered.

Thus, this thesis aims to characterise the population of children with AHDN with school and learning associated problems in psychological, biological and social terms and to address the question of whether there is a common behavioural phenotype or common biomarkers in children with AHDN. It was hypothesised that children with AHDN would be characterised by common behaviours typical of 'chronic anxiety' that would be readily identifiable to parents and teachers using published questionnaires. Consequently, these characteristics would be expected to have implications for the children's cognitive and visual attention.

The Current Thesis

Given the known relationship of anxiety to neurodevelopmental disorders (Vasa et al., 2014; Viggiano, Cacciola, Widmer, & Viggiano, 2015), it is probable that anxiety contributes more broadly to children with AHDN across diagnoses. Hence a better understanding of the shared commonalities in AHDN is urgently needed, given that research about this population in Australia remains limited, resulting in a lack of health and education related recognition

and access to resources for many children and families (McDowell & O'Keeffe, 2012). Thus, this thesis has sought to investigate the interaction of anxiety and transient short duration attention in children with AHDN. We are predicting that our findings will have greater educational generality than has been previously investigated, given that we propose anxiety as a common characteristic and context for behaviours in these children regardless of primary diagnosis or presenting concern. It was initially expected that the current results would indicate greater comorbidity of behaviours than has formally been recognised, suggesting that perhaps there is a need for re-evaluation of current ways of identifying children experiencing social, emotional and academic difficulties and extending beyond clinical boundaries of diagnosis to prioritisation of the individual functioning of the child. We acknowledge that other psychiatric disorders are also often co-morbid with neurodevelopmental disorders making it likely that children with AHDN may show physiological signs that fall into categories related to chronic anxiety or depression (Tofoli, Baes, Martins, & Juruena, 2011). However for this thesis we have not included clinical assessments of depression given that symptoms of anxiety typically precede the development of depression and other psychiatric disorders, and because there has generally been very little evidence justifying the classification of depression in children prior to puberty (Pine & Fox, 2015).

This thesis begins with a background literature review of anxiety, stress and fear in children, and challenges the current system of defining clinical disorders using a categorical diagnostic approach, such as relying on the DSM-5 and ICD-11. It is proposed that there is a need to broaden overarching understanding of disorders to include biopsychosocial factors and to prioritise the contribution of anxiety to children with AHDN (Chapter 2).

Chapter 3 includes a consideration of methodological issues acknowledging different perspectives across the literature regarding how best to define children struggling at school. Although the terms ‘Additional Education Needs’ or ‘Special Needs’ have been used

previously, *Additional Health and Developmental Needs* is used primarily in this thesis to reflect its use in an Australian context (O'Connor et al., 2015). Furthermore, Chapter 3 discusses the use of questionnaires such as the Autism Spectrum Quotient- Child Version (AQ- Child) (Auyeung, Baron-Cohen, Wheelwright, & Allison, 2008) and Spence Children's Anxiety Scale- Parent Report (SCAS-P) (Nauta et al., 2004) to measure behavioural traits, and a child version of the Attention Network Task (ANT) (Rueda et al., 2004) and Navon Task (Navon, 1977) to measure attentional processes.

This thesis also seeks to address several key research questions including whether all school children exhibit anxiety and/or have variations in their clinically defined attention/concentration span and if these attentional anomalies affect performance on traditional experimental attention tasks. Furthermore, we sought to investigate whether being classified as having an AHDN exacerbated the impact on task performance. Chapters 4 to 6 are experimental chapters outlining the original research conducted for this thesis. The first experimental chapter (Chapter 4) aimed to explore whether anxiety is a common biomarker for children with AHDN, regardless of diagnosis. Acknowledging that clinical anxiety is often quantified as an observable behaviour, common characteristics of anxiety were also explored, as measured by the Sleep Disturbance Scale for Children (SDSC) (Bruni et al., 1996), AQ- Child (Auyeung, Baron-Cohen, Wheelwright, & Allison, 2008), and Raven's Progressive Matrices for nonverbal intelligence (Raven, 1990).

The aim of the second experimental chapter (Chapter 5) grew out of the rationale that neurodevelopmental disorders such as ASD and anxiety have been shown to affect a bias towards local visual information, and so we set out to investigate whether anxiety contributed to a more or less local/global perceptual bias in visual attention in our AHDN group, using a Navon experimental paradigm (Bialystok, 2010; Navon, 1977). Indeed, most individuals inherently sample a scene, i.e., rapidly acquire meaning or 'gist' of the whole visual scene

such that there is ‘global precedence’. This means that they more readily first attend to a larger view of the world and more global information, rather than specific details, often referred to as seeing the ‘forest before the trees’ (Navon, 1977). On the other hand, a superiority to preferentially extract local details is common amongst those on the autism spectrum (Van der Hallen, Evers, Brewaeys, Van den Noortgate, & Wagemans, 2015). Whether a general local processing bias is attributable to a superior or enhanced ability to process local information (Enhanced Perceptual Functioning theory) (Mottron & Burack, 2001), difficulty integrating overall global meaning (Weak Central Coherence theory) (Happé & Frith, 2006), or is situation or context dependent (Van Eylen, Boets, Steyaert, Wagemans, & Noens, 2018) is contended across the literature, and will be examined here in children with AHDN. Furthermore it is well known that local details are more readily processed in individuals experiencing chronic anxiety while emotionally salient stimuli are usually prioritised (Barrett & Bar, 2009; Tyler & Tucker, 1982).

The third experimental chapter (Chapter 6) aimed to investigate whether there is a relationship between cognitive attention and chronic anxiety in children with AHDN. Posner and colleagues have theoretically conceptualised attention as a cognitive model of three separate networks, identified as relating to alerting, orienting and executive control, whereby each network can be associated with different neural networks (Petersen & Posner, 2012; Posner & Petersen, 1990) that have been hypothesised to be implicated in both acute and chronic anxiety (Pacheco-Unguetti, Acosta, Callejas, & Lupiáñez, 2010). Much of the research examining attention networks in adults and children has been conducted using the ANT (Neuhaus et al., 2010; Posner and Rothbart, 2013; Rueda et al., 2004). Thus this study used a customised child version of the ANT (Rueda et al., 2004) to explore whether Posner’s orienting, alerting or executive control attention networks are associated with parental perceptions of anxiety in their children who form our AHDN population.

Finally, Chapter 7 provides a general discussion summarising the key findings of the research presented in this thesis and a commentary on where these outcomes fit in the context of relevant literature. This chapter acknowledges limitations to the research overall. Importantly, the conclusion of the thesis highlights recommendations for psychologists to integrate findings in an evidence-based way for clinical practice. It is contended that psychologists can and should play a crucial role in advocating for children with AHDN and contribute to conceptualisations beyond traditional diagnostic categories, such as through a biopsychosocial approach.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (DSM-5®)*: American Psychiatric Pub.

Atkins, M. S., Cappella, E., Shernoff, E. S., Mehta, T. G., & Gustafson, E. L. (2017). Schooling and children's mental health: Realigning resources to reduce disparities and advance public health. *Annual review of clinical psychology, 13*, 123-147. https://doi.org/10.1146/annurev-clinpsy-032816-045234

Auyeung, B., Baron-Cohen, S., Wheelwright, S., & Allison, C. (2008). The autism spectrum quotient: Children's version (AQ-Child). *J Autism Dev Disord, 38*(7), 1230-1240. https://doi.org./10.1007/s10803-007-0504-z

Barrett, L. F., & Bar, M. (2009). See it with feeling: affective predictions during object perception. *Philosophical Transactions of the Royal Society B: Biological Sciences, 364*(1521), 1325-1334. http://doi/org/10.1098/rstb.2008.0312

Beesdo, K., Knappe, S., & Pine, D. S. (2009). Anxiety and anxiety disorders in children and adolescents: developmental issues and implications for DSM-V. *Psychiatric Clinics of North America, 32*(3), 483-524. https://doi.org/10.1016/j.psc.2009.06.002

Beidel, D. C., & Alfano, C. A. (2011). *Child anxiety disorders: A guide to research and treatment*: Routledge.

Bialystok, E. (2010). Global–local and trail-making tasks by monolingual and bilingual children: Beyond inhibition. *Developmental psychology, 46*(1), 93. https://doi.org/10.1037/a0015466

Bramlett, M. D., Read, D., Bethell, C., & Blumberg, S. J. (2009). Differentiating subgroups of children with special health care needs by health status and complexity of health care needs. *Maternal and child health journal, 13*(2), 151-163. http://doi.org/ 10.1007/s10995-008-0339-z

Bruni, O., Ottaviano, S., Guidetti, V., Romoli, M., Innocenzi, M., Cortesi, F., & Giannotti, F. (1996). The Sleep Disturbance Scale for Children (SDSC) Construct ion and validation of an instrument to evaluate sleep disturbances in childhood and adolescence. *Journal of sleep research, 5*(4), 251-261. https://doi.org/10.1111/j.1365-2869.1996.00251.x

Cavanagh, S. (2017). Early childhood matters most. *InPsych: The Bulletin of the Australian Psychological Society Ltd, 39*(6), 8. http://doi.org/10.1146/annurev-clinpsy-032816-045234

Dempsey, I., & Davies, M. (2013). National test performance of young Australian children with additional educational needs. *Australian Journal of Education, 57*(1), 5-18. https://doi.org/10.1177/0004944112468700

Elkins, J., Van Kraayenoord, C. E., & Jobling, A. (2003). Parents' attitudes to inclusion of their children with special needs. *Journal of Research in Special Educational Needs, 3*(2), 122-129. https://doi.org/10.1111/1471-3802.00005

Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: attentional control theory. *Emotion, 7*(2), 336. https://doi.org/10.1037/1528-3542.7.2.336

Forrest, C. B., Bevans, K. B., Riley, A. W., Crespo, R., & Louis, T. A. (2011). School outcomes of children with special health care needs. *Pediatrics, 128*(2), 303. https://doi.org/10.1542/peds.2010-3347

Fonseca, A. C., & Perrin, S. (2011). The clinical phenomenology and classification of child and adolescent anxiety. *Anxiety disorders in children and adolescents*, *2*, 25-55.

Fox, E., Russo, R., Bowles, R., & Dutton, K. (2001). Do threatening stimuli draw or hold visual attention in subclinical anxiety? *Journal of Experimental Psychology: General, 130*(4), 681. https://doi.org/10.1037/0096-3445.130.4.681

Garvey, W., O'Connor, M., Quach, J., & Goldfeld, S. (2020). Better support for children with additional health and developmental needs in school settings: Perspectives of education experts. *Child: care, health and development*. https://doi.org/10.1111/cch.12766

Goldfeld, S., O'Connor, M., Sayers, M., Moore, T., & Oberklaid, F. (2012). Prevalence and correlates of special health care needs in a population cohort of Australian children at school entry. *Journal of Developmental & Behavioral Pediatrics, 33*(4), 319-327. https://doi.org/10.1097/DBP.0b013e31824a7b8e

Goldfeld, S., O'Connor, M., Quach, J., Tarasuik, J., & Kvalsvig, A. (2015). Learning trajectories of children with special health care needs across the severity spectrum. *Academic pediatrics, 15*(2), 177-184. https://doi.org/10.1016/j.acap.2014.09.001s

Gullone, E. (2000). The development of normal fear: A century of research. *Clinical Psychology Review, 20*(4), 429-451. https://doi.org/10.1016/S0272-7358(99)00034-3

Happé, F., & Frith, U. (2006). The weak coherence account: detail-focused cognitive style in autism spectrum disorders. *J Autism Dev Disord, 36*(1), 5-25. https://doi.org/10.1007/s10803-005-0039-0

Lawrence, D., Johnson, S., Hafekost, J., Boterhoven de Haan, K., Sawyer, M., Ainley, J., & Zubrick, S. R. (2015). The mental health of children and adolescents: report on the second Australian child and adolescent survey of mental health and wellbeing. Department of Mental Health and Wellbeing. Department of Health, Canberra.

Looman, W. S., O'Conner-Von, S. K., Ferski, G. J., & Hildenbrand, D. A. (2009). Financial and employment problems in families of children with special health care needs: implications for research and practice. *Journal of Pediatric Health Care, 23*(2), 117-125. https://doi.org/10.1016/j.pedhc.2008.03.001

Macaulay, L., Deppeler, J., & Agbenyega, J. (2016). Access to quality education for students with disability. *Journal of Social Inclusion, 7*(2). http://doi.org/10.36251/josi.108

Mattson, G., Kuo, D. Z., & Committee on Psychological Aspects of Child and Family Health. (2019). Psychosocial factors in children and youth with special health care needs and their families. *Pediatrics, 143*(1). https://doi.org/10.1542/peds.2018-3171

Mavromaras, K. G., Moskos, M., & Mahuteau, S. (2016). *Evaluation of the NDIS: Intermediate report*: Department of Social Services.

McDowell, M., & O'Keeffe, M. (2012). Public services for children with special needs: discrimination by diagnosis? *Journal of paediatrics and child health, 48*(1), 2-5. https://doi.org/10.1111/j.1440-1754.2011.02394.x

McPherson, M., Arango, P., Fox, H., Lauver, C., McManus, M., Newacheck, P. W., . . . Strickland, B. (1998). A new definition of children with special health care needs. *Pediatrics, 102*(1), 137-139. https://doi.org/10.1542/peds.102.1.137

Miller, A., Shen, J., & Mâsse, L. C. (2016). Child functional characteristics explain child and family outcomes better than diagnosis: population-based study of children with autism or other neurodevelopmental disorders/disabilities. *Health reports, 27*(6), 9.

Mottron, L., & Burack, J. A. (2001). Enhanced perceptual functioning in the development of autism. n J. A. Burack, T. Charman, N. Yirmiya, & P. R. Zelazo (Eds.), *The development of autism: Perspectives from theory and research* (p. 131–148). Lawrence Erlbaum Associates Publishers.

Nauta, M. H., Scholing, A., Rapee, R. M., Abbott, M., Spence, S. H., & Waters, A. (2004). A parent-report measure of children's anxiety: psychometric properties and comparison with child-report in a clinic and normal sample. *Behav Res Ther, 42*(7), 813-839. http://doi.org/10.1016/S0005-7967(03)00200-6

Navon, D. (1977). Forest before trees: The precedence of global features in visual perception. *Cognitive psychology, 9*(3), 353-383. https://doi.org/10.1016/0010-0285(77)90012-3

Neuhaus, A. H., Urbanek, C., Opgen-Rhein, C., Hahn, E., Ta, T. M. T., Koehler, S., ... & Dettling, M. (2010). Event-related potentials associated with Attention Network Test. *International Journal of Psychophysiology*, *76*(2), 72-79. https://doi.org/10.1016/j.ijpsycho.2010.02.005

Newacheck, P. W., Strickland, B., Shonkoff, J. P., Perrin, J. M., McPherson, M., McManus, M., . . . Arango, P. (1998). An epidemiologic profile of children with special health care needs. *Pediatrics, 102*(1), 117-123. https://doi.org/10.1542/peds.102.1.117

Noam, G. G., & Hermann, C. A. (2002). Where education and mental health meet: Developmental prevention and early intervention in schools. *Dev Psychopathol, 14*(4), 861-875. https://doi.org/10.1017/s0954579402004108

O'Connor, M., O'Connor, E., Quach, J., Vashishtha, R., & Goldfeld, S. (2019). Trends in the prevalence and distribution of teacher-identified special health-care needs across three successive population cohorts. *Journal of paediatrics and child health, 55*(3), 312-319. https://doi.org/10.1017/s0954579402004108

O'Connor, M., Quach, J., Goldfeld, S., Gold, L., Aston, R., Beatson, R., & Hopkins, D. (2015). *Approaches to the provision of educational support for children and young people with additional health and developmental needs: Autism Spectrum Disorder*s. Centre for Community Child Health, Melbourne, Victoria.

Pacheco-Unguetti, A. P., Acosta, A., Callejas, A., & Lupiáñez, J. (2010). Attention and anxiety: Different attentional functioning under state and trait anxiety. *Psychol Sci, 21*(2), 298-304. https://doi.org/10.1177/0956797609359624

Petersen, S. E., & Posner, M. I. (2012). The attention system of the human brain: 20 years after. *Annu Rev Neurosci, 35*, 73-89. doi:10.1146/annurev-neuro-062111-150525.

Pine, D. S., & Fox, N. A. (2015). Childhood antecedents and risk for adult mental disorders. *Annual Review of Psychology, 66*, 459-485. https://doi.org/10.1146/annurev-psych-010814-015038

Posner, M. I., & Petersen, S. E. (1990). The attention system of the human brain. *Annu Rev Neurosci, 13*(1), 25-42. https://doi.org/10.1146/annurev.ne.13.030190.000325

Posner, M. I., & Rothbart, M. K. (2013). *Development of attention networks.* In B. R. Kar (Ed.), *APA human brain development series. Cognition and brain development: Converging evidence from various methodologies* (p. 61–83). American Psychological Association. https://doi.org/10.1037/14043-004

Raven, J. (1990). Court, JH, & Raven, J.(1990). Coloured progressive matrices. *Manual for Raven's Progressive Matrices and Vocabulary Scales*.

Reimherr, F. W., Marchant, B. K., Gift, T. E., & Steans, T. A. (2017). ADHD and anxiety: clinical significance and treatment implications. *Current psychiatry reports, 19*(12), 109. https://doi.org/10.1007/s11920-017-0859-6

Rueda, M. R., Fan, J., McCandliss, B. D., Halparin, J. D., Gruber, D. B., Lercari, L. P., & Posner, M. I. (2004). Development of attentional networks in childhood. *Neuropsychologia, 42*(8), 1029-1040. doi:10.1016/j.neuropsychologia.2003.12.012

Rzepecka, H., McKenzie, K., McClure, I., & Murphy, S. (2011). Sleep, anxiety and challenging behaviour in children with intellectual disability and/or autism spectrum disorder. *Res Dev Disabil, 32*. doi:10.1016/j.ridd.2011.05.034

Skellern, C., Schluter, P., & McDowell, M. (2005). From complexity to category: responding to diagnostic uncertainties of autistic spectrum disorders. *Journal of paediatrics and child health, 41*(8), 407-412. https://doi.org/10.1111/j.1440-1754.2005.00634.x

State Government of Vicotria- Department of Education and Training (2016). Inclusive Education for All Students with Disabilities and Additional Needs. Retrieved from:

https://www.education.vic.gov.au/Documents/about/department/PSD-Review-Response.pdf

Steimer, T. (2002). The biology of fear-and anxiety-related behaviors. *Dialogues in clinical neuroscience, 4*(3), 231.

Tofoli, S. M., Martins, C. M. S., & Juruena, M. (2011). Early life stress, HPA axis, and depression. *Psychology & Neuroscience, 4*(2), 229-234. https://doi.org/10.3922/j.psns.2011.2.008

Tyler, S. K., & Tucker, D. M. (1982). Anxiety and perceptual structure: Individual differences in neuropsychological function. *Journal of Abnormal Psychology, 91*(3), 210. https://doi.org/10.1037/0021-843X.91.3.210

Van der Hallen, R., Evers, K., Brewaeys, K., Van den Noortgate, W., & Wagemans, J. (2015). Global processing takes time: A meta-analysis on local–global visual processing in ASD. *Psychol Bull, 141*(3), 549. https://doi.org/10.1037/bul0000004

Van Dyck, P. C., Kogan, M. D., McPherson, M. G., Weissman, G. R., & Newacheck, P. W. (2004). Prevalence and characteristics of children with special health care needs. *Archives of pediatrics & adolescent medicine, 158*(9), 884-890. https://doi.org/10.1001/archpedi.158.9.884

Van Eylen, L., Boets, B., Steyaert, J., Wagemans, J., & Noens, I. (2018). Local and global visual processing in autism spectrum disorders: Influence of task and sample characteristics and relation to symptom severity. *J Autism Dev Disord, 48*(4), 1359-1381. https://doi.org/10.1007/s10803-015-2526-2

Vasa, R. A., Carroll, L. M., Nozzolillo, A. A., Mahajan, R., Mazurek, M. O., Bennett, A. E., . . . Bernal, M. P. (2014). A systematic review of treatments for anxiety in youth with autism spectrum disorders. *J Autism Dev Disord, 44*(12), 3215-3229. https://doi.org/10.1007/s10803-014-2184-9

Viggiano, A., Cacciola, G., Widmer, D. A., & Viggiano, D. (2015). Anxiety as a neurodevelopmental disorder in a neuronal subpopulation: Evidence from gene expression data. *Psychiatry research, 228*(3), 729-740. https://doi.org/10.1007/s10803-015-2526-2

Walker, P. M., Carson, K. L., Jarvis, J. M., McMillan, J. M., Noble, A. G., Armstrong, D. J., . . . Palmer, C. D. (2018). How do educators of students with disabilities in specialist settings understand and apply the Australian Curriculum framework? *Australasian Journal of Special and Inclusive Education, 42*(2), 111-126. https://doi.org/10.1017/jsi.2018.13

World Health Organization. (2018). *International classification of diseases for mortality and morbidity statistics* (11th Revision). Retrieved from https://icd.who.int/browse11/l-m/en

World Health Organization. (2001). *International classification of functioning, disability and health: ICF*: World Health Organization.

Chapter 2- Anxiety, Stress and Fear as Potential Core Traits of Children with Additional Health and Developmental Needs

This chapter has been submitted as a manuscript for publication to the 'Australian Journal of Education' and is currently under review.

Cross, A.J, Laycock, R., Goharpey, N., Crewther, S. G. (2020). Anxiety, Stress and Fear as Potential Core Traits of Children with Additional Health and Developmental Needs. *Manuscript submitted for publication to the Australian Journal of Education.*

Anxiety, Stress and Fear as Potential Core Traits of Children with Additional Health and Developmental Needs

Anxiety is a common descriptive term associated with a fearful, emotionally stressful state. All children experience acute episodes of stress and occasional moderate anxiety as a part of normal development. Anxiety is manifested in both adults and children as a number of physical (e.g., muscle tension, racing heart, dry mouth, shortness of breath), physiological (e.g., disturbed sleep and eating patterns), behavioural (e.g. avoidance, withdrawal, restlessness) and cognitive (e.g., apprehension, rumination, difficulty concentrating) responses (American Psychiatric Association [APA], 2013; World Health Organisation [WHO], 2018). Such symptoms are characteristic of both acute state and chronic anxiety (Guillen-Riquelme & Buela-Casal, 2014). Currently the prevalence of clinical anxiety disorders in children as defined by DSM and ICD criteria is thought to be approximately 7% both in Australia (Goodsell et al., 2017) and worldwide (Polanczyk, Salum, Sugaya, Caye, & Rohde, 2015). Thus, this review aims to examine the biological and psychosocial characteristics of childhood anxiety.

Indeed, for the ~20% of Australian children who find the school environment socially and educationally difficult (Goldfeld, O'Connor, Sayers, Moore, & Oberklaid, 2012; O'Connor, Quach & Goldfeld, 2020), daily functioning is also likely to be stressful resulting in persistent anxiety and frequent episodes of acute fear. For these children, commonly referred to as children with Additional Health and Developmental Needs (AHDN), life is likely to be characterised by excessive worry that they cannot explain easily to themselves or others, and which in turn negatively impacts upon many aspects of their school environment such as the ability to attend to teachers or parents, to learn, or to stay on task (i.e., concentrate for long periods of time) (based on Eysenck, Derakshan, Santos, & Calvo, 2007). Sleeping and eating routines are also likely to be perturbed and accompanied by feelings of irritability,

worthlessness, muscle tension and fatigue beyond developmentally appropriate periods (APA, 2013). Anxiety has been shown to have a detrimental impact on cognition, particularly sustained and other types of attention (Basso, Schefft, Ris, & Dember, 1996; Becker et al., 2017; Eysenck & Calvo, 1992; Eysenck et al., 2007; Janelle, 2002; Mankowska, Harciarek, & Heilman, 2020) and working memory (Shackman et al., 2006).

Persistent and chronic childhood anxiety symptoms have often been associated with decreased quality of life (Martinsen et al., 2016) and an enduring vulnerability to clinically defined anxiety and depressive disorders during adolescence and adulthood (Beesdo, Knappe, & Pine, 2009; Koenen et al., 2009; Kovacs & Lopez-Duran, 2010) as well as other associated adolescent and adult mental health issues (McGorry, 2013; Ong, Wickramaratne, Tang, & Weissman, 2006; van Os, 2013). This is particularly true if the childhood anxiety is not responded to appropriately at the time (Beesdo et al., 2009). Furthermore, the fact that anxiety is the most commonly occurring psychiatric disorder in adulthood, and across the lifespan in general, resulting in significant global, social and financial impacts on individuals and the community in general (Bandelow & Michaelis, 2015; Beesdo et al., 2009; Koenen et al., 2009), highlights the need for intervention during childhood.

The group of school children falling into the AHDN category includes those with neurodevelopmental disorders. Such neurodevelopmental disorders are usually characterised by impairments in cognition, communication and behaviour arising from atypical central nervous system development (Dietrich et al., 2005; Jablensky et al., 2001; Moreno-De-Luca et al., 2013; WHO, 2013) and anxiety (Grahame & Rodgers, 2014), though DSM-5 does not include anxiety as a diagnostic criteria. However contrary to DSM-5 in 2013, many later studies have suggested that anxiety contributes to and exacerbates common symptoms of Autism Spectrum Disorder (ASD) such as social and cognitive deficits (Vasa et al., 2014)

and some have gone so far as to argue that chronic anxiety in children should be considered a neurodevelopmental disorder *per se* (Viggiano, Cacciola, Widmer, & Viggiano, 2015).

Anxiety levels in 40-80% of children with ASD are reported to be higher than found in the general population (Bandelow & Michaelis, 2015; Green & Ben-Sasson, 2010; Hollocks, Lerh, Magiati, Meiser-Stedman, & Brugha, 2019; Lidstone et al., 2014; Renno & Wood, 2013; van Steensel, Bögels, & Perrin, 2011; White, Oswald, Ollendick, & Scahill, 2009; Wijnhoven, Creemers, Vermulst, & Granic, 2018). Anxiety is also common in Attention Deficit and Hyperactivity Disorder (ADHD) where 13-50% are reported as clinically anxious (Manassis, Tannock, Young, & Francis-John, 2007).

In an Australian school context, ASD is one of the most important neurodevelopmental disorders to address as it has become the most commonly teacher identified disorder for children with AHDN (O'Connor, O'Connor, Quach, Vashishtha, & Goldfeld, 2019). ASD is a neurodevelopmental disorder that is characterised by restricted interests and deficits in social interaction and communication (APA, 2013) and such children frequently require additional educational support (Boulet, Boyle, & Schieve, 2009). As noted above, individuals diagnosed with ASD are at a particularly increased risk of experiencing mental health problems including anxiety during childhood (Kim, Szatmarxi, Bryson, Streiner, & Wilson, 2000) and as adults (Kim, Szatmari, Bryson, Streiner, & Wilson, 2000; Lugo-Marín et al., 2019; Underwood et al., 2019). This is not surprising, as anxiety has featured in the conceptualisation of ASD since the concept was first formalised by Leo Kanner in the 1940s when he described several early cases as experiencing persistent fearfulness, worry and phobias (Kanner, 1943; Kerns & Kendall, 2014).

Whether anxiety is a core feature or rather a co-morbidity of ASD has long been debated in the literature, given that it can be difficult to differentiate anxiety from symptoms of ASD such as inflexibility in routine and social impairments (Gotham et al., 2013; Green &

Ben-Sasson, 2010; Grondhuis & Aman, 2012; Kerns & Kendall, 2014; Renno & Wood, 2013; Uljarevic, Nuske, & Vivanti, 2016). As a consequence it is even more difficult to assess whether such difficulties have anxiety or autism-based origins with important implications for targeting treatment (Vasa et al., 2016). Past research has also indicated that individuals in the general population who have high levels of non-clinical autism traits experience a similar occurrence of comorbid anxiety and depression compared to those with a clinical diagnosis of ASD (Freeth, Bullock, & Milne, 2013; Ketelaars et al., 2008; Rosbrook & Whittingham, 2010).

The manifestation of anxiety symptoms is also reported across many disorders of neurodevelopmental origin, which the literature suggests may be the cause or result of social and psychological factors such as the inability to cope with uncertainty, language or learning problems (Beitchman et al., 2001), IQ (Grisham et al., 2011; Koenen et al., 2009; Martin et al., 2007), or of feeling different from peers (Flensborg-Madsen, Tolstrup, Sørensen, & Mortensen, 2012; Martin et al., 2007). However, what the literature has not yet adequately considered is whether these social, emotional and academic observations are indeed behavioural symptoms of endemic biological anxiety. What remains to be investigated is the relationship between anxiety in children with AHDN who may not necessarily be clinically diagnosed with a neurodevelopmental or other clinical disorder, but who still struggle at school. Given that these children are likely to experience high levels of anxiety (Cross, Goharpey, Laycock & Crewther, 2019), it is imperative that research be initiated into how best to determine if it possible to characterise the large heterogeneous group of children with AHDN and to determine how best to monitor and intervene early to treat their ongoing anxieties.

Anxiety, Stress and Fear as Central Nervous System Responses

Anxiety (worry about the unknown future), fear (response to immediate threat) and stress (fear and anxiety generated by the ongoing here and now which includes the current social environment) are labels that tend to be semantically dissociable in terms of the time duration with which they are associated and how the situation is perceived by the observer, though all conditions are interlinked behaviourally, psychologically and physiologically and probably have the same biological basis (Duval, Javanbakht, & Liberzon, 2015; Shin & Liberzon, 2010). Subsequently, interaction with stressful environments are complex and incorporate brain driven responses that are most easily defined in terms of the neuroendocrine, autonomic and behavioural systems that have evolved in most vertebrates to enhance an individual's ability to cope with transient threats to safety (Radley, Morilak, Viau, & Campeau, 2015). Stress from a physiological point of view can be broadly considered as a disruption to the body's state of 'harmonious balance' or homeostasis (Johnson, Kamilaris, Chrousos, & Gold, 1992). While transient stress and feelings of anxiety can be considered to be an adaptive process, chronic stress and associated chronic anxiety is also known to be harmful to overall health (Cohen, Janicki-Deverts, & Miller, 2007), especially if endured during development (Teicher, Samson, Anderson, & Ohashi, 2016).

Anxiety is the perception of stress and if the prolonged exposure to stress-related hormones continues can lead to the development of an anxiety disorder. As alluded to above, the chronic aspect is associated with behavioural changes in attention, sleep, appetite, cognitive processes and social engagement (Eysenck, 2000; Eysenck & Calvo, 1992; Racic et al., 2017; Wiegner, Hange, Björkelund, & Ahlborg, 2015). Thus, anxiety can be distinguished from stress as a reaction that is sustained after the potentially fearful threat of the stressor has subsided and often endures for a longer period of time (Davis, Walker, Miles, & Grillon, 2010). Anxiety tends to be more concerned with other non-evidential future potential threats. In regards to the nature of the threatening stimuli, anxiety generally occurs

in relation to the anticipation of a threat and fear as a response to an actual acute threat (Grupe & Nitschke, 2013; Tovote, Fadok, & Lüthi, 2015).

Recent physiological understandings of anxiety have highlighted the roles of the central nervous system and the peripheral autonomic nervous system in fear, stress and anxiety responses (reviewed extensively in Wiener, Rohr, Naor, Villringer, & Okon-Singer, 2020). Earlier understanding of neural systems involved with anxiety occurred in the 1990's-2000's when the role of the amygdala, and limbic system more generally, became more recognised as part of the brain's response to anxiety (LeDoux, 2000; LeDoux & Pine, 2016). However, it has been Eysenck and colleagues (Eysenck & Calvo, 1992; Eysenck, Derakshan, Santos, & Calvo, 2007) who were among the first to develop a model (Attentional Control Theory) that highlights the close relationship between anxiety and cognition. Eysenck's Attention Control Theory (1992; 2007) holds that anxiety impairs efficient processing of the goal directed attentional system by increasing attention to threat related/perceived stimuli and detracting from the original task. In particular this theory proposes that the relationship between anxiety impacts the effectiveness or 'quality of performance' rather than the ability to complete the task. Increased effort to overcome anxiety has also been shown to result in higher blood pressure resulting in emotional dysregulation associated with increased activation of the visually driven subcortical pulvinar amygdala network (that drives rapid activation of the 'social brain') (Wiener et al., 2020).

Neuroanatomy of Fear, Stress and Anxiety Circuits

As discussed above, the differentiation of anxiety and fear has long been debated across the cognitive literature with the consensus being that they are separate but overlapping constructs (Gullone, King, & Ollendick, 2000). From a clinical viewpoint when childhood fears persist beyond typical developmental periods, and are associated with an excessive response beyond normal response times they are defined as persistent anxiety or a phobia

(APA, 2013; Miller, Barrett, & Hampe, 1974; Ollendick, King, & Muris, 2002). Such clinical definitions are supported by more recent neuroscientific understanding of transient fear and anxiety as involving common neuroanatomical circuits with stressors usually being perceived by the visual system (or at least drawing the attention of the eyes) (McFadyen, Mattingley, & Garrido, 2019; Wiener et al., 2020). Relevant visual information is projected from the retina to the superior colliculus for control of appropriate eye movements and thence to pulvinar and V5 (middle temporal area), and parietal attention areas, with the pulvinar also projecting to areas of the amygdala and the hippocampus (Shin & Liberzon, 2010). As alluded to above, this subcortical network of emotional processing areas was previously often referred to as the limbic system (Wiener et al., 2020). More recent evidence demonstrates cortical regions, forming part of the Default Mode Network, as the site of persistent worry and rumination (DeJong, Fox, & Stein, 2019; Misaki et al., 2020; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008; Zhang & Volkow, 2019).

Anxiety is also a physiological concept associated with systemic neurophysiological, endocrinological, psychological and behavioural changes in response to a threatening situation (Steimer, 2002). When used by psychologists however, anxiety is usually described behaviourally rather than defined biopsychosocially (Beidel & Alfano, 2011; Bylsma, Mauss, & Rottenberg, 2016). At a basic evolutionary level, acute anxiety is understood as an adaptive (‘freeze, fight, flight or fright’) response to threat, underpinned by complex physiological responses involving autonomic, neural, cardiovascular and hormonal responses via the sympathetic nervous system in an attempt to achieve and re-establish homeostasis (Bracha, 2004; Bracha, Williams, & Bracha, 2004; Gladwin, Hashemi, van Ast, & Roelofs, 2016; Jansen, Van Nguyen, Karpitskiy, Mettenleiter, & Loewy, 1995). However if, as alluded to earlier, anxiety becomes a chronic persistent trait, it tends to be maladaptive and generally interferes with the ability to activate and maintain attention (i.e., concentration duration)

(Betts, Mckay, Maruff, & Anderson, 2006; Moran, 2012). Chronic anxiety also interferes with abilities relating to daily functioning such as academic learning and social interactions in young children and has been reported to lead to a lifelong trajectory of pathological levels of fearfulness (Broeren, Muris, Diamantopoulou, & Baker, 2013). Thus from a clinical viewpoint, if anxiety is not addressed appropriately in childhood then it is increasingly recognised as an important clinical risk factor for lifelong mental illness and decreased quality of life (McGorry, 2013).

Attention and Anxiety

On a day to day level it is well established that anxiety impacts on the way in which the world is perceived, however the relationship between attention and anxiety remains complex (Heeren & McNally, 2016) but of great importance to a young child's ability to learn in a school situation. As indicated earlier, consciously directed behaviours are dependent on attention to something in the environment, requiring working memory and usually salience to create context that is influenced by emotions (Eysenck & Calvo, 1992; Eysenck et al., 2007; Wiener et al., 2020). As a result, emotions are known to impact on cognition and perception, therefore affecting sustained attention and behaviours (Brereton, Tonge, & Einfeld, 2006; Ellenbogen & Schwartzman, 2009; Reinholdt-Dunne, Mogg, & Bradley, 2009). Thus, for children with AHDN, the combination of chronically heightened anxiety and as a consequence also impaired attention, means it would be expected that the ability to engage in the classroom environment or appropriately in social interactions would be significantly impaired.

Attention has long been referred to as a physiological cerebral blood based competitive process (James, 1890) whereby the most salient information is prioritised in the face of other information competing for limited cognitive resources of the individual (Fan et al., 2012; James, 1890; Markett et al., 2014). 'Attention' when used clinically by

psychologists is a particularly broad term with variable theoretical explanations (Johnston & Pashler, 1998; Näätänen, 2018) but primarily relates to the ability to stay focussed on a task (Betts et al., 2006; Moran, 2012). By comparison the perspectives of experimental psychologists incorporate aspects of transient eye movement-driven spatial and temporal attention that is needed for rapid on-line selection of salient goal-directed information processing. Adopting this latter broad perspective, this thesis will focus on three key theoretical understandings of attention (Goodale & Westwood, 2004; Johnson, 2005; Navon, 1977; Posner & Petersen, 1990).

In all primates including humans, the visual system predominates in driving attention and working memory and is central to all goal directed behaviour (Corbetta & Shulman, 1998; Corbetta & Shulman, 2002; Zeil, Boeddeker, & Hemmi, 2008). Until recently the conscious human visual system has usually been conceptualised (Goodale & Milner, 1992) as two retino-geniculo cortical pathways implicated in transient eye movement driven attention and behaviour with the dorsal stream (the 'where' action pathway) and the ventral stream (the 'what' or perception pathway) (Goodale, Króliczak, & Westwood, 2005). More recently interest has shifted back to the third evolutionarily oldest stream, the retina-brainstem superior colliculus-pulvinar-amygdala pathway that is fast and predominantly important in vision postnatally and in emotional processing later in life (Goodale & Westwood, 2004; Johnson, 2005) (Figure 2.1 below) and is now very much tied to the impairment in emotion regulation associated with both acute and chronic anxiety and depression (Weiner et al., 2020). Hence, children who experience chronic anxiety are likely to have the lowest level of top-down executive control using the less consciously, less verbally controlled subcortical pathway.

In terms of development, the more rapidly conducting of the cortical streams that drive attention and eye movements, the dorsal stream has been shown to be suspectable and

vulnerable to impairment during development (Braddick, Atkinson, & Wattam-Bell, 2003; Brown & Crewther, 2017; Klaver et al., 2008; Lovegrove, Bowling, Badcock, & Blackwood, 1980; Stein & Walsh, 1997). The dorsal stream is predominantly derived from the faster conducting retinal magnocellular ganglion cells and is important for rapid activation and direction of selective visual attention (Bullier, 2001; Laycock, Crewther, & Crewther, 2007). Impaired dorsal stream functioning is proposed to exist in many neurodevelopmental and psychiatric disorders including ASD (Pellicano, Gibson, Maybery, Durkin, & Badcock, 2005; Spencer et al., 2000), Williams Syndrome (Atkinson et al., 1997) and Schizophrenia (Schechter, Butler, Silipo, Zemon, & Javitt, 2003). Similar impairments are also known to extend to subthreshold autism-like neurotypical samples (Sutherland & Crewther, 2010).

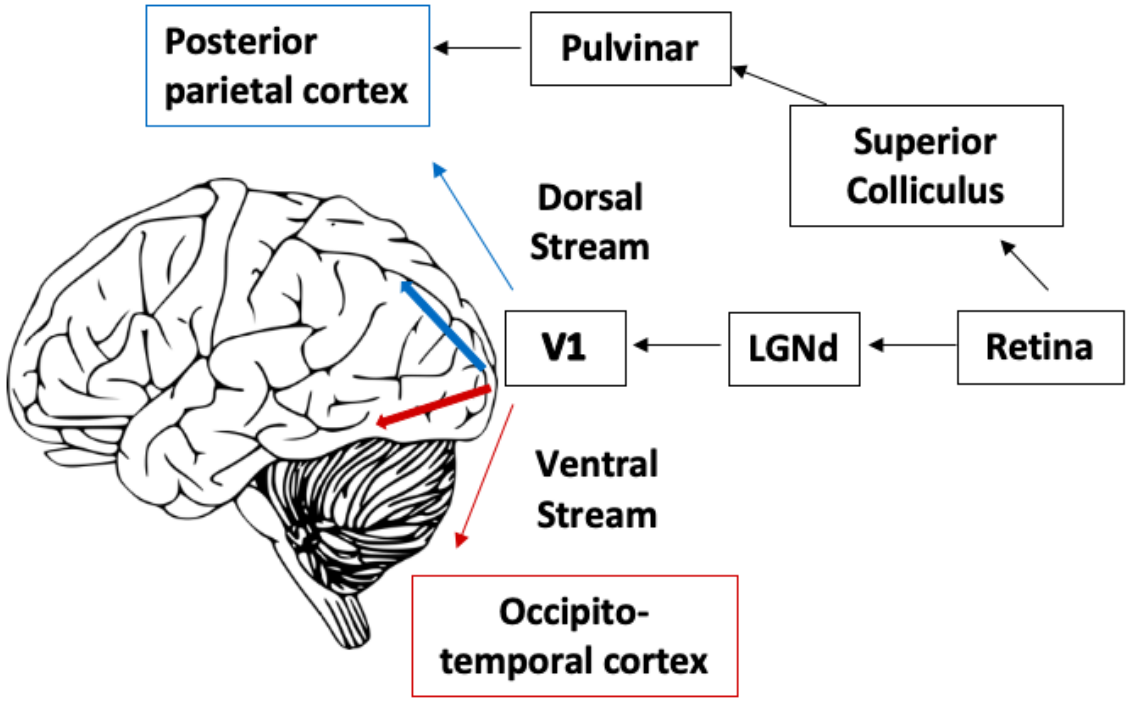


Figure 2.1. Representation of Key Visual System Pathways for Perception and Action. Adapted from "An evolving view of duplex vision: separate but interacting cortical pathways

for perception and action" by M. A. Goodale and D. A. Westwood, 2004 *Current Opinion in Neurobiology, 14(2),* pg. 204.

Dorsal stream impairments have implications for learning as noted above but also for survival in the sense of the need to be able to rapidly acquire meaning or 'gist' of the whole visual scene ('global precedence') and then secondly to access the detailed ('local') parts to form a global picture (Navon, 1977). Indeed, most individuals inherently sample a whole scene meaning that they more readily first attend to a global view of the world, rather than to specific details. On the other hand, a tendency to preferentially extract local details has been reported amongst those with depression and trait or chronic anxiety (Basso et al., 1996; Tyler & Tucker, 1982) as well as those on the autism spectrum (Van der Hallen, Evers, Brewaeys, Van den Noortgate, & Wagemans, 2015). Whether the underlying mechanism for this phenomenon is due to an enhanced ability to process local information (Enhanced Perceptual Functioning theory) (Mottron & Burack, 2001), or a difficulty extracting global meaning (Weak Central Coherence theory) (Happé & Frith, 2006), or a preference for detail but ability to operate either way continues to be debated in the literature (Van Eylen, Boets, Steyaert, Wagemans, & Noens, 2018). Regardless, emotionally salient stimuli are usually prioritised (Barrett & Bar, 2009) with global or 'gist' level information generally found to be processed through the direct superior colliculus- pulvinar- amygdala pathway (Méndez-Bértolo et al., 2016), whereas it is local details that are more readily processed in individuals experiencing chronic anxiety (Tyler & Tucker, 1982).

Attention is also often theoretically conceptualised as a cognitive model of three separate networks, identified as relating to alerting, orienting and executive control, whereby each network has an anatomical basis forming an attention system in the brain (Petersen & Posner, 2012; Posner & Petersen, 1990). Much of the research examining attention networks utilises the Attention Network Task (ANT), which is now a widely used attention-based task

assessing these conceptual networks (Neuhaus et al., 2010; Posner & Rothbard, 2013; Rueda et al., 2004). Indeed both acute and chronic anxiety have been shown to have differential effects on these three attention networks, with some evidence that trait anxiety has deleterious effects on the executive control network, while state anxiety is associated with hyperfunctioning of the alerting and orienting (Pacheco-Unguetti, Acosta, Callejas, & Lupiáñez, 2010)

Clinical Diagnoses of Anxiety

Clinical diagnoses as drawn from DSM-5, defined anxiety in adults and children as an umbrella term for a group of disorders characterised by a disproportionate anticipatory response to a future threat that is closely associated with a fear-based response to real or imagined immediate threats that result in behaviours such as avoidance (APA, 2013). Generally speaking, the threshold for a diagnosis of an anxiety disorder in children is less than in adults to allow for flexibility in characterisation. For example, in Generalised Anxiety Disorder children only require one of six generalised anxiety physical symptoms whereas adults require three over a six-month period (APA, 2013). More specially, the DSM-5 categorises a number of specific anxiety disorders including Separation Anxiety Disorder; Selective Mutism; Specific Phobia; Social Anxiety Disorder; Panic Disorder; Agoraphobia; Generalised Anxiety Disorder; and Anxiety Disorder- Substance/ Medication Induced or Due to Another Medical Condition (APA, 2013). Acknowledging the malleable nature of the categorisation of mental disorders, Obsessive-Compulsive and Trauma and Stressor Related Disorders, previously listed as anxiety disorders in DSM-IV, have been moved to their own categories in the DSM-5 (Stein, Craske, Friedman, & Phillips, 2014). However, this decision remains controversial, given that many researchers and clinicians consider Obsessive Compulsive/Trauma based disorders to be anxiety in nature (Abramowitz & Jacoby, 2014; Friedman et al., 2011).

Whether chronic anxiety can be defined differently in childhood compared with in adulthood in terms of observable behaviours is debateable. However, this leads to many broader anxiety-related behaviours in children being overlooked by psychologists (Baumeister, Vohs, & Funder, 2007) and other primary health professionals such as GP's (Aydin et al., 2020; O'Brien, Harvey, Young, Reardon, & Creswell, 2017). Such lack of diagnostic recognition has negative impact on the availability and access to treatment for children. Indeed there is poor understanding and recognition of childhood anxiety in the general population (Furnham & Lousley, 2013; Paulus, Wadsworth, & Hayes-Skelton, 2015), including educators (Snyder et al., 2009) and parents (Reardon, Harvey, Young, O'Brien, & Creswell, 2018) particularly in younger children. This situation particularly affects undiagnosed children who experience school-based problems such as those among the child population with AHDN. In addition, school-based childhood anxiety is often masked by other behaviours such as social withdrawal (Rapee, Kennedy, Ingram, Edwards, & Sweeney, 2005), task or situation avoidance (Whiteside, Gryczkowski, Ale, Brown-Jacobsen, & McCarthy, 2013), changes in attention or concentration (Mogg et al., 2015), disruptive behaviour (Bubier & Drabick, 2009), fidgeting (Okazaki, Liu, Longworth, & Minn, 2002) and/or problems sleeping (Fletcher et al., 2016).

Underlying physiological markers of anxiety may also be expressed as somatic complaints such as headaches and stomach aches (Beidel, Christ, & Long, 1991) or seen as 'just' worries and fears (Borkovec, Ray, & Stober, 1998) but are not recognised as persistent symptoms of chronic maladaptive anxiety or even depression (Nolen-Hoeksema et al., 2008). Consequently, diagnostic categorisation based on behavioural symptoms cannot be solely relied upon to detect anxiety disorders in young people and may also be more comprehensively informed by objective biological measures (Aldao & De Los Reyes, 2016).

Worry and Cognitive Symptoms of Anxiety

Vasey and Daleiden (1994) defined worry as "an anticipatory cognitive process involving repetitive, primarily verbal thoughts related to possible threatening outcomes and their potential consequences" (p. 186). As alluded to in Chapter 1, all children express worry and fear as part of typical development (Muris, Meesters, Merckelbach, Sermon, & Zwakhalen, 1998). It can therefore be difficult for parents, teachers and health professionals to differentiate normal from pathological worrying (Caes, Fisher, Clinch, Tobias, & Eccleston, 2016). Wilson (2010) summarises that normal and pathological levels of worry in children are differentiated by higher levels of intensity and poorer control over worries but not generally by the frequency of worry itself. The primary content of worry is developmentally dependent on a child's age and cognitive capacity. Reflecting this, Vasey, Crnic and Carter (2004) and Muris et al. (1998) highlight that worries become increasingly complex throughout childhood and progress from worrying primarily about physical health to school performance and behavioural norms/ social evaluation with age. Muris et al. (2002) propose that this is likely due to the emergence of the ability to consider multiple future possibilities including the potential of negative consequences.

Accordingly, most children do not recognise that they feel anxious and are not able to identify and verbalise their anxiety before seven years of age, consistent with Piaget's preoperational stage defined by egocentric thinking (Piaget, 1952). According to DSM-5 criteria, worry is most characteristic of Generalised Anxiety Disorder (APA, 2013), though it is also present in all other anxiety disorders (Wilson, 2010), including in children and adolescents (8-18 years) (Rabner, Mian, , Langer, Comer & Pincus, 2017), and in other psychiatric disorders such as depression (Olatunji, Wolitzky-Taylor, Sawchuk, & Ciesielski, 2010). Similarly, other forms of repetitive negative thinking such as chronic rumination (Ehring & Watkins, 2008; McEvoy, Watson, Watkins, & Nathan, 2013; Nolen-Hoeksema et al., 2008; Smith & Alloy, 2009), and intolerance of uncertainty (Einstein, 2014; McEvoy &

Erceg-Hurn, 2016) are identified in anxiety and mood disorders across the literature and are referred to as the cognitive, emotional and behavioural ways a person responds in an uncertain situation (Dugas, Freeston, & Ladouceur, 1997; Dugas, Gosselin, & Ladouceur, 2001; Osmanağaoğlu, Creswell, & Dodd, 2018).

What is apparent from the above discussion is that regardless of the conceptualisation of anxious thinking styles, such ideas share many underlying physiological processes and behaviours associated with biological markers of chronic stress and anxiety (Everly & Lating, 2013) including increased heart rate (Coll, Kagan, & Reznick, 1984), higher blood pressure and cortisol, lower heart rate variability, lower respiratory sinus arrythmia, higher skin conductive level and greater left frontal activity (Aldao, Mennin, & McLaughlin, 2013; Delgado et al., 2009; Hofmann et al., 2005; Ottaviani et al., 2016; Verkuil, Brosschot, Borkovec, & Thayer, 2009), amygdala changes (Kalin, 2017; Schmidt et al., 1997), and default network activity (Zhang & Volkow, 2019). Subsequently, these chronic physiological responses contribute to anxious behaviours such as sleep disturbance (Pillai & Drake, 2015) and impaired problem solving ability (Ottaviani et al., 2014).

Risk Factors and Aetiology of Anxiety Disorders

Anxiety disorders are moderately heritable (between 30-50%), suggesting that both genetics and environmental factors contribute to their development (Bartlett, Singh, & Hunter, 2017; Eley et al., 2003; Hettema, Neale, & Kendler, 2001; Hettema, Prescott, Myers, Neale, & Kendler, 2005; Shimada-Sugimoto, Otowa, & Hettema, 2015). This reflects the well-established diathesis-stress model, acknowledging the relationship between predisposing genetic factors and stressors in the onset of psychiatric disorders (Smoller, 2016). Accordingly, risk factors for the development of anxiety disorders can be identified very early in life. There is much research to support behavioural inhibition, an anxious temperament style and enduring pattern of behaviour of increased sensitivity, wariness and

avoidance in novel or unfamiliar situations (Coll et al., 1984; Hudson, Dodd, Lyneham, & Bovopoulous, 2011; Pérez-Edgar & Fox, 2005), in infancy or early childhood as being associated with anxiety disorders including social and generalised anxiety later in life (Hudson et al., 2011; Muris, van Brakel, Arntz, & Schouten, 2011; Pérez-Edgar & Guyer, 2014).

Families from both genetic and environmental viewpoints evidently play an important role in the onset and maintenance of childhood anxiety (Bögels & Brechman-Toussaint, 2006). Significantly increased levels of anxiety are observed in children of parents with anxiety disorders (Beidel & Turner, 1997) as well as in first degree relatives of children with anxiety disorders (Last, Hersen, Kazdin, Orvaschel, & Perrin, 1991). Thus, anxious parenting styles strongly influence familial aggregation of anxiety (Van Gastel, Legerstee, & Ferdinand, 2009) and children may be exposed to modelling of fear and avoidance behaviours from their parents (Percy, Creswell, Garner, O'Brien, & Murray, 2016). Not surprisingly, development of anxiety or mitigation of anxiety is mediated by an anxious parenting style, parent stress and quality of relationship between the parent and the child (Platt, Williams, & Ginsburg, 2016). In particular, overprotective and critical parenting styles are most associated with an increased risk of anxiety disorders in the offspring of both anxious and non-anxious parents (McLeod, Wood, & Weisz, 2007; Rapee, 1997; Segrin, Woszidlo, Givertz, & Montgomery, 2013). Parents with their own anxiety disorder are more likely to exhibit lower warmth and sensitivity to their children due to their preoccupation with internal distress, thus resulting in either overinvolvement or increased punishment in their parenting style (Bayer, Sanson, & Hemphill, 2006).

From a neurodevelopmental perspective, maternal stress while the child is in utero is another significant risk factor for later development of anxiety in the child. From the critical earliest phase of embryonic development, maternal stress and anxiety is associated with

inflammation that inevitably affects maternal immune system functioning (Vasistha et al., 2019) that can affect both maternal and embryonic gene transcription (i.e., epigenetic changes), leading to long term influences on brain development (Bale et al., 2010; Litzky et al., 2018). Maternal immune activation, for instance, is linked to the development of both anxiety and ASD in the child (Estes & McAllister, 2016; Solek, Farooqi, Verly, Lim, & Ruthazer, 2018). Maternal stress in the antenatal period is also known to affect foetal development (Van den Bergh, Mulder, Mennes, & Glover, 2005).

At birth, these infants will demonstrate neurological signs known to be physiological markers of stress, including cardiac vagal tone overactivity and perform worse on behavioural examinations (Van den Bergh et al., 2005). Antenatal exposure to stress and anxiety for the infant is also reported to be associated with negative effects on interactions with caregiver, language, attention and emotional regulation in infancy, lower academic performance, poor attention, hyperactivity and behavioural difficulties in childhood; and impulsive behaviour, ADHD and behavioural disorders in adolescence (Van den Bergh, Van Calster, Smits, Van Huffel, & Lagae, 2008). There is no single cause for the enduring outcomes of early exposure to anxiety and stress, although a likely contributor is cortisol crossing the placenta (Van den Bergh et al., 2005). A general susceptibility to psychopathology persists into adulthood, highlighting the intertwined biological relationship between anxiety, cognition and behaviour.

Currently there is no evidence that single genes cause an anxiety disorder, though there is emerging evidence for the role of a range of individual genes (see Shidama-Sugimoto, Otow & Hettema, 2015 for a review) and more generalised metabolic and bioenergetic pathways and epigenetic changes, that are known in other physiologically stressful situations to be affected by prolonged environmental stressors and anxious behaviours (Park et al., 2019). Genome-wide analyses have also implicated several candidate

genes in anxiety regulation in both animal and human models (Gottschalk & Domschke, 2017; Morris-Rosendahl, 2002; Norrholm & Ressler, 2009; Sokolowska & Hovatta, 2013). These include phosphodiesterase 4B (PED4B) for anxiety in relation to chronic stress (Meier et al., 2018) and associated negative educational outcomes (Meier et al., 2019), glutamic acid decarboxylase 2 (Gad2) in anxiety disorder predisposition and regulator of g-protein signalling 2 (Rgs2) in emotionality (Rangasamy, D'Mello, & Narayanan, 2013; Sokolowska & Hovatta, 2013). The role of stress induced epigenetic changes in the genome are now being viewed as offering potential therapeutic treatments for anxiety disorders especially those associated with early childhood trauma (Park et al., 2019). Adverse childhood events, such as severe illness, trauma and exposure to violence, are linked to the development of anxiety disorders in childhood (Spinhoven et al., 2010) and are evident in the accelerated shortening of telomere length in DNA to the development of anxiety.

Assessment of Anxiety

Evidence-based assessment of anxiety in children is generally aligned to DSM or ICD criteria conducted as a diagnostic interview, using instruments such as the Diagnostic Interview Schedule for Children (Rapee, 2012). Although structured diagnostic interviews are considered the 'gold standard' method for the assessment of childhood anxiety, they are seldom used by clinicians in the community presumably due to limited access to assessment instruments and time availability, as well as a current belief that they are not helpful in clinical practice (Whiteside, Sattler, Hathaway, & Douglas, 2016). Self or parent report questionnaires are commonly used to assess the presence and the severity of anxiety symptoms in children (Rapee, 2012). Instruments such as the Spence Children's Anxiety Scale (SCAS) (Nauta et al., 2004; Spence, Barrett, & Turner, 2003) and the Screen for Anxiety and Related Disorders (SCARED) (Birmaher et al., 1997) are commonly utilised and

are often considered to be advantageous in assessing anxiety as they are more time and cost efficient compared to clinical interviews (Nauta, 2005).

Enhanced Approaches to Clinical Diagnoses of Anxiety

Acknowledging the limitations of assessing anxiety and other clinical diagnoses when relying on diagnostic categorisation, there is currently growing criticism challenging the nosology of anxiety and other neurodevelopmental and psychiatric disorders as categorised in the DSM-5 and ICD-11. Of note, emerging approaches to diagnosis have emphasised a dimensional rather than categorical conceptualisations of disorders, such as Research Domain Criteria (RDoC) (Cuthbert, 2014) and Hierarchical Taxonomy of Psychopathology (HiTOP) (Kotov, Krueger, & Watson, 2018). RDoC continues to use the concept of mental disorders even though it has been established to highlight key domains of human behaviour and functioning in the context of biological (as well as behavioural and environmental) systems (Cuthbert, 2014; Insel & Cuthbert, 2015). These domains include Negative Valence (anxiety); Positive Valence (motivation for reward when engaging in different tasks); Cognitive (particularly attention and visual processing); Social (ability to communicate socially) and Arousal/Regulatory (sleep and biological processes of anxiety) (Insel et al., 2010; Insel, 2014).

However in regards to translating the theoretical conception of clinical frameworks that prioritise biological processes in clinical practice for psychologists, the RDoC framework remains a developing evidence base (McKay & Tolin, 2017) and has so far provided little guidance for clinicians (Weinberger, Glick, & Klein, 2015). Thus, RDoC has been criticised for overly emphasising biological factors despite the framework's attempts to be inclusive of social and environmental contributions to the development and maintenance of clinical disorders (Franklin, Jamieson, Glenn, & Nock, 2015; Hershenberg & Goldfried, 2015). Similarly, although HiTOP has a strong clinical focus (Hopwood et al., 2019; Ruggero

et al., 2019), the theory remains in its infancy and requires more research in order to provide a mainstream evidence based approach. It is subsequently imperative that an integrated approach that addresses the current criticisms of RDoC and HiTOP, and bridges the gap between experimental research and clinical approach, is applied to psychological practice, such as utilising the well-established Biopsychosocial Model (Engel, 1977).

The Biopsychosocial Model of Anxiety

The Biopsychosocial Model (Engel, 1977) is a complex and multifaceted comprehensive framework contending that biological, psychosocial and social factors all contribute to the development of physical and psychological disorders. Comprehensive biopsychosocial formulation from a psychological point of view incorporates predisposing contributions (e.g. genetics), precipitating (e.g. stressors) and perpetuating factors (what keeps the problem going- e.g. inadequate support at school) and the child's strengths or protective factors (Selzer & Ellen, 2014). While the Biopsychosocial Model is considered by many to be a useful clinical tool, it has been criticised for being overly simplistic, lacking a clear evidence base, and not accounting for the complexities of mental health, particularly from the field of psychiatry (Álvarez, Pagani, & Meucci, 2012; Ghaemi, 2011). Furthermore, although conceived as an advance on exclusive emphasis on biological factors (i.e., biomedical model), there have been concerns as to what determines an over or under emphasis of biological, psychological or social elements. Indeed it has been argued that psychiatry, despite adopting the biopsychosocial model, still has an overwhelming emphasis on the biological (Benning, 2015). On the other hand, the biopsychosocial model is considered central to psychological practice and has been proposed as a way of increasing the evidence base of the profession by providing a scientific framework to bring together varied theoretical perspectives (Karunamuni, Imayama, & Goonetilleke, 2020; Melchert, 2007; Melchert, 2010).

In general, psychologists tend to prioritise psychological and social elements in their assessments and subsequently overlook biological contributions (Suls & Rothman, 2004). This is reflected in international clinical practice guidelines, where 'gold-standard' approaches do not include the examination of biological processes. Guidelines for the management of Generalised Anxiety Disorder and Panic Disorder by the National Institute of Clinical Excellence, for instance, fail to include assessment of biological indicators of anxiety beyond differentiating panic from an acute medical condition in an Emergency Department setting (National Institute for Health and Care Excellence, 2011). Biological factors are also important in treatment where there is potential for the implementation of individualised management strategies that accurately pinpoint targets for therapeutic change such as sleep or irritability in anxiety and is measured by objective biological outcomes (Hofmann, Curtiss, & McNally, 2016). The implementation of methods to assess biological contributions of anxiety in clinical assessment settings is likely to be accessible to psychologists through physiological, behavioural and cognitive biomarkers. A behavioural 'biomarker' in this thesis is defined as a measure of biological processes, and as noted above, includes biologically driven behaviours such as sleep and anxiety. The term 'biological' in this context can be broad and includes such factors that may have led to the development of the child's current diagnoses and ongoing difficulties, including genetics, physical conditions and medications (Campbell & Rohrbaugh, 2013).

Biological Measures of Anxiety

A biopsychosocial assessment and subsequent treatment of anxiety in children should prioritise both psychological information and physiological data in order to ascertain a more comprehensive understanding of the presentation (e.g. changes in cortisol that may not be evident in behaviour), to confirm the relationship between biological processes and behaviours and to guide the most appropriate interventions (Kagan, Reznick, & Snidman,

1987). Psychologists generally assess these responses through client or parent self-report questionnaires more often than behavioural observation (Baumeister et al., 2007) or objective physiological data in adults and children (Aldao & De Los Reyes, 2016; De Los Reyes & Aldao, 2015). On the other hand, experimentalists have long used the physiological measures of neuroendocrine arousal responses such as increased cortisol, heart rate, galvanic skin response and blood pressure, but psychological and physiological responses are seldom studied together (Baum, Grunberg, & Singer, 1982). Despite this, psychophysiological research suggests that there is often a discrepancy between subjective reports and objective biological measures of anxiety (Blechert & Wilhelm, 2014).

Biomarkers of acute anxiety are associated with sympathetic nervous system responses, including increased heart rate, temperature changes and hot flushes, sweating, nausea, shaking and changes in bowel movements (Richards & Bertram, 2000). For instance, the DSM-5 includes symptoms of muscle tension and associated features to include somatic symptoms (sweating, nausea, diarrhea) and symptoms of autonomic arousal (heart rate, shortness of breath, dizziness) for a diagnosis of Generalised Anxiety Disorder (APA, 2013), though these are based on self-report rather than direct measurement.

Rather than relying on autonomic arousal, the identification of chronic anxiety may be evident in child behaviours recognisable by professionals, teachers and parents such as changes to eating and sleeping patterns. Such behaviours are likely to provide clinical information in children who will sometimes not be able to voice their worries. In children with ASD and their parents, there is generally a discrepancy in reported levels of anxiety - i.e., those with ASD tend to underreport their symptoms and this is often contributed to by the child's communication difficulties (Kalvin et al., 2020; Magiati, Chan, Tan, & Poon, 2014). Changes in eating behaviour are common associations with anxiety, whereby the cortisol response to stress is associated with increased or decreased snacking and food

consumption (Newman, O'Connor, & Conner, 2007). Sleep also shows a bidirectional relationship with anxiety (Alfano, Ginsburg, & Kingery, 2007) and is known to affect behaviour in both typical and atypical development. Children who have ASD or an Intellectual Disability (ID) are at an increased risk of experiencing sleep problems compared to typically developing peers (Rzepecka, McKenzie, McClure, & Murphy, 2011). Importantly, sleep problems and anxiety are thought to exacerbate challenging behaviours expressed in children with neurodevelopmental disorders (May, Cornish, Conduit, Rajaratnam, & Rinehart, 2015; Rzepecka et al., 2011).

Childhood sleep difficulties are associated with generalised anxiety, increased behavioural and physical health issues and attention problems (Fletcher et al., 2016; James & Hale, 2017; Simola, Liukkonen, Pitkäranta, Pirinen, & Aronen, 2014). Early sleep disturbances often persist beyond childhood (Sneddon, Peacock, & Crowley, 2013; Thome & Skuladottir, 2005) and are predictive of anxiety in adulthood but not depression where symptoms are more associated with low mood and loss of interest and motivation (Gregory, Caspy, Elley, Moffitt, O'Connor, & Coulton, 2005) and often prolonged sleep patterns (Dregan & Armstrong, 2010). This highlights the importance of exploring sleep in anxiety assessment despite the fact that common sleep measures used in research, such as actigraphy or smart watches which are relatively easy to utilise, are not commonly considered in clinical practice.

Conclusions and Future Directions

The aim of this review was to explore various biopsychosocial perspectives in the conceptualisation of childhood anxiety. In order to determine an evidence-based understanding of anxiety, current neuroanatomical and cognitive definitions of anxiety were explored, and the literature of the aetiology of anxiety and associated risk factors was summarised. It was clear from this review that biological underpinnings are central to the

manifestation of anxiety symptoms and should be used to inform clinical assessment of anxiety in children beyond diagnostic categorisation. Accordingly, this review highlights that the physiology of anxiety is likely to substantially affect a child's ability to maintain concentration and engagement in educational and social contexts and should therefore be fundamental to informing the clinical assessment and treatment of anxiety in children. Acknowledging that contemporary experimental research advocating for biological based approaches such as the RDoC framework requires broad clinical applicability, a biopsychosocial approach is proposed as a way of enhancing current methods of recognising anxiety.

Despite extensive research, the bridging of experimental science and clinical psychology remains inadequate in the context of childhood anxiety. Further research is needed to explore how anxiety can be best recognised biopsychosocially in children, particularly in 'at risk' populations such as those with AHDN (O'Connor, Quach, & Goldfeld, 2020). These investigations are likely to have far reaching preventative impacts by providing an opportunity to recognise and treat both disordered and subthreshold anxiety that may alter the trajectory of development for any child.

References

Abramowitz, J. S., & Jacoby, R. J. (2014). Obsessive-compulsive disorder in the DSM-5. *Clinical Psychology: Science and Practice*, *21*(3), 221-235.

Aldao, A., & De Los Reyes, A. (2016). Introduction to the special section: Toward implementing physiological measures in clinical assessments of adult mental health. *Journal of psychopathology and behavioral assessment, 38*(1), 1-4. http://doi.org/10.1007/s10862-015-9521-y

Aldao, A., Mennin, D. S., & McLaughlin, K. A. (2013). Differentiating worry and rumination: Evidence from heart rate variability during spontaneous regulation. *Cognitive therapy and research, 37*(3), 613-619. http://doi.org/10.1007/s10608-012-9485-0

Alfano, C. A., Ginsburg, G. S., & Kingery, J. N. (2007). Sleep-related problems among children and adolescents with anxiety disorders. *Journal of the American Academy of Child & Adolescent Psychiatry, 46*(2), 224-232. http://doi.org/10.1097/01.chi.0000242233.06011.8e

Álvarez, A. S., Pagani, M., & Meucci, P. (2012). The clinical application of the biopsychosocial model in mental health: a research critique. *American journal of physical medicine & rehabilitation, 91*(13), S173-S180. http://doi.org/10.1097/PHM.0b013e31823d54be

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (DSM-5®)*: American Psychiatric Pub.

Atkinson, J., King, J., Braddick, O., Nokes, L., Anker, S., & Braddick, F. (1997). A specific deficit of dorsal stream function in Williams' syndrome. *Neuroreport, 8*(8), 1919-1922.

Aydin, S., Crone, M. R., Siebelink, B. M., Vermeiren, R. R., Numans, M. E., & Westenberg, P. M. (2020). Recognition of anxiety disorders in children: a cross-sectional vignette-based survey among general practitioners. *BMJ open*, *10*(4), e035799. http://doi.org/10.1136/bmjopen-2019-035799

Bale, T. L., Baram, T. Z., Brown, A. S., Goldstein, J. M., Insel, T. R., McCarthy, M. M., . . . Susser, E. S. (2010). Early life programming and neurodevelopmental disorders. *Biol Psychiatry*, *68*(4), 314-319. http://doi.org/10.1016/j.biopsych.2010.05.028

Bandelow, B., & Michaelis, S. (2015). Epidemiology of anxiety disorders in the 21st century. *Dialogues in clinical neuroscience*, *17*(3), 327.

Barrett, L. F., & Bar, M. (2009). See it with feeling: affective predictions during object perception. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *364*(1521), 1325-1334. http://doi.org/10.1093/acprof:oso/9780195395518.003.0042

Bartlett, A. A., Singh, R., & Hunter, R. G. (2017). Anxiety and epigenetics. In *Neuroepigenomics in Aging and Disease* (pp. 145-166): Springer.

Basso, M. R., Schefft, B. K., Ris, M. D., & Dember, W. N. (1996). Mood and global-local visual processing. *Journal of the International Neuropsychological Society*, *2*(3), 249-255. http://doi.org/10.1017/S1355617700001193

Baum, A., Grunberg, N. E., & Singer, J. E. (1982). The use of psychological and neuroendocrinological measurements in the study of stress. *Health psychology*, *1*(3), 217. http://doi.org/10.1037/0278-6133.1.3.217

Baumeister, R. F., Vohs, K. D., & Funder, D. C. (2007). Psychology as the science of self-reports and finger movements: Whatever happened to actual behavior? *Perspectives on Psychological Science*, *2*(4), 396-403. http://doi.org/10.1111/j.1745-6916.2007.00051.x

Bayer, J. K., Sanson, A. V., & Hemphill, S. A. (2006). Parent influences on early childhood internalizing difficulties. *Journal of Applied Developmental Psychology, 27*(6), 542-559. http://doi.org/10.1016/j.appdev.2006.08.002

Becker, K. R., Plessow, F., Coniglio, K. A., Tabri, N., Franko, D. L., Zayas, L. V., . . . Eddy, K. T. (2017). Global/local processing style: Explaining the relationship between trait anxiety and binge eating. *International Journal of Eating Disorders, 50*(11), 1264-1272. http://doi.org/10.1002/eat.22772

Beesdo, K., Knappe, S., & Pine, D. S. (2009). Anxiety and anxiety disorders in children and adolescents: developmental issues and implications for DSM-V. *Psychiatric Clinics of North America, 32*(3), 483-524. http://dx.doi.org/10.1016/j.psc.2009.06.002

Beidel, D. C., & Alfano, C. A. (2011). *Child anxiety disorders: A guide to research and treatment*: Routledge.

Beidel, D. C., Christ, M. A. G., & Long, P. J. (1991). Somatic complaints in anxious children. *Journal of abnormal child psychology,* 19(6), 659-670. http://doi.org/10.1007/BF00918905

Beidel, D. C., & Turner, S. M. (1997). At risk for anxiety: I. Psychopathology in the offspring of anxious parents. *Journal of the American Academy of Child & Adolescent Psychiatry, 36*(7), 918-924. http://doi.org/10.1097/00004583-199707000-00013

Beitchman, J. H., Wilson, B., Johnson, C. J., Atkinson, L., Young, A., Adlaf, E., . . . Douglas, L. (2001). Fourteen-year follow-up of speech/language-impaired and control children: Psychiatric outcome. *Journal of the American Academy of Child & Adolescent Psychiatry, 40*(1), 75-82. http://doi.org/10.1097/00004583-200101000-00019

Benning, T. B. (2015). Limitations of the biopsychosocial model in psychiatry. *Advances in Medical Education and practice, 6*, 347.

Betts, J., Mckay, J., Maruff, P., & Anderson, V. (2006). The development of sustained attention in children: The effect of age and task load. *Child Neuropsychology, 12*(3), 205-221. http://doi.org.au/10.2147/AMEP.S82937

Birmaher, B., Khetarpal, S., Brent, D., Cully, M., Balach, L., Kaufman, J., & Neer, S. M. (1997). The Screen for Child Anxiety Related Emotional Disorders (SCARED): Scale Construction and Psychometric Characteristics. *Journal of the American Academy of Child & Adolescent Psychiatry*, *36*(4), 545-553. http://doi.org/10.1097/00004583-199704000-00018

Blechert, J., & Wilhelm, F. H. (2014). Psychophysiology. *The Wiley handbook of anxiety disorders*, 274-294.

Bögels, S. M., & Brechman-Toussaint, M. L. (2006). Family issues in child anxiety: Attachment, family functioning, parental rearing and beliefs. *Clinical Psychology Review, 26*(7), 834-856. http://doi.org/10.1016/j.cpr.2005.08.001

Borkovec, T., Ray, W. J., & Stober, J. (1998). Worry: A cognitive phenomenon intimately linked to affective, physiological, and interpersonal behavioral processes. *Cognitive therapy and research, 22*(6), 561-576. http://doi.org/10.1023/A:1018790003416

Boulet, S. L., Boyle, C. A., & Schieve, L. A. (2009). Health care use and health and functional impact of developmental disabilities among US children, 1997-2005. *Archives of pediatrics & adolescent medicine, 163*(1), 19-26. http://doi.org/10.1001/archpediatrics.2008.506

Bracha, H. S. (2004). Freeze, flight, fight, fright, faint: Adaptationist perspectives on the acute stress response spectrum. *CNS spectrums, 9*(9), 679-685. http://doi.org/10.1017/S1092852900001954

Bracha, S., Williams, A. E., & Bracha, A. S. (2004). Does" fight or flight" need updating? Psychosomatics, 45(5), 448-449. http://doi.org/10.1176/appi.psy.45.5.448

Braddick, O., Atkinson, J., & Wattam-Bell, J. (2003). Normal and anomalous development of visual motion processing: motion coherence and ‘dorsal-stream vulnerability’. *Neuropsychologia, 41*(13), 1769-1784. http://doi.org/10.1016/s0028-3932(03)00178-7

Brereton, A. V., Tonge, B. J., & Einfeld, S. L. (2006). Psychopathology in children and adolescents with autism compared to young people with intellectual disability. *J Autism Dev Disord, 36*(7), 863-870. http://doi.org/10.1007/s10803-006-0125-y

Broeren, S., Muris, P., Diamantopoulou, S., & Baker, J. R. (2013). The course of childhood anxiety symptoms: Developmental trajectories and child-related factors in normal children. *Journal of abnormal child psychology, 41*(1), 81-95. http://doi.org/10.1007/s10802-012-9669-9

Brown, A. C., & Crewther, D. P. (2017). Autistic children show a surprising relationship between global visual perception, non-verbal intelligence and visual parvocellular function, not seen in typically developing children. *Front Hum Neurosci, 11*, 239. http://doi.org/10.3389/fnhum.2017.00239

Bubier, J. L., & Drabick, D. A. (2009). Co-occurring anxiety and disruptive behavior disorders: The roles of anxious symptoms, reactive aggression, and shared risk processes. *Clinical Psychology Review, 29*(7), 658-669. http://doi.org/10.1016/j.cpr.2009.08.005

Bullier, J. (2001). Integrated model of visual processing. *Brain research reviews, 36*(2-3), 96-107. http://doi.org/10.1016/S0165-0173(01)00085-6

Bylsma, L. M., Mauss, I. B., & Rottenberg, J. (2016). Is the divide a chasm?: Bridging affective science with clinical practice. *Journal of psychopathology and behavioral assessment, 38*(1), 42-47. http://doi.org/10.1007/s10862-015-9525-7

Caes, L., Fisher, E., Clinch, J., Tobias, J. H., & Eccleston, C. (2016). The development of worry throughout childhood: Avon Longitudinal Study of Parents and Children data. *British journal of health psychology, 21*(2), 389-406. http://doi.org/10.1111/bjhp.12174

Campbell, W. H., & Rohrbaugh, R. M. (2013). *The biopsychosocial formulation manual: A guide for mental health professionals*: Routledge. http://doi.org/10.4324/9780203956489

Cohen, S., Janicki-Deverts, D., & Miller, G. E. (2007). Psychological stress and disease. *Jama, 298*(14), 1685-1687. http://doi.org/10.1001/jama.298.14.1685

Coll, C. G., Kagan, J., & Reznick, J. S. (1984). Behavioral inhibition in young children. *Child Dev*, 1005-1019. http://doi.org/10.2307/1130152

Corbetta, M., & Shulman, G. L. (1998). Human cortical mechanisms of visual attention during orienting and search. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences, 353*(1373), 1353-1362. http://doi.org/10.1098/rstb.1998.0289

Corbetta, M., & Shulman, G. L. (2002). Control of goal-directed and stimulus-driven attention in the brain. *Nat Rev Neurosci, 3*(3), 201-215. http://doi.org/10.1038/nrn755

Cross, A. J., Goharpey, N., Laycock, R., & Crewther, S. G. (2019). Anxiety as a Common Biomarker for School Children with Additional Health and Developmental Needs Irrespective of Diagnosis. *Front Psychol, 10*, 1420. http://doi.org/10.3389/fpsyg.2019.01420

Cuthbert, B. N. (2014). The RDoC framework: facilitating transition from ICD/DSM to dimensional approaches that integrate neuroscience and psychopathology. *World Psychiatry, 13*(1), 28-35. http://doi.org/10.1002/wps.20087

Davis, M., Walker, D. L., Miles, L., & Grillon, C. (2010). Phasic vs sustained fear in rats and humans: role of the extended amygdala in fear vs anxiety. *Neuropsychopharmacology, 35*(1), 105-135. http://doi.org/10.1038/npp.2009.109

De Los Reyes, A., & Aldao, A. (2015). Introduction to the special issue: Toward implementing physiological measures in clinical child and adolescent assessments. *Journal of Clinical Child & Adolescent Psychology, 44*(2), 221-237. http://doi.org/10.1080/15374416.2014.891227

DeJong, H., Fox, E., & Stein, A. (2019). Does rumination mediate the relationship between attentional control and symptoms of depression? *Journal of behavior therapy and experimental psychiatry, 63*, 28-35. http://doi.org/10.1016/j.jbtep.2018.12.007

Delgado, L. C., Guerra, P., Perakakis, P., Mata, J. L., Pérez, M. N., & Vila, J. (2009). Psychophysiological correlates of chronic worry: Cued versus non-cued fear reaction. *International Journal of Psychophysiology, 74*(3), 280-287. http://doi.org/10.1016/j.ijpsycho.2009.10.007

Dietrich, K. N., Eskenazi, B., Schantz, S., Yolton, K., Rauh, V. A., Johnson, C. B., . . . Berman, R. F. (2005). Principles and practices of neurodevelopmental assessment in children: lessons learned from the Centers for Children's Environmental Health and Disease Prevention Research. *Environmental health perspectives, 113*(10), 1437-1446. http://doi.org/10.1289/ehp.7672

Dregan, A., & Armstrong, D. (2010). Adolescence sleep disturbances as predictors of adulthood sleep disturbances—a cohort study. *Journal of Adolescent Health, 46*(5), 482-487. http://doi.org/10.1016/j.jadohealth.2009.11.197

Dugas, M. J., Freeston, M. H., & Ladouceur, R. (1997). Intolerance of uncertainty and problem orientation in worry. Cognitive therapy and research, 21(6), 593-606. https://doi.org/10.1023/A:1021890322153

Dugas, M. J., Gosselin, P., & Ladouceur, R. (2001). Intolerance of uncertainty and worry: Investigating specificity in a nonclinical sample. *Cognitive therapy and research, 25*(5), 551-558. https://doi.org/10.1023/A:1005553414688

Duval, E. R., Javanbakht, A., & Liberzon, I. (2015). Neural circuits in anxiety and stress disorders: a focused review. *Therapeutics and clinical risk management, 11*, 115. https://doi.org/10.2147/TCRM.S48528

Ehring, T., & Watkins, E. R. (2008). Repetitive negative thinking as a transdiagnostic process. *International journal of cognitive therapy, 1*(3), 192-205. http://doi.org/10.1521/ijct.2008.1.3.192

Einstein, D. A. (2014). Extension of the transdiagnostic model to focus on intolerance of uncertainty: a review of the literature and implications for treatment. Clinical Psychology: Science and Practice, 21(3), 280-300. http://doi.org/10.1111/cpsp.12077

Eley, T. C., Bolton, D., O'connor, T. G., Perrin, S., Smith, P., & Plomin, R. (2003). A twin study of anxiety-related behaviours in pre-school children. *Journal of Child Psychology And Psychiatry, 44*(7), 945-960. http://doi.org/10.1111/1469-7610.00179

Ellenbogen, M. A., & Schwartzman, A. E. (2009). Selective attention and avoidance on a pictorial cueing task during stress in clinically anxious and depressed participants. *Behav Res Ther, 47*(2), 128-138. http://doi.org/10.1016/j.brat.2008.10.021

Engel, G. L. (1977). The need for a new medical model: a challenge for biomedicine. *Science, 196*(4286), 129-136. http://doi.org/10.1126/science.847460

Estes, M. L., & McAllister, A. K. (2016). Maternal immune activation: Implications for neuropsychiatric disorders. *Science, 353*(6301), 772-777. http://doi.org/10.1126/science.aag3194

Everly, G. S., & Lating, J. M. (2013). Stress-related disease: A review. In *A Clinical Guide to the Treatment of the Human Stress Response* (pp. 67-102): Springer. http://doi.org/10.1007/0-306-47800-5_4

Eysenck, M. W. (2000). A cognitive approach to trait anxiety. *European Journal of Personality, 14*(5), 463-476. http://doi.org/10.1002/1099-0984(200009/10)14:5%3C463::AID-PER393%3E3.0.CO;2-3

Eysenck, M. W., & Calvo, M. G. (1992). Anxiety and performance: The processing efficiency theory. *Cogn Emot, 6*(6), 409-434. http://doi.org/10.1007/978-3-642-68390-9_6

Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: attentional control theory. Emotion, 7(2), 336. http://doi.org/10.1037/1528-3542.7.2.336

Fan, J., Bernardi, S., Dam, N. T., Anagnostou, E., Gu, X., Martin, L., . . . Soorya, L. (2012). Functional deficits of the attentional networks in autism. *Brain Behav, 2*(5), 647-660. http://doi.org/10.1002/brb3.90

Flensborg-Madsen, T., Tolstrup, J., Sørensen, H. J., & Mortensen, E. L. (2012). Social and psychological predictors of onset of anxiety disorders: results from a large prospective cohort study. *Social psychiatry and psychiatric epidemiology, 47*(5), 711-721. http://doi.org/10.1007/s00127-011-0373-9

Fletcher, F. E., Conduit, R., Foster-Owens, M. D., Rinehart, N. J., Rajaratnam, S. M., & Cornish, K. M. (2016). The association between anxiety symptoms and sleep in school-aged children: A combined insight from the Children's Sleep Habits Questionnaire and actigraphy. *Behavioral sleep medicine*, 1-16. http://doi.org/10.1080/15402002.2016.1180522

Franklin, J. C., Jamieson, J. P., Glenn, C. R., & Nock, M. K. (2015). How developmental psychopathology theory and research can inform the research domain criteria (RDoC) project. *Journal of Clinical Child & Adolescent Psychology, 44*(2), 280-290. http://doi.org/10.1080/15374416.2013.873981

Freeth, M., Bullock, T., & Milne, E. (2013). The distribution of and relationship between autistic traits and social anxiety in a UK student population. *Autism, 17*(5), 571-581. http://doi.org/10.1177/1362361312445511

Friedman, M. J., Resick, P. A., Bryant, R. A., Strain, J., Horowitz, M., & Spiegel, D. (2011). Classification of trauma and stressor-related disorders in DSM-5. *Depression and anxiety*, *28*(9), 737-749. http://doi.org/10.1002/da.20845

Furnham, A., & Lousley, C. (2013). Mental health literacy and the anxiety disorders. *Health, 5(3),* 521- 531.http://doi.org/10.4236/health.2013.53A071

Ghaemi, S. N. (2011). The biopsychosocial model in psychiatry: A critique. *American Journal of Psychiatry, 121*, 451-457.

Gladwin, T. E., Hashemi, M. M., van Ast, V., & Roelofs, K. (2016). Ready and waiting: Freezing as active action preparation under threat. *Neuroscience Letters, 619*, 182-188. http://doi.org/10.1016/j.neulet.2016.03.027

Goodale, M. A., Króliczak, G., & Westwood, D. A. (2005). Dual routes to action: contributions of the dorsal and ventral streams to adaptive behavior. *Progress in brain research, 149*, 269-283. http://doi.org/10.1016/S0079-6123(05)49019-6

Goodale, M. A., & Milner, A. D. (1992). Separate visual pathways for perception and action. *Trends in Neuroscience, 15*(1), 20-25. http://doi.org/10.1016/0166-2236(92)90344-8

Goodale, M. A., & Westwood, D. A. (2004). An evolving view of duplex vision: separate but interacting cortical pathways for perception and action. Current opinion in neurobiology, 14(2), 203-211. http://doi.org/10.1016/j.conb.2004.03.002

Goodsell, B. T., Lawrence, D. M., Ainley, J., Sawyer, M., Zubrick, S. R., & Maratos, J. (2017). Child and adolescent mental health and educational outcomes: an analysis of educational outcomes from Young Minds Matter: the second Australian Child and Adolescent Survey of Mental Health and Wellbeing.

Goldfeld, S., O'Connor, M., Sayers, M., Moore, T., & Oberklaid, F. (2012). Prevalence and correlates of special health care needs in a population cohort of Australian children at school entry. *Journal of Developmental & Behavioral Pediatrics, 33*(4), 319-327. http://doi.org/10.1097/DBP.0b013e31824a7b8e

Gotham, K., Bishop, S. L., Hus, V., Huerta, M., Lund, S., Buja, A., . . . Lord, C. (2013). Exploring the relationship between anxiety and insistence on sameness in autism spectrum disorders. *Autism Research, 6*(1), 33-41. http://doi.org/10.1002/aur.1263

Gottschalk, M. G., & Domschke, K. (2017). Genetics of generalized anxiety disorder and related traits. *Dialogues in clinical neuroscience, 19*(2), 159.

Grahame, V., & Rodgers, J. (2014). Anxiety in neurodevelopmental disorders: phenomenology, assessment and intervention. In *Neurodevelopmental Disorders* (pp. 288-308): Psychology Press.

Green, S. A., & Ben-Sasson, A. (2010). Anxiety disorders and sensory over-responsivity in children with autism spectrum disorders: is there a causal relationship? *J Autism Dev Disord, 40*(12), 1495-1504. http://doi.org/10.1007/s10803-010-1007-x

Gregory, A. M., Caspi, A., Eley, T. C., Moffitt, T. E., O'Connor, T. G., & Poulton, R. (2005). Prospective longitudinal associations between persistent sleep problems in childhood and anxiety and depression disorders in adulthood. *Journal of abnormal child psychology, 33*(2), 157-163.http://doi.org/10.1007/s10802-005-1824-0

Grisham, J., Fullana, M., Mataix-Cols, D., Moffitt, T., Caspi, A., & Poulton, R. (2011). Risk factors prospectively associated with adult obsessive-compulsive symptom

dimensions and obsessive-compulsive disorder. *Psychological medicine, 41*(12), 2495. http://doi.org/10.1017/S0033291711000894

Grondhuis, S. N., & Aman, M. G. (2012). Assessment of anxiety in children and adolescents with autism spectrum disorders. Research in Autism Spectrum Disorders, 6(4), 1345-1365. http://doi.org/10.1016/j.rasd.2012.04.006

Grupe, D. W., & Nitschke, J. B. (2013). Uncertainty and anticipation in anxiety: an integrated neurobiological and psychological perspective. *Nature Reviews Neuroscience, 14*(7), 488-501. http://doi.org/10.1038/nrn3524

Guillen-Riquelme, A., & Buela-Casal, G. (2014). Meta-analysis of group comparison and meta-analysis of reliability generalization of the State-Trait Anxiety Inventory Questionnaire (STAI). *Revista espanola de salud publica*, *88*(1), 101-112. http://doi.org/10.4321/s1135-57272014000100007

Gullone, E., King, N. J., & Ollendick, T. H. (2000). The development and psychometric evaluation of the Fear Experiences Questionnaire: An attempt to disentangle the fear and anxiety constructs. *Clinical Psychology & Psychotherapy: An International Journal of Theory & Practice, 7*(1), 61-75. http://doi.org/10.1002/(SICI)1099-0879(200002)7:1%3C61::AID-CPP227%3E3.0.CO;2-P

Happé, F., & Frith, U. (2006). The weak coherence account: detail-focused cognitive style in autism spectrum disorders. *J Autism Dev Disord*, *36*(1), 5-25. http://doi.org/10.1007/s10803-005-0039-0

Heeren, A., & McNally, R. J. (2016). An integrative network approach to social anxiety disorder: The complex dynamic interplay among attentional bias for threat, attentional control, and symptoms. *Journal of Anxiety Disorders, 42*, 95-104. http://doi.org/10.1016/j.janxdis.2016.06.009

Hershenberg, R., & Goldfried, M. R. (2015). Implications of RDoC for the research and practice of psychotherapy. *Behavior Therapy, 46*(2), 156-165. http://doi.org/10.1016/j.beth.2014.09.014

Hettema, J. M., Neale, M. C., & Kendler, K. S. (2001). A review and meta-analysis of the genetic epidemiology of anxiety disorders. *American Journal of Psychiatry, 158*(10), 1568-1578. http://doi.org/10.1176/appi.ajp.158.10.1568

Hettema, J. M., Prescott, C. A., Myers, J. M., Neale, M. C., & Kendler, K. S. (2005). The structure of genetic and environmental risk factors for anxiety disorders in men and women. *Archives of general psychiatry, 62*(2), 182-189. http://doi.org/10.1001/archpsyc.62.2.182

Hofmann, S. G., Curtiss, J., & McNally, R. J. (2016). A complex network perspective on clinical science. *Perspectives on Psychological Science, 11*(5), 597-605. http://doi.org/10.1177/1745691616639283

Hofmann, S. G., Moscovitch, D. A., Litz, B. T., Kim, H.-J., Davis, L. L., & Pizzagalli, D. A. (2005). The worried mind: autonomic and prefrontal activation during worrying. *Emotion, 5*(4), 464. http://doi.org/10.1037/1528-3542.5.4.464

Hollocks, M. J., Lerh, J. W., Magiati, I., Meiser-Stedman, R., & Brugha, T. S. (2019). Anxiety and depression in adults with autism spectrum disorder: a systematic review and meta-analysis. *Psychological medicine, 49*(4), 559-572. http://doi.org/10.1017/S0033291718002283

Hopwood, C. J., Bagby, R. M., Gralnick, T., Ro, E., Ruggero, C., Mullins-Sweatt, S., . . . Krueger, R. F. (2019). Integrating psychotherapy with the hierarchical taxonomy of psychopathology (HiTOP). *Journal of Psychotherapy Integration*. http://doi.org/10.1037/int0000156

Hudson, J. L., Dodd, H. F., Lyneham, H. J., & Bovopoulous, N. (2011). Temperament and family environment in the development of anxiety disorder: Two-year follow-up. *Journal of the American Academy of Child & Adolescent Psychiatry, 50*(12), 1255-1264. e1251. http://doi.org/10.1016/j.jaac.2011.09.009

Insel, T., Cuthbert, B., Garvey, M., Heinssen, R., Pine, D. S., Quinn, K., . . . Wang, P. (2010). Research domain criteria (RDoC): toward a new classification framework for research on mental disorders. *American Journal of Psychiatry, 167*(7), 748 http://doi.org/10.1176/appi.ajp.2010.09091379

Insel, T. R. (2014). The NIMH research domain criteria (RDoC) project: precision medicine for psychiatry. *American Journal of Psychiatry, 171*(4), 395-397. http://doi.org/10.1176/appi.ajp.2014.14020138

Insel, T. R., & Cuthbert, B. N. (2015). Brain disorders? Precisely. *Science, 348*(6234), 499-500. http://doi.org/10.1126/science.aab2358

Jablensky, A., Johnson, R., Bunney, W., Cruz, M., Durkin, M., Familusi, J., . . . Kaaya, S. (2001). *Neurological, Psychiatric, and Developmental Disorders; Meeting the Challenge in the Developing World*. National Academy Press.

James, S., & Hale, L. (2017). Sleep Duration and Child Well-Being: A Nonlinear Association. *Journal of Clinical Child & Adolescent Psychology, 46*(2), 258-268. http://doi.org/10.1080/15374416.2016.1204920

James, W. (1890). *The Principles of Psychology. 2*. Henry Holt and Company.

Janelle, C. M. (2002). Anxiety, arousal and visual attention: A mechanistic account of performance variability. *Journal of sports sciences, 20*(3), 237-251. http://doi.org/10.1080/026404102317284790

Jansen, A. S., Van Nguyen, X., Karpitskiy, V., Mettenleiter, T. C., & Loewy, A. D. (1995). Central command neurons of the sympathetic nervous system: basis of the fight-or-

flight response. *Science, 270*(5236), 644-646. http://doi.org/10.1126/science.270.5236.644

Johnson, E. O., Kamilaris, T. C., Chrousos, G. P., & Gold, P. W. (1992). Mechanisms of stress: a dynamic overview of hormonal and behavioral homeostasis. *Neuroscience & Biobehavioral Reviews, 16*(2), 115-130. http://doi.org/10.1016/S0149-7634(05)80175-7

Johnson, M. H. (2005). Subcortical face processing. *Nature Reviews Neuroscience, 6*(10), 766. http://doi.org/10.1038/nrn1766

Johnston, J. C., & Pashler, H. (1998). Attentional limitations in dual-task performance. *Attention*, 155-189. Psychology Press/Erlbaum (UK) Taylor & Francis.

Kagan, J., Reznick, J. S., & Snidman, N. (1987). The physiology and psychology of behavioral inhibition in children. *Child Dev*, 1459-1473. https://doi.org/10.2307/1130685

Kalin, N. H. (2017). Mechanisms underlying the early risk to develop anxiety and depression: A translational approach. *European Neuropsychopharmacology, 27*(6), 543-553. http://doi.org/10.1016/j.euroneuro.2017.03.004

Kalvin, C. B., Marsh, C. L., Ibrahim, K., Gladstone, T. R., Woodward, D., Grantz, H., . . . Sukhodolsky, D. G. (2020). Discrepancies between parent and child ratings of anxiety in children with autism spectrum disorder. *Autism Research, 13*(1), 93-103. http://doi.org/10.1002/aur.2220

Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous child, 2*(3), 217-250.

Karunamuni, N., Imayama, I., & Goonetilleke, D. (2020). Pathways to well-being: Untangling the causal relationships among biopsychosocial variables. *Social Science & Medicine*, 112846. http://doi.org/10.1016/j.socscimed.2020.112846

Kerns, C. M., & Kendall, P. C. (2014). Autism and anxiety: Overlap, similarities, and differences. In *Handbook of autism and anxiety* (pp. 75-89): Springer, Cham. http://doi.org/10.1007/978-3-319-06796-4_6

Ketelaars, C., Horwitz, E., Sytema, S., Bos, J., Wiersma, D., Minderaa, R., & Hartman, C. A. (2008). Brief report: Adults with mild autism spectrum disorders (ASD): Scores on the autism spectrum quotient (AQ) and comorbid psychopathology. *J Autism Dev Disorders*, 38(1), 176-180. http://doi.org/10.1007/s10803-007-0358-4

Kim, J. A., Szatmari, P., Bryson, S. E., Streiner, D. L., & Wilson, F. J. (2000). The prevalence of anxiety and mood problems among children with autism and Asperger syndrome. *Autism, 4*(2), 117-132. http://doi.org/10.1177/1362361300004002002

Klaver, P., Lichtensteiger, J., Bucher, K., Dietrich, T., Loenneker, T., & Martin, E. (2008). Dorsal stream development in motion and structure-from-motion perception. *Neuroimage, 39*(4), 1815-1823. http://doi.org/10.1016/j.neuroimage.2007.11.009

Koenen, K. C., Moffitt, T. E., Roberts, A. L., Martin, L. T., Kubzansky, L., Harrington, H., . . . Caspi, A. (2009). Childhood IQ and adult mental disorders: a test of the cognitive reserve hypothesis. *American Journal of Psychiatry, 166*(1), 50-57. http://doi.org/10.1176/appi.ajp.2008.08030343

Kotov, R., Krueger, R. F., & Watson, D. (2018). A paradigm shift in psychiatric classification: the Hierarchical Taxonomy Of Psychopathology (HiTOP). *World Psychiatry, 17*(1), 24. http://doi.org/10.1002/wps.20478

Kovacs, M., & Lopez-Duran, N. (2010). Prodromal symptoms and atypical affectivity as predictors of major depression in juveniles: implications for prevention. *Journal of Child Psychology And Psychiatry, 51*(4), 472-496. http://doi.org/10.1111/j.1469-7610.2010.02230.x

Last, C. G., Hersen, M., Kazdin, A., Orvaschel, H., & Perrin, S. (1991). Anxiety disorders in children and their families. Archives of general psychiatry, 48(10), 928-934. http://doi.org/10.1001/archpsyc.1991.01810340060008

Laycock, R., Crewther, S. G., & Crewther, D. P. (2007). A role for the 'magnocellular advantage' in visual impairments in neurodevelopmental and psychiatric disorders. *Neurosci Biobehav Rev, 31*(3), 363-376. http://doi.org/10.1016/j.neubiorev.2006.10.003

LeDoux, J. E. (2000). Emotion circuits in the brain. Annu Rev Neurosci, 23(1), 155-184. http://doi.org/10.1146/annurev.neuro.23.1.155

LeDoux, J. E., & Pine, D. S. (2016). Using neuroscience to help understand fear and anxiety: a two-system framework. *American Journal of Psychiatry*. http://doi.org/10.1176/appi.ajp.2016.16030353

Lidstone, J., Uljarević, M., Sullivan, J., Rodgers, J., McConachie, H., Freeston, M., . . . Leekam, S. (2014). Relations among restricted and repetitive behaviors, anxiety and sensory features in children with autism spectrum disorders. *Research in Autism Spectrum Disorders*, *8*(2), 82-92. http://doi.org/10.1016/j.rasd.2013.10.001

Litzky, J. F., Deyssenroth, M. A., Everson, T. M., Lester, B. M., Lambertini, L., Chen, J., & Marsit, C. J. (2018). Prenatal exposure to maternal depression and anxiety on imprinted gene expression in placenta and infant neurodevelopment and growth. *Pediatric research, 83*(5), 1075. http://doi.org/10.1038/pr.2018.27

Lovegrove, W. J., Bowling, A., Badcock, D., & Blackwood, M. (1980). Specific reading disability: differences in contrast sensitivity as a function of spatial frequency. *Science, 210*(4468), 439-440. http://doi.org/10.1126/science.7433985

Lugo-Marín, J., Magán-Maganto, M., Rivero-Santana, A., Cuellar-Pompa, L., Alviani, M., Jenaro-Rio, C., . . . Canal-Bedia, R. (2019). Prevalence of psychiatric disorders in

adults with autism spectrum disorder: A systematic review and meta-analysis. *Research in Autism Spectrum Disorders, 59*, 22-33. http://doi.org/10.1016/j.rasd.2018.12.004

Magiati, I., Chan, J. Y., Tan, W.-L. J., & Poon, K. K. (2014). Do non-referred young people with Autism Spectrum Disorders and their caregivers agree when reporting anxiety symptoms? A preliminary investigation using the Spence Children's Anxiety Scale. *Research in Autism Spectrum Disorders, 8*(5), 546-558. http://doi.org/10.1016/j.rasd.2014.01.015

Manassis, K., Tannock, R., Young, A., & Francis-John, S. (2007). Cognition in anxious children with attention deficit hyperactivity disorder: a comparison with clinical and normal children. *Behavioral and Brain Functions*, *3*(1), 4. https://doi.org/10.1186/1744-9081-3-4

Mankowska, A., Harciarek, M., & Heilman, K. M. (2020). Feeling and Looking Down: Impact of Depressive Symptoms on the Allocation of Vertical Attention. *Cognitive and Behavioral Neurology*, *33*(2), 137-144. http://doi.org/10.1097/WNN.0000000000000232

Markett, S., Reuter, M., Montag, C., Voigt, G., Lachmann, B., Rudorf, S., . . . Weber, B. (2014). Assessing the function of the fronto-parietal attention network: insights from resting-state fMRI and the attentional network test. *Hum Brain Mapp*, *35*(4), 1700-1709. http://doi.org/10.1002/hbm.22285

Martin, L. T., Kubzansky, L. D., LeWinn, K. Z., Lipsitt, L. P., Satz, P., & Buka, S. L. (2007). Childhood cognitive performance and risk of generalized anxiety disorder. *International Journal of Epidemiology*, *36*(4), 769-775. http://doi.org/10.1093/ije/dym063

Martinsen, K. D., Neumer, S.-P., Holen, S., Waaktaar, T., Sund, A. M., & Kendall, P. C. (2016). Self-reported quality of life and self-esteem in sad and anxious school children. *BMC psychology*, *4*(1), 45. http://doi.org/10.1186/s40359-016-0153-0

May, T., Cornish, K., Conduit, R., Rajaratnam, S. M., & Rinehart, N. J. (2015). Sleep in high-functioning children with autism: longitudinal developmental change and associations with behavior problems. *Behavioral sleep medicine*, *13*(1), 2-18. http://doi.org/10.1080/15402002.2013.829064

McEvoy, P. M., & Erceg-Hurn, D. M. (2016). The search for universal transdiagnostic and trans-therapy change processes: Evidence for intolerance of uncertainty. *Journal of anxiety disorders*, *41*, 96-107. http://doi.org/10.1016/j.janxdis.2016.02.002

McEvoy, P. M., Watson, H., Watkins, E. R., & Nathan, P. (2013). The relationship between worry, rumination, and comorbidity: Evidence for repetitive negative thinking as a transdiagnostic construct. *Journal of affective disorders*, *151*(1), 313-320. http://doi.org/10.1016/j.jad.2013.06.014

McFadyen, J., Mattingley, J. B., & Garrido, M. I. (2019). An afferent white matter pathway from the pulvinar to the amygdala facilitates fear recognition. *eLife*, *8*, e40766. http://doi.org/10.7554/eLife.40766

McGorry, P. D. (2013). Early clinical phenotypes, clinical staging, and strategic biomarker research: building blocks for personalized psychiatry. *Biol Psychiatry*, *74*(6), 394-395. http://doi.org/10.1016/j.biopsych.2013.07.004

McKay, D., & Tolin, D. F. (2017). Empirically supported psychological treatments and the Research Domain Criteria (RDoC). *Journal of affective disorders*, *216*, 78-88. http://doi.org/10.1016/j.jad.2016.10.018

McLeod, B. D., Wood, J. J., & Weisz, J. R. (2007). Examining the association between parenting and childhood anxiety: A meta-analysis. *Clinical Psychology Review, 27*(2), 155-172. http://doi.org/10.1016/j.cpr.2006.09.002

Meier, S., Trontti, K., Als, T. D., Laine, M., Pedersen, M. G., Bybjerg-Grauholm, J., . . . Hougaard, D. M. (2018). Genome-wide association study of anxiety and stress-related disorders in the iPSYCH cohort. *bioRxiv*, 263855. https://doi.org/10.1101/263855

Meier, S. M., Trontti, K., Purves, K. L., Als, T. D., Grove, J., Laine, M., . . . Sokolowska, E. (2019). Genetic variants associated with anxiety and stress-related disorders: a genome-wide association study and mouse-model study. *JAMA psychiatry, 76*(9), 924-932. https://doi.org/10.1001/jamapsychiatry.2019.1119

Melchert, T. P. (2007). Strengthening the scientific foundations of professional psychology: Time for the next steps. *Professional Psychology: Research and Practice, 38*(1), 34. http://doi.org/10.1037/0735-7028.38.1.34

Melchert, T. P. (2010). The growing need for a unified biopsychosocial approach in mental health care. *Procedia-Social and Behavioral Sciences, 5*, 356-361. http://doi.org/10.1016/j.sbspro.2010.07.104

Méndez-Bértolo, C., Moratti, S., Toledano, R., Lopez-Sosa, F., Martínez-Alvarez, R., Mah, Y. H., . . . Strange, B. A. (2016). A fast pathway for fear in human amygdala. *Nature neuroscience, 19*(8), 1041-1049. http://doi.org/10.1038/nn.4324

Miller, L. C., Barrett, C. L., & Hampe, E. (1974). *Phobias of childhood in a prescientific era. In A. Davids, Child personality and psychopathology: Current topics*: John Wiley & Sons.

Misaki, M., Tsuchiyagaito, A., Zoubi, O. A., Paulus, M., Bodurka, J., & Investigators, T. (2020). Connectome-wide search for functional connectivity locus associated with

pathological rumination as a target for real-time fMRI neurofeedback intervention. *NeuroImage: Clinical*, 102244. http://doi.org/10.1016/j.nicl.2020.102244

Mogg, K., Salum, G., Bradley, B., Gadelha, A., Pan, P., Alvarenga, P., . . . Manfro, G. (2015). Attention network functioning in children with anxiety disorders, attention-deficit/hyperactivity disorder and non-clinical anxiety. *Psychological medicine, 45*(12), 2633-2646. http://doi.org/10.1017/S0033291715000586

Moran, A. (2012). Concentration: Attention and performance. *The Oxford handbook of sport and performance psychology*, 117-130. http://doi.org/10.1093/oxfordhb/9780199731763.013.0006

Moreno-De-Luca, A., Myers, S. M., Challman, T. D., Moreno-De-Luca, D., Evans, D. W., & Ledbetter, D. H. (2013). Developmental brain dysfunction: revival and expansion of old concepts based on new genetic evidence. *The Lancet Neurology, 12*(4), 406-414. http://doi.org/10.1016/S1474-4422(13)70011-5

Morris-Rosendahl, D. J. (2002). Are there anxious genes? *Dialogues in clinical neuroscience, 4*(3), 251.

Mottron, L., & Burack, J. A. (2001). Enhanced perceptual functioning in the development of autism. In J. A. Burack, T. Charman, N. Yirmiya, & P. R. Zelazo (Eds.), The development of autism: Perspectives from theory and research (p. 131–148). Lawrence Erlbaum Associates Publishers.

Muris, P., Merckelbach, H., Meesters, C., & van den Brand, K. (2002). Cognitive development and worry in normal children. *Cognitive therapy and research, 26*(6), 775-787. http://doi.org/10.1023/A:1021241517274

Muris, P., Meesters, C., Merckelbach, H., Sermon, A., & Zwakhalen, S. (1998). Worry in normal children. *Journal of the American Academy of Child & Adolescent Psychiatry, 37*(7), 703-710. http://doi.org/10.1097/00004583-199807000-00009

Muris, P., van Brakel, A. M., Arntz, A., & Schouten, E. (2011). Behavioral inhibition as a risk factor for the development of childhood anxiety disorders: A longitudinal study. *Journal of Child and Family Studies, 20*(2), 157-170. http://doi.org/10.1007/s10826-010-9365-8

Näätänen, R. (2018). *Attention and brain function*: Routledge.

National Institute for Health and Care Excellence (2011). Generalised anxiety disorder and panic disorder in adults: management. In: NICE London.

Nauta, M. H. (2005). *Anxiety disorders in children and adolescents: Assessment, cognitive behavioural therapy, and predictors of treatment outcome*: University of Groningen.

Nauta, M. H., Scholing, A., Rapee, R. M., Abbott, M., Spence, S. H., & Waters, A. (2004). A parent-report measure of children's anxiety: psychometric properties and comparison with child-report in a clinic and normal sample. *Behav Res Ther, 42*(7), 813-839. http://doi.org/10.1016/S0005-7967(03)00200-6

Navon, D. (1977). Forest before trees: The precedence of global features in visual perception. *Cognitive psychology, 9*(3), 353-383. http://doi.org/10.1016/0010-0285(77)90012-3

Neuhaus, A. H., Urbanek, C., Opgen-Rhein, C., Hahn, E., Ta, T. M. T., Koehler, S., ... & Dettling, M. (2010). Event-related potentials associated with Attention Network Test. *International Journal of Psychophysiology*, *76*(2), 72-79. https://doi.org/10.1016/j.ijpsycho.2010.02.005

Newman, E., O'Connor, D. B., & Conner, M. (2007). Daily hassles and eating behaviour: the role of cortisol reactivity status. *Psychoneuroendocrinology, 32*(2), 125-132. http://doi.org/10.1016/j.psyneuen.2006.11.006

Nolen-Hoeksema, S., Wisco, B. E., & Lyubomirsky, S. (2008). Rethinking rumination. *Perspectives on psychological science, 3*(5), 400-424. http://doi.org/10.1111/j.1745-6924.2008.00088.x

Norrholm, S. D., & Ressler, K. J. (2009). Genetics of anxiety and trauma-related disorders. *Neuroscience, 164*(1), 272-287. http://doi.org/10.1016/j.neuroscience.2009.06.036

O'Brien, D., Harvey, K., Young, B., Reardon, T., & Creswell, C. (2017). GPs' experiences of children with anxiety disorders in primary care: a qualitative study. *Br J Gen Pract, 67*(665), e888-e898. http://doi.org/10.3399/bjgp17X693473

O'Connor, M., O'Connor, E., Quach, J., Vashishtha, R., & Goldfeld, S. (2019). Trends in the prevalence and distribution of teacher-identified special health-care needs across three successive population cohorts. *Journal of paediatrics and child health, 55*(3), 312-319. http://doi.org/10.1111/jpc.14192

O'Connor, M., Quach, J., & Goldfeld, S. (2020). Children on the Edge: Starting School with Additional Health and Developmental Needs. In *Health and Education Interdependence* (pp. 75-89): Springer.

Okazaki, S., Liu, J. F., Longworth, S. L., & Minn, J. Y. (2002). Asian American-White American differences in expressions of social anxiety: A replication and extension. *Cultural Diversity and Ethnic Minority Psychology, 8*(3), 234. http://doi.org/10.1037/1099-9809.8.3.234

Olatunji, B. O., Wolitzky-Taylor, K. B., Sawchuk, C. N., & Ciesielski, B. G. (2010). Worry and the anxiety disorders: A meta-analytic synthesis of specificity to GAD. *Applied and Preventive Psychology, 14*(1-4), 1-24. http://doi.org/10.1016/j.appsy.2011.03.001

Ollendick, T. H., King, N. J., & Muris, P. (2002). Fears and phobias in children: Phenomenology, epidemiology, and aetiology. *Child and Adolescent Mental Health, 7*(3), 98-106. http://doi.org/10.1111/1475-3588.00019

Ong, S. H., Wickramaratne, P., Tang, M., & Weissman, M. M. (2006). Early childhood sleep and eating problems as predictors of adolescent and adult mood and anxiety disorders. *Journal of affective disorders, 96*(1-2), 1-8. http://doi.org/10.1016/j.jad.2006.05.025

Osmanağaoğlu, N., Creswell, C., & Dodd, H. F. (2018). Intolerance of Uncertainty, anxiety, and worry in children and adolescents: A meta-analysis. *Journal of affective disorders, 225*, 80-90. http://doi.org/10.1016/j.jad.2017.07.035

Ottaviani, C., Borlimi, R., Brighetti, G., Caselli, G., Favaretto, E., Giardini, I., . . . Ruggiero, G. M. (2014). Worry as an adaptive avoidance strategy in healthy controls but not in pathological worriers. *International Journal of Psychophysiology, 93*(3), 349-355. http://doi.org/10.1016/j.ijpsycho.2014.05.010

Ottaviani, C., Thayer, J. F., Verkuil, B., Lonigro, A., Medea, B., Couyoumdjian, A., & Brosschot, J. F. (2016). Physiological concomitants of perseverative cognition: A systematic review and meta-analysis. *Psychol Bull, 142*(3), 231. http://doi.org/10.1037/bul0000036

Pacheco-Unguetti, A. P., Acosta, A., Callejas, A., & Lupiáñez, J. (2010). Attention and anxiety: Different attentional functioning under state and trait anxiety. *Psychol Sci, 21*(2), 298-304. http://doi.org/10.1177/0956797609359624

Park, C., Rosenblat, J. D., Brietzke, E., Pan, Z., Lee, Y., Cao, B., . . . McIntyre, R. S. (2019). Stress, epigenetics and depression: a systematic review. *Neuroscience & Biobehavioral Reviews, 102,* 139-152. http://doi.org/10.1016/j.neubiorev.2019.04.010

Paulus, D. J., Wadsworth, L. P., & Hayes-Skelton, S. A. (2015). Mental health literacy for anxiety disorders: how perceptions of symptom severity might relate to recognition of psychological distress. *Journal of Public Mental Healt*h, 14(2), 94. http://doi.org/10.1108/JPMH-09-2013-0064

Pellicano, E., Gibson, L., Maybery, M., Durkin, K., & Badcock, D. R. (2005). Abnormal global processing along the dorsal visual pathway in autism: a possible mechanism for weak visuospatial coherence? *Neuropsychologia, 43*(7), 1044-1053. http://doi.org/10.1016/j.neuropsychologia.2004.10.003

Percy, R., Creswell, C., Garner, M., O'Brien, D., & Murray, L. (2016). Parents' verbal communication and childhood anxiety: A systematic review. *Clinical child and family psychology review, 19*(1), 55-75. http://doi.org/10.1007/s10567-015-0198-2

Petersen, S. E., & Posner, M. I. (2012). The attention system of the human brain: 20 years after. *Annu Rev Neurosci, 35*, 73-89. http://doi.org/10.1146/annurev-neuro-062111-150525

Piaget, J. (1952). Play, dreams and imitation in childhood. W W Norton & Co.

Pillai, V., & Drake, C. L. (2015). Sleep and repetitive thought: the role of rumination and worry in sleep disturbance. In *Sleep and affect* (pp. 201-225): Elsevier.

Platt, R., Williams, S. R., & Ginsburg, G. S. (2016). Stressful life events and child anxiety: Examining parent and child mediators. *Child Psychiatry & Human Development, 47*(1), 23-34. http://doi.org/10.1007/s10578-015-0540-4

Polanczyk, G. V., Salum, G. A., Sugaya, L. S., Caye, A., & Rohde, L. A. (2015). Annual research review: A meta-analysis of the worldwide prevalence of mental disorders in children and adolescents. *Journal of child psychology and psychiatry, 56*(3), 345-365. http://doi.org/10.1111/jcpp.12381

Posner, M. I., & Petersen, S. E. (1990). The attention system of the human brain. *Annu Rev Neurosci, 13*(1), 25-42. http://doi.org/10.1146/annurev.ne.13.030190.000325

Posner, M. I., & Rothbart, M. K. (2013). *Development of attention networks.* In B. R. Kar (Ed.), *APA human brain development series. Cognition and brain development: Converging evidence from various methodologies* (p. 61–83). American Psychological Association. https://doi.org/10.1037/14043-004

Rabner, J., Mian, N. D., Langer, D. A., Comer, J. S., & Pincus, D. (2017). The relationship between worry and dimensions of anxiety symptoms in children and

adolescents. *Behavioural and cognitive psychotherapy, 45*(2), 124-138. http://doi.org/10.1017/S1352465816000448

Racic, M., Todorovic, R., Ivkovic, N., Masic, S., Joksimovic, B., & Kulic, M. (2017). Self-perceived stress in relation to anxiety, depression and health-related quality of life among health professions students: a cross-sectional study from Bosnia and Herzegovina. *Slovenian Journal of Public Health, 56*(4), 251-259. http://doi.org/10.1515/sjph-2017-0034

Radley, J., Morilak, D., Viau, V., & Campeau, S. (2015). Chronic stress and brain plasticity: mechanisms underlying adaptive and maladaptive changes and implications for stress-related CNS disorders. *Neuroscience & Biobehavioral Reviews, 58*, 79-91. http://doi.org/10.1016/j.neubiorev.2015.06.018

Rangasamy, S., D'Mello, S. R., & Narayanan, V. (2013). Epigenetics, autism spectrum, and neurodevelopmental disorders. *Neurotherapeutics, 10*(4), 742-756. http://doi.org/10.1007/s13311-013-0227-0

Rapee, R. M. (2012). Anxiety disorders in children and adolescents: Nature, development, treatment and prevention. Anxiety disorders in children and adolescents: Nature, development, treatment and prevention. In Rey JM (ed), I*ACAPAP e-Textbook of Child and Adolescent Mental Health*. Geneva: International Association for Child and Adolescent Psychiatry and Allied Professions.

Rapee, R. M. (1997). Potential role of childrearing practices in the development of anxiety and depression. *Clinical Psychology Review, 17*(1), 47-67. http://doi.org/10.1016/S0272-7358(96)00040-2

Rapee, R. M., Kennedy, S., Ingram, M., Edwards, S., & Sweeney, L. (2005). Prevention and early intervention of anxiety disorders in inhibited preschool children. *Journal of*

consulting and clinical psychology, 73(3), 488. http://doi.org/10.1037/0022-006X.73.3.488

Reardon, T., Harvey, K., Young, B., O'Brien, D., & Creswell, C. (2018). Barriers and facilitators to parents seeking and accessing professional support for anxiety disorders in children: qualitative interview study. *European child & adolescent psychiatry, 27*(8), 1023-1031. http://doi.org/10.1007/s00787-018-1107-2

Reinholdt-Dunne, M. L., Mogg, K., & Bradley, B. P. (2009). Effects of anxiety and attention control on processing pictorial and linguistic emotional information. *Behav Res Ther, 47*(5), 410-417. http://doi.org/10.1016/j.brat.2009.01.012

Renno, P., & Wood, J. J. (2013). Discriminant and convergent validity of the anxiety construct in children with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 43*(9), 2135-2146. http://doi.org/10.1007/s10803-013-1767-1

Richards, J. C., & Bertram, S. (2000). Anxiety sensitivity, state and trait anxiety, and perception of change in sympathetic nervous system arousal. *Journal of anxiety disorders, 14*(4), 413-427. http://doi.org/10.1016/S0887-6185(00)00031-1

Rosbrook, A., & Whittingham, K. (2010). Autistic traits in the general population: What mediates the link with depressive and anxious symptomatology? *Research in Autism Spectrum Disorders, 4*(3), 415-424. http://doi.org/10.1016/j.rasd.2009.10.012

Rueda, M. R., Fan, J., McCandliss, B. D., Halparin, J. D., Gruber, D. B., Lercari, L. P., & Posner, M. I. (2004). Development of attentional networks in childhood. *Neuropsychologia, 42*(8), 1029-1040. http://doi.org/10.1016/j.neuropsychologia.2003.12.012

Ruggero, C. J., Kotov, R., Hopwood, C. J., First, M., Clark, L. A., Skodol, A. E., . . . Cicero, D. C. (2019). Integrating the Hierarchical Taxonomy of Psychopathology (HiTOP)

into clinical practice. *Journal of consulting and clinical psychology, 87*(12), 1069. http://doi.org/10.1037/ccp0000452

Rzepecka, H., McKenzie, K., McClure, I., & Murphy, S. (2011). Sleep, anxiety and challenging behaviour in children with intellectual disability and/or autism spectrum disorder. *Res Dev Disabil, 32*(6), 2758-2766. http://doi.org/10.1016/j.ridd.2011.05.034

Schechter, I., Butler, P. D., Silipo, G., Zemon, V., & Javitt, D. C. (2003). Magnocellular and parvocellular contributions to backward masking dysfunction in schizophrenia. *Schizophrenia research, 64*(2-3), 91-101. http://doi.org/10.1016/S0920-9964(03)00008-2

Schmidt, L. A., Fox, N. A., Rubin, K. H., Sternberg, E. M., Gold, P. W., Smith, C. C., & Schulkin, J. (1997). Behavioral and neuroendocrine responses in shy children. *Developmental Psychobiology: The Journal of the International Society for Developmental Psychobiology, 30*(2), 127-140. http://doi.org/10.1002/(SICI)1098-2302(199703)30:2%3C127::AID-DEV4%3E3.0.CO;2-S

Segrin, C., Woszidlo, A., Givertz, M., & Montgomery, N. (2013). Parent and child traits associated with overparenting. *Journal of Social and Clinical Psychology, 32*(6), 569-595. http://doi.org/10.1521/jscp.2013.32.6.569

Selzer, R., & Ellen, S. (2014). Formulation for beginners. *Australasian Psychiatry, 22*(4), 397-401. http://doi.org/10.1177/1039856214536240

Shackman, A. J., Sarinopoulos, I., Maxwell, J. S., Pizzagalli, D. A., Lavric, A., & Davidson, R. J. (2006). Anxiety selectively disrupts visuospatial working memory. *Emotion, 6*(1), 40. http://doi.org/10.1037/1528-3542.6.1.40

Shimada-Sugimoto, M., Otowa, T., & Hettema, J. M. (2015). Genetics of anxiety disorders: Genetic epidemiological and molecular studies in humans. *Psychiatry and clinical neurosciences, 69*(7), 388-401. http://doi.org/10.1111/pcn.12291

Shin, L. M., & Liberzon, I. (2010). The neurocircuitry of fear, stress, and anxiety disorders. *Neuropsychopharmacology, 35*(1), 169. http://doi.org/10.1038/npp.2009.83

Simola, P., Liukkonen, K., Pitkäranta, A., Pirinen, T., & Aronen, E. T. (2014). Psychosocial and somatic outcomes of sleep problems in children: a 4-year follow-up study. *Child: care, health and development, 40*(1), 60-67. http://doi.org/10.1111/j.1365-2214.2012.01412.x

Smith, J. M., & Alloy, L. B. (2009). A roadmap to rumination: A review of the definition, assessment, and conceptualization of this multifaceted construct. *Clinical psychology review, 29*(2), 116-128. http://doi.org/10.1016/j.cpr.2008.10.003

Smoller, J. W. (2016). The genetics of stress-related disorders: PTSD, depression, and anxiety disorders. *Neuropsychopharmacology, 41*(1), 297-319. http://doi.org/10.1038/npp.2015.266

Sneddon, P., Peacock, G. G., & Crowley, S. L. (2013). Assessment of sleep problems in preschool aged children: an adaptation of the Children's Sleep Habits Questionnaire. *Behavioral sleep medicine, 11*(4), 283-296. http://doi.org/10.1080/15402002.2012.707158

Snyder, J., Bullard, L., Wagener, A., Leong, P. K., Snyder, J., & Jenkins, M. (2009). Childhood anxiety and depressive symptoms: Trajectories, relationship, and association with subsequent depression. *Journal of Clinical Child & Adolescent Psychology, 38*(6), 837-849. http://doi.org/10.1080/15374410903258959

Sokolowska, E., & Hovatta, I. (2013). Anxiety genetics–findings from cross-species genome-wide approaches. *Biology of mood & anxiety disorders, 3*(1), 9. http://doi.org/10.1186/2045-5380-3-9

Solek, C. M., Farooqi, N., Verly, M., Lim, T. K., & Ruthazer, E. S. (2018). Maternal immune activation in neurodevelopmental disorders. *Developmental Dynamics, 247*(4), 588-619. http://doi.org/10.1002/dvdy.24612

Spence, S. H., Barrett, P. M., & Turner, C. M. (2003). Psychometric properties of the Spence Children's Anxiety Scale with young adolescents. *Journal of anxiety disorders, 17*(6), 605-625. http://doi.org/10.1016/S0887-6185(02)00236-0

Spencer, J., O'Brien, J., Riggs, K., Braddick, O., Atkinson, J., & Wattam-Bell, J. (2000). Motion processing in autism: evidence for a dorsal stream deficiency. *Neuroreport, 11*(12), 2765-2767.

Spinhoven, P., Elzinga, B. M., Hovens, J. G., Roelofs, K., Zitman, F. G., van Oppen, P., & Penninx, B. W. (2010). The specificity of childhood adversities and negative life events across the life span to anxiety and depressive disorders. *Journal of affective disorders, 126*(1-2), 103-112. http://doi.org/10.1016/j.jad.2010.02.132

Steimer, T. (2002). The biology of fear-and anxiety-related behaviors. *Dialogues in clinical neuroscience, 4*(3), 231.

Stein, D. J., Craske, M. A., Friedman, M. J., & Phillips, K. A. (2014). Anxiety disorders, obsessive-compulsive and related disorders, trauma-and stressor-related disorders, and dissociative disorders in DSM-5. *American Journal of Psychiatry, 171*(6), 611-613. http://doi.org/10.1176/appi.ajp.2014.14010003

Stein, J., & Walsh, V. (1997). To see but not to read; the magnocellular theory of dyslexia. *Trends in neurosciences, 20*(4), 147-152. http://doi.org/10.1016/S0166-2236(96)01005-3

Suls, J., & Rothman, A. (2004). Evolution of the biopsychosocial model: prospects and challenges for health psychology. *Health psychology, 23*(2), 119. http://doi.org/10.1037/0278-6133.23.2.119

Sutherland, A., & Crewther, D. P. (2010). Magnocellular visual evoked potential delay with high autism spectrum quotient yields a neural mechanism for altered perception. *Brain, 133*(7), 2089-2097. http://doi.org/10.1093/brain/awq122

Teicher, M. H., Samson, J. A., Anderson, C. M., & Ohashi, K. (2016). The effects of childhood maltreatment on brain structure, function and connectivity. *Nature Reviews Neuroscience, 17*(10), 652. http://doi.org/10.1038/nrn.2016.111

Thome, M., & Skuladottir, A. (2005). Changes in sleep problems, parents distress and impact of sleep problems from infancy to preschool age for referred and unreferred children. *Scandinavian Journal of Caring Sciences, 19*(2), 86-94. http://doi/10.1111/j.1471-6712.2005.00322.x

Tovote, P., Fadok, J. P., & Lüthi, A. (2015). Neuronal circuits for fear and anxiety. *Nature Reviews Neuroscience, 16*(6), 317-331. http://doi.org/10.1038/nrn3945

Tyler, S. K., & Tucker, D. M. (1982). Anxiety and perceptual structure: Individual differences in neuropsychological function. *Journal of Abnormal Psychology, 91*(3), 210. http://doi.org/10.1037/0021-843X.91.3.210

Uljarevic, M., Nuske, H., & Vivanti, G. (2016). Anxiety in autism spectrum disorder. In *psychiatric symptoms and comorbidities in autism spectrum disorder* (pp. 21-38): Springer.http://doi.org/10.1007/978-3-319-29695-1_2

Underwood, J. F., Kendall, K. M., Berrett, J., Lewis, C., Anney, R., van den Bree, M. B., & Hall, J. (2019). Autism spectrum disorder diagnosis in adults: phenotype and genotype findings from a clinically derived cohort. *The British Journal of Psychiatry*, 1-7. http://doi.org/10.1192/bjp.2019.30

Van den Bergh, B. R., Mulder, E. J., Mennes, M., & Glover, V. (2005). Antenatal maternal anxiety and stress and the neurobehavioural development of the fetus and child: links and possible mechanisms. A review. *Neuroscience & Biobehavioral Reviews, 29*(2), 237-258. http://doi.org/10.1016/j.neubiorev.2004.10.007

Van den Bergh, B. R., Van Calster, B., Smits, T., Van Huffel, S., & Lagae, L. (2008). Antenatal maternal anxiety is related to HPA-axis dysregulation and self-reported depressive symptoms in adolescence: a prospective study on the fetal origins of depressed mood. *Neuropsychopharmacology, 33*(3), 536. http://doi.org/10.1038/sj.npp.1301450

Van der Hallen, R., Evers, K., Brewaeys, K., Van den Noortgate, W., & Wagemans, J. (2015). Global processing takes time: A meta-analysis on local–global visual processing in ASD. *Psychol Bull, 141*(3), 549. http://doi.org/10.1037/bul0000004

Van Eylen, L., Boets, B., Steyaert, J., Wagemans, J., & Noens, I. (2018). Local and global visual processing in autism spectrum disorders: Influence of task and sample characteristics and relation to symptom severity. *J Autism Dev Disord, 48*(4), 1359-1381. http://doi.org/10.1007/s10803-015-2526-2

Van Gastel, W., Legerstee, J., & Ferdinand, R. (2009). The role of perceived parenting in familial aggregation of anxiety disorders in children. *Journal of anxiety disorders, 23*(1), 46-53. http://doi.org/10.1016/j.janxdis.2008.03.014

van Os, J. (2013). The dynamics of subthreshold psychopathology: implications for diagnosis and treatment. *American Journal of Psychiatry, 170* (7), 695.http://doi.org/10.1176/appi.ajp.2013.13040474

van Steensel, F. J., Bögels, S. M., & Perrin, S. (2011). Anxiety disorders in children and adolescents with autistic spectrum disorders: a meta-analysis. *Clinical child and family psychology review, 14*(3), 302. http://doi.org/10.1007/s10567-011-0097-0

Vasa, R. A., Carroll, L. M., Nozzolillo, A. A., Mahajan, R., Mazurek, M. O., Bennett, A. E., . . . Bernal, M. P. (2014). A systematic review of treatments for anxiety in youth with autism spectrum disorders. *J Autism Dev Disord, 44*(12), 3215-3229. http://doi.org/10.1007/s10803-014-2184-9

Vasa, R. A., Mazurek, M. O., Mahajan, R., Bennett, A. E., Bernal, M. P., Nozzolillo, A. A., . . . Coury, D. L. (2016). Assessment and treatment of anxiety in youth with autism spectrum disorders. *Pediatrics, 137(*Supplement 2), S115-S123. http://doi.org/10.1542/peds.2015-2851J

Vasey, M. W., Crnic, K. A., & Carter, W. G. (1994). Worry in childhood: A developmental perspective. *Cognitive therapy and research, 18(*6), 529-549. http://doi.org/10.1007/BF02355667

Vasey, M. W., & Daleiden, E. L. (1994). Worry in children. In G. C. L. Davey & F. Tallis (Eds.), *Wiley series in clinical psychology. Worrying: Perspectives on theory, assessment and treatment* (p. 185–207). John Wiley & Sons.

Vasistha, N. A., Pardo-Navarro, M., Gasthaus, J., Weijers, D., Müller, M. K., García-González, D., . . . von Engelhardt, J. (2019). Maternal inflammation has a profound effect on cortical interneuron development in a stage and subtype-specific manner. *Molecular psychiatry*, 1-17. http://doi.org/10.1038/s41380-019-0539-5

Verkuil, B., Brosschot, J. F., Borkovec, T. D., & Thayer, J. F. (2009). Acute autonomic effects of experimental worry and cognitive problem solving: Why worry about worry? *International journal of clinical and health psychology, 9*(3), 439-453.

Viggiano, A., Cacciola, G., Widmer, D. A., & Viggiano, D. (2015). Anxiety as a neurodevelopmental disorder in a neuronal subpopulation: Evidence from gene expression data. *Psychiatry research, 228*(3), 729-740. http://doi.org/10.1016/j.psychres.2015.05.032

Weinberger, D. R., Glick, I. D., & Klein, D. F. (2015). Whither Research Domain Criteria (RDoC)?: The good, the bad, and the ugly. *JAMA psychiatry, 72*(12), 1161-1162. http://doi.org/10.1001/jamapsychiatry.2015.1743

White, S. W., Oswald, D., Ollendick, T., & Scahill, L. (2009). Anxiety in children and adolescents with autism spectrum disorders. *Clinical psychology review, 29*(3), 216-229. http://doi.org/10.1016/j.cpr.2009.01.003

Whiteside, S. P., Gryczkowski, M., Ale, C. M., Brown-Jacobsen, A. M., & McCarthy, D. M. (2013). Development of child-and parent-report measures of behavioral avoidance related to childhood anxiety disorders. *Behavior Therapy*, *44*(2), 325-337. http://doi.org/10.1016/j.beth.2013.02.006

Whiteside, S. P., Sattler, A. F., Hathaway, J., & Douglas, K. V. (2016). Use of evidence-based assessment for childhood anxiety disorders in community practice. *Journal of anxiety disorders, 39*, 65-70. http://doi.org/10.1016/j.janxdis.2016.02.008

Wiegner, L., Hange, D., Björkelund, C., & Ahlborg, G. (2015). Prevalence of perceived stress and associations to symptoms of exhaustion, depression and anxiety in a working age population seeking primary care-an observational study. *BMC family practice, 16*(1), 38. http://doi.org/10.1186/s12875-015-0252-7

Wiener, A., Rohr, C. S., Naor, N., Villringer, A., & Okon-Singer, H. (2020). Emotion Regulation in Essential Hypertension: Roles of Anxiety, Stress, and the Pulvinar. *Frontiers in Behavioral Neuroscience*. http://doi.org/10.3389/fnbeh.2020.00080

Wijnhoven, L. A., Creemers, D. H., Vermulst, A. A., & Granic, I. (2018). Prevalence and risk factors of anxiety in a clinical Dutch sample of children with an autism spectrum disorder. *Frontiers in psychiatry, 9*, 50. http://doi.org/10.3389/fpsyt.2018.00050

Wilson, C. (2010). Pathological worry in children: What is currently known? *Journal of Experimental Psychopathology, 1*(1), jep. 008110. http://doi.org/10.5127/jep.008110

World Health Organization. (2013). *Meeting report: autism spectrum disorders and other developmental disorders: from raising awareness to building capacity*: World Health Organization, Geneva, Switzerland 16-18 September 2013.

World Health Organization. (2018). *International classification of diseases for mortality and morbidity statistics* (11th Revision). Retrieved from https://icd.who.int/browse11/l-m/en

Zeil, J., Boeddeker, N., & Hemmi, J. M. (2008). Vision and the organization of behaviour. *Current Biology, 18*(8), R320-R323. http://doi.org/10.1016/j.cub.2008.02.017

Zhang, R., & Volkow, N. D. (2019). Brain default-mode network dysfunction in addiction. *Neuroimage, 200,* 313-331. http://dx.doi.org/10.1016/j.neuroimage.2019.06.036

Chapter 3- Methodological Issues

This chapter provides background and context to the methods used in the experimental chapters of this thesis including participant choice, participant numbers and study design.

Population Characterisation

Given that this thesis aimed to examine a wide range of children who require additional support at school for social, emotional and/or academic reasons, a key methodological consideration was how to best define the population. It was evident when reviewing academic literature and government frameworks that terms used to describe children experiencing various types of difficulties were either not adequately defined, or the definition varied across contexts and cultures (Norwich, 2013; Van Der Lee, Mokkink, Grootenhuis, Heymans, & Offringa, 2007). Several labels were contemplated for our population, and it should be acknowledged that many aspects of each label had overlap. A summary of considerations regarding population characterisation is outlined below.

Disability

Disability has been defined by the International Classification of Functioning, Disability and Health, a framework for the World Health Organisation, as "an umbrella term for impairments, activity limitations, and participation restrictions, denoting the negative aspects of the interaction between an individual (with a health condition) and that individual's contextual factors (environmental and personal factors)" (World Health Organisation, 2011, p.7). Exactly what constitutes a disability, and whether this is best viewed through the lens of a medical or social model, has been the subject of much ongoing debate (Anastasiou & Kauffman, 2013). Generally speaking, the medical model proposes that disabilities are impairments of biological origin distinct from psychosocial factors (Brittain, 2004) whereas

the social model of disability highlights the barriers of society from overall inclusion (Oliver, 2013). The World Health Organisation has historically distinguished impairment and disability with an impairment defined as a "loss or abnormality of psychological, physiological, or anatomical structure or function" (World Health Organisation, 1980, p. 45) whereas a disability can be "any restriction or lack (resulting from an impairment) of ability to perform an activity in the manner or within the range considered normal for a human being" (Bickenbach, Chatterji, Badley, & Üstün, 1999, p. 1175). Not all children who require extra support at school have a disability, and therefore we did not consider the term to be adequately reflective of the population group used in this thesis. Thus, *Special Health Care Needs* is used more frequently in the healthcare system than 'disability' (Krahn, Walker, & Correa-De-Araujo, 2015).

Additional and Special Educational Needs

Dempsey and Davies (2013) defined *Additional Educational Needs* as children requiring a specialist intervention at school, such as additional educational support. Although this definition refers to children in Australia excluded from NAPLAN testing, the exact time frame and frequency of intervention remains variable and particular to each child, though usually it is for prolonged duration during primary school at least. Using an Australian population, they considered 'Additional Education Needs' to include children with varied diagnoses, not limited to learning disabilities, emotional and behavioural difficulties and autism (Dempsey & Davies, 2013). The terms *Additional Support Needs* in Scotland and *Special Education Needs* in England are used to describe children requiring extra support in those particular countries, though again what is included in this definition (e.g. learning, emotional and behavioural difficulties) is varied and has been expanding due to increased recognition of difficulties and unusual needs of many children (Farrell, 2001; Riddell & Carmichael, 2019). For example, Additional Needs has also been broadly associated with

learning difficulties that require support and therapeutic intervention (Wong & Press, 2017). Whilst the notions of Additional and Special Educational Needs is important in identifying children requiring extra support at school, the label did not appear to adequately emphasise the inclusion of subthreshold or undiagnosed emerging needs required for this thesis. Additionally, *Special Needs* has been criticised as an ineffective euphemism for disability that is less inclusive of different types of disability such as neurodevelopmental disorders including ASD and ADHD (Gernsbacher, Raimond, Balinghasay, & Boston, 2016).

Additional Health and Developmental Needs and Special Health Care Needs

Special Health Care Needs and *Additional Health and Developmental Needs* are both commonly used across the literature to include "children with special health care needs …. who have or are at increased risk for a chronic physical, developmental, behavioural, or emotional condition" (McPherson et al., 1998 p. 138) that may affect participation at school. Importantly, the definition highlights that children with Additional Health and Developmental Needs may "also require health and related services of a type or amount beyond that required by children generally" (McPherson et al., 1998, p. 138). Regardless of the term used, the fundamental principles of Additional Health and Developmental/ Special Health Care Needs are that the definition is deliberately broad to be inclusive of children with varied difficulties that would benefit from early intervention (Newacheck, Rising, & Kim, 2006), does not require a clinical diagnosis (O'Connor, Quach, Vashishtha, & Goldfeld, 2019) and considers the difficulties children face as existing along a continuum (O'Connor, Quach, & Goldfeld, 2020). Additional Health and Developmental/ Special Health Care Needs have important clinical implications given that at least 20% of Australian school children are reported to experience Additional Health and Developmental Needs in their first year of formal education (Goldfeld, O'Connor, Sayers, Moore, & Oberklaid, 2012), reflecting a shift towards inclusive funding for all students using a non-categorical approach while

emphasising the need to prioritise the identification of individual learning needs for each child (Sharma, Forlin, & Furlonger, 2015).

Additional Health and Developmental/ Special Health Care Needs are considered to be either established (diagnosed at school entry) or emerging (at risk of a chronic condition and often identified by teachers) (Goldfeld, O'Connor, Quach, Tarasuik, & Kvalsvig, 2015). Established and emerging needs are conceptualised as falling within the following areas; physical disability, visual impairment, hearing impairment, speech impairment, learning disability, emotional problems, behavioural problems, home environment and trauma (Goldfeld et al., 2012; O'Connor et al., 2019; O'Connor, Rosema, Quach, Kvalsvig, & Goldfeld, 2016). Specific examples of encompassing diagnoses are varied but include neurodevelopmental disorders such as ASD or cerebral palsy, learning disability such as reading problems, and medical conditions like asthma (Goldfeld et al., 2012; O'Connor et al., 2020).

Although undiagnosed or emerging needs often fall within a 'grey area' (Goldfeld et al., 2015; Newacheck et al., 2006), recent Australian literature has attempted to identify these from both teacher and parent perspectives. O'Connor and colleagues (2016; 2019) determined that emerging needs could be identified by teachers as those children requiring additional support, impacting on ability to engage in the classroom and/or the need for further assessment based on data associated with the Australian Early Development Census (Brinkman, Gregory, Goldfeld, Lynch, & Hardy, 2014). Similarly, emerging needs at school and more generally were recognised when parents reported that their child would require medication or medical, mental health or educational services or treatment more than their peers overall based on data from the Longitudinal Study of Australian Children (O'Connor et al., 2016).

This thesis will adopt the label *Additional Health and Developmental Needs* rather than Special Health Care Needs. The most important rationale for this decision was based on considerations of the current population. Although Special Needs is often used interchangeably with Additional Needs (Rowe et al., 2017), the word 'special' has been criticised by disability advocates as noted above (Sussman, Kattari, Baezconde-Garbanati, & Glackin, 2020). Importantly, the term Additional Health and Developmental Needs has been commonly accepted by the Murdoch Children's Research Institute (Australia's largest child health research facility) (e.g. O'Connor et al., 2015) and the Australian Federal Government (e.g. Howell-Meurs et al., 2014) and used to define population groups for research purposes similar to that used in the current thesis. Thus, *Additional Health and Developmental Needs* has been used and established in the same community as the population used in this thesis (i.e. children in Melbourne, Australia) and is reflected in relevant government policy and funding models.

Recruitment, Inclusion Criteria and Determining the Sample Size

Once the definition of the population was established, we set out to best understand the attention and anxiety profile of children with Additional Health and Developmental Needs. This research was conducted with the approval of the La Trobe University Human Ethics Committee (Approval number: HEC16-121/HEC18139), Victorian Department of Education Ethics Committee (Approval number: 2017_003294) and the Victorian Catholic Schools Ethics Committee (Approval number: CEM00889). Participants with Additional Health and Developmental Needs were recruited from a school holiday therapy program in Melbourne, Australia called SHINE (www.shine.org.au). The aim of SHINE is to target children experiencing significant difficulties at school and to ascertain a more generalised and comprehensive assessment and treatment plan in order to make or confirm a clinical diagnosis using standardised measures from a multi-disciplinary team of allied health

professionals, including psychologists, speech pathologists and occupational therapists at no financial cost.

The program occurs annually during school hours in the first three weeks of January before the school year begins and children usually attend daily for one week. Children are usually identified as candidates for SHINE by their teachers if they are behind academically (e.g. reading ability) or socially (e.g. limited friendships). Teachers suggest the program, but children have to be referred by their parents with supporting information from practitioners and teachers including any past medical and psychological reports, information regarding medication and therapy or treatments, school report and assessments of intelligence. Parents provided information about a child's, vision and hearing, however further screening (eye examination by an optometrist and hearing tests by an audiologist) were completed on-site when potential for sensory problems was indicated.. At the time of data collection, children who attended SHINE had either formally diagnosed or undiagnosed difficulties recognised by teachers. As of 2019, the criteria to attend the program has been narrowed and now only accepts formally diagnosed children.

Children attending this program were deemed to have Additional Health and Developmental Needs by virtue of requiring more support than their peers generally (McPherson et al., 1998). Inclusion criteria for the Additional Health and Developmental Needs sample reflected children attending the therapy program, and included a range of diagnosed and undiagnosed needs including Attention Deficit Hyperactive Disorder (ADHD); Auditory Processing Impairments and Disorders; Communicative Social Deficits; Confidence & Self- Esteem Difficulties; ASD; Language Delay; Language Impairment; Language Disorders; Specific Language Impairment; Anxiety; Reading Delay, Impairment or Disorder; Dyslexia, Semantic and Pragmatic Disorders; Sensory Processing Disorders; Speech Sound Disorders and Dyspraxia; Spelling Delay or Impairment; Writing Delay,

Impairment or Disorder; and Dysgraphia. Children with physical disability, intellectual disability, medical issues, or major mental health concerns related to trauma were excluded from the program despite these children still meeting criteria for Additional Health and Developmental Needs. A small typically developing sample of nine participants was also recruited from St Margaret Mary's Primary School in Melbourne, Australia and were excluded if they had received any clinical developmental or mental health diagnosis or required ongoing additional help from school. There were no reported hearing difficulties reported, however eye examinations were also completed by an optometrist when indicated. The low participant numbers in the control group is due to the community and school lockdowns that followed COVID-19 impacts in Australia. To date, these restrictions are still in place and further completion of data collection has subsequently not been possible prior to the submission date of this thesis.

A power analysis was conducted to determine the sample size needed for each of the three experimental studies in this thesis, though the required sample size for controls was not attained in the time available given the prolonged COVID pandemic here in Australia. Additionally, the participant focus of this thesis was children with Additional Health and Developmental Needs (as discussed in Chapter 1). Thus, it is the intention of the research lab associated with this thesis to continue data collection among both populations as part of ongoing research projects. In terms of the current thesis, the Additional Health and Developmental Needs group participant numbers vary between the experimental chapters due to the exclusion of outliers and incomplete data for some children. All three experimental chapters of this thesis are inclusive of the same overall AHDN and TD samples, including the age-matched subsamples.

Choice of Tests and Final Design

The choice of tests employed reflects the general hypotheses of this thesis (outlined in Chapter 1) that chronic anxiety would be a common characteristic amongst children with Additional Health and Developmental Needs and that prolonged heightened anxiety would affect visual attention and performance and potentially contribute to educational performance. Although the use of physiological measures is known to be important but underutilised in the assessment of anxiety (Wilhelm & Roth, 2001), they were not used directly in experimental methods of this thesis given it was important for the tests used to be widely accessible and easily implemented for psychologists, other health professionals and teachers.

In order to investigate anxiety, we chose a widely used parent-rated questionnaire the Spence Children's Anxiety Scale- Parent Report (SCAS-P) (Appendix E). The SCAS- P is a measure of childhood anxiety with good reliability (Cronbach's $\alpha = 0.89$), convergent validity and divergent validity (anxious group: $Z = 387.7$, $p < 0.001$; control group: $Z = 49.8$, $p < 0.001$) when correlated with the Child Behaviour Checklist (CBCL) externalising and internalising subscales (refer to Nauta et al., 2004 for further details of psychometric properties). We also included a measure of autism traits and sleep scales as a way to assess behaviours that we predicted would be associated with anxiety. The Autism Quotient (AQ-Child) (Appendix F) is a well-known measure of autism-like behaviours with good test-retest reliability ($r = 0.85$, $p < 0.001$) and good construct validity as demonstrated by high specificity (95%) and sensitivity (95%) in identifying children with ASD using a cut off score of 76 (Auyeung, Baron-Cohen, Wheelwright, & Allison, 2008). We chose the Sleep Disturbance Scale for Children (SDSC) (Bruni et al., 1996) (Appendix G) to measure sleep as an extensively used questionnaire in childhood sleep literature with reasonable test-retest reliability ($r = 0.71$) and good validity (AUC = 0.91), sensitivity (0.89/89%) and specificity (0.74/74%) in identifying childhood sleep disorders with a cut off score of 39.

Behavioural questionnaires that are known to be effective in the experimental identification of developmental symptoms such as anxiety and inattention in childhood were also utilised to explore how anxiety and related behavioural characteristics might impact on the ability of our two samples to function day to day, particularly at school where children with Additional Health and Developmental Needs generally have poorer education engagement and academic outcomes (Forrest, Bevans, Riley, Crespo, & Louis, 2011; Goldfeld et al., 2015). Although such screening tools have been suggested to increase communication of parent perceived potential developmental vulnerabilities to health care professionals across cultures, they are currently not in standard clinical use in Australia (Garg et al., 2018).

We chose to use widely used experimental measures of attention- computerised child versions of the Attention Network Task (Rueda et al., 2004) and a Navon Task (Navon, 1977). Attention was measured using a computer based psychophysical approach. Such methodological approaches are considered to be a rigorous, practical and accessible method of neuroscience research (Read, 2015), and likely to answer questions that are often clinically considered to be affected by anxiety. A psychophysics approach is also proposed to be a non-invasive technique to bridge the gap between cognitive neuroscience and education (Ansari, Coch, & De Smedt, 2011; Goswami, 2006). In children, it is recommended that a psychophysiological approach to research is conducted alongside the collection of generalised classroom behavioural data given the ability of psychophysics to measure neural processes and performance over a short period of time (i.e. milliseconds) compared to behaviours that are usually measured across hours to months (Mercier & Charland, 2013; Mercier, Léger, Girard, & Dion, 2012) and thus this approach was used across the experimental chapters of this thesis.

References

Anastasiou, D., & Kauffman, J. M. (2013). The social model of disability: Dichotomy between impairment and disability. *The Journal of Medicine and Philosophy: A Forum for Bioethics and Philosophy of Medicine,38*(4), 441-459. http://doi.org/10.1093/jmp/jht026

Ansari, D., Coch, D., & De Smedt, B. (2011). Connecting Education and Cognitive Neuroscience: Where will the journey take us? *Educational Philosophy and Theory, 43*(1), 37-42. https://doi.org/10.1111/j.1469-5812.2010.00705.x

Auyeung, B., Baron-Cohen, S., Wheelwright, S., & Allison, C. (2008). The autism spectrum quotient: Children's version (AQ-Child). *J Autism Dev Disord, 38*(7), 1230-1240. https://doi.org./10.1007/s10803-007-0504-z

Bickenbach, J. E., Chatterji, S., Badley, E. M., & Üstün, T. B. (1999). Models of disablement, universalism and the international classification of impairments, disabilities and handicaps. *Social science & medicine, 48*(9), 1173-1187. https://doi.org/10.1016/s0277-9536(98)00441-9

Brinkman, S. A., Gregory, T. A., Goldfeld, S., Lynch, J. W., & Hardy, M. (2014). Data resource profile: the Australian early development index (AEDI). *International Journal of Epidemiology, 43*(4), 1089-1096. https://doi.org/10.1093/ije/dyu085

Brittain, I. (2004). Perceptions of disability and their impact upon involvement in sport for people with disabilities at all levels. *Journal of sport and social issues, 28*(4), 429-452. https://doi.org/10.1177/0193723504268729

Dempsey, I., & Davies, M. (2013). National test performance of young Australian children with additional educational needs. *Australian Journal of Education, 57*(1), 5-18. https://doi.org/10.1177/0004944112468700

Farrell, P. (2001). Current issues in special needs: Special education in the last twenty years: Have things really got better? *British Journal of Special Education, 28*(1), 3-9. https://doi.org/10.1111/1467-8527.t01-1-00197

Forrest, C. B., Bevans, K. B., Riley, A. W., Crespo, R., & Louis, T. A. (2011). School outcomes of children with special health care needs. *Pediatrics, 128*(2), 303. https://doi.org/10.1542/peds.2010-3347

Garg, P., Ha, M. T., Eastwood, J., Harvey, S., Woolfenden, S., Murphy, E., . . . McKenzie, A. (2018). Health professional perceptions regarding screening tools for developmental surveillance for children in a multicultural part of Sydney, Australia. *BMC family practice, 19*(1), 42. https://doi.org/10.1186/s12875-018-0728-3

Gernsbacher, M. A., Raimond, A. R., Balinghasay, M. T., & Boston, J. S. (2016). "Special needs" is an ineffective euphemism. *Cognitive research: principles and implications, 1*(1), 29. https://doi.org/10.1186/s41235-016-0025-4

Goldfeld, S., O'Connor, M., Sayers, M., Moore, T., & Oberklaid, F. (2012). Prevalence and correlates of special health care needs in a population cohort of Australian children at school entry. *Journal of Developmental & Behavioral Pediatrics, 33*(4), 319-327. https://doi.org/10.1097/DBP.0b013e31824a7b8e

Goldfeld, S., O'Connor, M., Quach, J., Tarasuik, J., & Kvalsvig, A. (2015). Learning trajectories of children with special health care needs across the severity spectrum. *Academic pediatrics, 15*(2), 177-184. https://doi.org/10.1016/j.acap.2014.09.001s

Goswami, U. (2006). Neuroscience and education: from research to practice? *Nature Reviews Neuroscience, 7*(5), 406-413. http://doi.org/10.1038/nrn1907

Howell-Meurs, S., O'Connor, M., Kvalsvig, A., & Goldfeld, S. . (2014). *The school functioning of children with additional health and developmental care needs in the*

primary years: A literature review. Melbourne, Australia: Centre for Community Child Health.

Krahn, G. L., Walker, D. K., & Correa-De-Araujo, R. (2015). Persons with disabilities as an unrecognized health disparity population. *American journal of public health, 105*(S2), S198-S206. https://doi.org/10.2105/AJPH.2014.302182

McPherson, M., Arango, P., Fox, H., Lauver, C., McManus, M., Newacheck, P. W., . . . Strickland, B. (1998). A new definition of children with special health care needs. *Pediatrics, 102*(1), 137-139. https://doi.org/10.1542/peds.102.1.137

Mercier, J., & Charland, P. (2013). An agenda for neuroeducation: relating psychophysiological and behavioral data across time scales of learning. *Neuroeducation, 2*(1), 71-86. http://doi.org/10.24046/neuroed.20130201.71

Mercier, J., Léger, P.-M., Girard, C., & Dion, J.-S. (2012). Bridging the gap between cognitive neuroscience and education: Psychophysiological and behavioral data collection in authentic contexts. *Neuroeducation, 1*(1), 5-28. http://doi.org/10.24046/neuroed.20120101.5

Nauta, M. H., Scholing, A., Rapee, R. M., Abbott, M., Spence, S. H., & Waters, A. (2004). A parent-report measure of children's anxiety: psychometric properties and comparison with child-report in a clinic and normal sample. *Behav Res Ther, 42*(7), 813-839. http://doi.org/10.1016/S0005-7967(03)00200-6

Navon, D. (1977). Forest before trees: The precedence of global features in visual perception. *Cognitive psychology, 9*(3), 353-383. https://doi.org/10.1016/0010-0285(77)90012-3

Newacheck, P. W., Rising, J. P., & Kim, S. E. (2006). Children at risk for special health care needs. *Pediatrics, 118*(1), 334-342. https://doi.org/10.1542/peds.102.1.117

Norwich, B. (2013). Categories of special educational needs. *The SAGE Handbook of Special Education: Two Volume Set, 1*, 55. http://doi.org/10.4135/9781446282236.n3

O'Connor, M., O'Connor, E., Quach, J., Vashishtha, R., & Goldfeld, S. (2019). Trends in the prevalence and distribution of teacher-identified special health-care needs across three successive population cohorts. *Journal of paediatrics and child health, 55*(3), 312-319. https://doi.org/10.1017/s0954579402004108

O'Connor, M., Rosema, S., Quach, J., Kvalsvig, A., & Goldfeld, S. (2016). Parent and teacher perceptions of emerging special health care needs. *Journal of paediatrics and child health, 52*(10), 950-956. https://doi.org/10.1111/jpc.13188

O'Connor, M., Quach, J., & Goldfeld, S. (2020). Children on the Edge: Starting School with Additional Health and Developmental Needs. In *Health and Education Interdependence* (pp. 75-89): Springer.

O'Connor, M., Quach, J., Goldfeld, S., Gold, L., Aston, R., Beatson, R., & Hopkins, D. (2015). *Approaches to the provision of educational support for children and young people with additional health and developmental needs: Autism Spectrum Disorders*. Centre for Community Child Health, Melbourne, Victoria.

Oliver, M. (2013). The social model of disability: Thirty years on. *Disability & society, 28*(7), 1024-1026. https://doi.org/10.1080/09687599.2013.818773

Read, J. (2015). The place of human psychophysics in modern neuroscience. *Neuroscience, 296*, 116-129. https://doi.org/10.1016/j.neuroscience.2014.05.036

Riddell, S., & Carmichael, D. (2019). The biggest extension of rights in Europe? Needs, rights and children with additional support needs in Scotland. *International Journal of Inclusive Education*, 1-18. http://doi.org/10.1080/13603116.2019.1580925

Rowe, G., Counihan, C., Ellis, S., Gee, D., Graham, K., Henderson, M., . . . Carter-Bennett, J. (2017). *The Handbook for Nursing Associates and Assistant Practitioners*: SAGE.

Rueda, M. R., Fan, J., McCandliss, B. D., Halparin, J. D., Gruber, D. B., Lercari, L. P., & Posner, M. I. (2004). Development of attentional networks in childhood.

Neuropsychologia, 42(8), 1029-1040. http://doi.org/10.1016/j.neuropsychologia.2003.12.012

Sharma, U., Forlin, C., & Furlonger, B. (2015). *Contemporary models of funding inclusive education for students with Autism Spectrum Disorder*. *A report commissioned by the Program for Students with Disabilities Review Unit for the Department of Education and Training for the State of Victoria.* Melbourne, Victoria.

Sussman, S., Kattari, S. K., Baezconde-Garbanati, L., & Glackin, S. N. (2020). Commentary: The Problems of Grouping All Adversity Into a Special Populations Label. *Evaluation & the Health Professions, 43*(1), 66-70. http://doi.org/10.1177/0163278719882738

Van Der Lee, J. H., Mokkink, L. B., Grootenhuis, M. A., Heymans, H. S., & Offringa, M. (2007). Definitions and measurement of chronic health conditions in childhood: a systematic review. *Jama, 297*(24), 2741-2751. http://doi.org/10.1001/jama.297.24.2741

Wilhelm, F. H., & Roth, W. T. (2001). The somatic symptom paradox in DSM-IV anxiety disorders: suggestions for a clinical focus in psychophysiology. *Biological psychology, 57*(1-3), 105-140. http://doi.org/10.1016/S0301-0511(01)00091-6

World Health Organisation. (1980). *International classification of impairments, disabilities, and handicaps: a manual of classification relating to the consequences of disease, published in accordance with resolution WHA29. 35 of the Twenty-ninth World Health Assembly, May 1976.* Retrived from: https://apps.who.int/iris/handle/10665/41003

World Health Organisation. (2011). *World report on disability 2011*. Retrived from: https://www.who.int/disabilities/world_report/2011/report/en/

Wong, S., & Press, F. (2017). Interprofessional work in early childhood education and care services to support children with additional needs: two approaches. *Australian Journal of Learning Difficulties, 22*(1), 49-56. http://doi.org/10.1080/19404158.2017.1322994

Chapter 4 - Anxiety as a Common Biomarker for School Children with Additional Health and Developmental Needs Irrespective of Diagnosis

This chapter has been published in the journal 'Frontiers in Psychology':

Cross, A. J., Goharpey, N., Laycock, R., & Crewther, S. G. (2019). Anxiety as a Common Biomarker for School Children with Additional Health and Developmental Needs Irrespective of Diagnosis. *Frontiers in Psychology*, *10*, 1420.

Abstract

Currently very little evidence is available regarding the biological characteristics and common comorbid behaviours that are associated with children characterised by learning difficulties who require additional support at school. These children are usually referred to as having Additional Health and Developmental Needs by the Australian Government and the associated public education systems more broadly though the problems may arise from academic, social and/or emotional stressors and may or may not include children with clinically diagnosed neurodevelopmental disorders. Thus, the aim of this study was to investigate the relationship between anxiety levels (Spence Children's Anxiety Scale- Parent Report), autism traits (Autism Spectrum Quotient – Child Version) and sleep quality (Sleep Disturbance Scale for Children) in children with Additional Health and Developmental Needs without an intellectual disability, but with either a diagnosis of Autism Spectrum Disorder (ASD) (N = 25), Speech and Language Impairment (N = 37) or Other Diagnosis (N = 22). Our results demonstrated that these children with Additional Health and Developmental Needs showed atypically high levels of anxiety and impaired sleep quality, with the ASD group reporting more impairments associated with comorbid anxiety and sleep quality than either of the other clinically diagnosed groups. In fact, greater anxiety level was associated with a greater number of autism traits and poorer sleep quality regardless of diagnostic group suggesting that anxiety is a common experience for children with Additional Health and Developmental Needs. It is suggested that assessment of anxiety, sleep behaviours and autism traits may be useful markers for early identification of children within this population, thus providing scope for early and targeted intervention.

Keywords: Anxiety, Autism Spectrum Disorder, Autism Traits, Sleep, Language Impairment, Learning Difficulties, Additional Needs Children

Anxiety as a Common Biomarker for School Children with Additional Health and Developmental Needs Irrespective of Diagnosis

Childhood is the most critical developmental period (Irwin, Siddiqi, & Hertzman, 2007), making the identification of educational and mental health difficulties and the need for developmentally appropriate early intervention fundamental (Atkins, Cappella, Shernoff, Mehta, & Gustafson, 2017; Noam & Hermann, 2002). It is estimated that at least 1 in 5 children in Australia require extra support at school due to a wide range of diagnosed and undiagnosed developmental disorders, learning, behavioural and/or emotional difficulties (Goldfeld, O'Connor, Sayers, Moore, & Oberklaid, 2012). These children are classified by the Australian Government and public education system as having Additional Health and Developmental Needs (AHDN) (Howell-Meurs, et al., 2014; O'Connor et al., 2015), sometimes referred to as Special Health Care Needs (Bethell et al., 2002; O'Connor, O'Connor, Quach, Vashishtha, & Goldfeld, 2019). Thus AHDN children have come to be categorised as "those who have, or are at increased risk for a chronic physical, developmental, behavioural, or emotional condition and who also require health and related services of a type or amount beyond that required by children generally" (McPherson et al., 1998, p. 138). Such needs may be established (diagnosed at school entry) or emerging (identified by teachers) (Goldfeld, O'Connor, Quach, Tarasuik, & Kvalsvig, 2015), suggesting that difficulties noted at school may be indicative of an underlying biological problem. The developmental characteristics of children with AHDN are largely unknown, given that they are often excluded from research, government policies and access to funding for interventions (Dempsey & Davies, 2013; McDowell & O'Keeffe, 2012).

We set out to investigate whether such a group of children with AHDN share common biological characteristics and behavioural comorbidities irrespective of the aetiology or environmental source of their primary difficulty. Anecdotally it is often assumed that

learning difficulties are a source of anxiety, a claim that is supported by evidence that lower intellectual ability is related to increased anxiety, sleep difficulties and unsuccessful social interactions (Rzepecka, McKenzie, McClure, & Murphy, 2011). Lower childhood IQ is also known to be associated with an increased risk of developing Generalised Anxiety Disorder (GAD), obsessive-compulsive symptoms, depression and schizophrenia in adulthood (Grisham et al., 2011; Koenen et al., 2009; Martin et al., 2007). Conversely, higher childhood IQ can be a protective factor for anxiety, with performance one standard deviation above the mean on a Full Scale IQ assessment at the age of seven thought to reduce the lifetime risk of a GAD diagnosis by 50% (Martin et al., 2007). Thus, this study focussed on investigating anxiety in children with a range of diagnoses who were identified as struggling at school.

Anxiety is a universal human experience, underpinning basic adaptive behaviours such as the 'fight, flight or freeze' response (Bracha, 2004). By comparison, diagnosed or clinical childhood anxiety is a leading burden of disease (Baranne & Falissard, 2018; World Health Organisation [WHO] (WHO, 2013b) and is associated with poor self-esteem and decreased quality of life, with even subthreshold symptoms being predictive of clinical anxiety, depression and mood disorders in both adolescence and adulthood (Kovacs & Lopez-Duran, 2010; Martinsen et al., 2016; Rapee, 2012; van Os, 2013).

Given that anxiety is known to affect an individual's entire biological system, we further propose that certain behaviours may be symptomatic of anxiety (core biomarkers) (Maron & Nutt, 2017; Meyer, 2017; Shadli, Glue, McIntosh, & McNaughton, 2015), such as insomnia and worry (prolonged rumination about future events) (McGorry, 2013; van Os, 2013). These behaviours may predict behavioural expressions of anxiety (such as sleep and autism traits) in young children who do not necessarily meet full diagnostic classification of an Anxiety Disorder but still have deficits in everyday functioning. Identification of core biomarkers is especially important for children who may not be able to verbally express their

anxiety or identify emotions due to difficulties with speech and language such as those with Autism Spectrum Disorder (ASD) (Green & Ben-Sasson, 2010). Early intervention has been reported to reduce anxiety in children, however longer term outcomes remain largely unknown in adolescence and adulthood (Barrett, Farrell, Ollendick, & Dadds, 2006; Neil & Christensen, 2009; Werner-Seidler, Perry, Calear, Newby, & Christensen, 2017), highlighting the need for better detection earlier in childhood (Bayer et al., 2011; Fisak, Richard, & Mann, 2011; Neil & Christensen, 2009).

Anxiety shares many core features and is commonly comorbid with ASD (Grondhuis & Aman, 2012; Kerns & Kendall, 2014), where anxiety has been suggested as an underlying cause of ASD symptoms (Gotham et al., 2013; Green & Ben-Sasson, 2010). An otherwise neurotypical child who presents with anxiety often exhibits a spectrum of behaviours consistent with ASD traits such as rigidity of thought, inflexible behaviour, sleep difficulties and emotional dysregulation (van Steensel, Bögels, & Perrin, 2011). Such observations have led to the conceptualisation of the spectrum of autism as including non-clinical individuals in the wider population who possess related traits to varying degrees (Auyeung, Baron-Cohen, Wheelwright, & Allison, 2008), and whose behaviour is recognised as associated with anxiety, depression, worse educational performance (Freeth, Bullock, & Milne, 2013; Rosbrook & Whittingham, 2010) and sleep disturbances (Limoges, Mottron, Bolduc, Berthiaume, & Godbout, 2005).

Anxiety and sleep have a bidirectional relationship (Alvaro, Roberts, & Harris, 2013; Kahn, Sheppes, & Sadeh, 2013). Sleep problems in childhood are associated with increased symptoms of Generalised Anxiety Disorder, somatic complaints, aggression, poorer empathy and decreased attention (Brand et al., 2016; Fischer, Anthony, Lalich, & Blue, 2014; Fletcher et al., 2016; James & Hale, 2017; Simola, Liukkonen, Pitkäranta, Pirinen, & Aronen, 2014) and are recognised as having negative consequences for learning and attention, reduced

concentration and immune system functioning (Curcio, Ferrara, & De Gennaro, 2006; Segerstrom & Miller, 2004). Difficulty with sleep can be a behavioural consequence of anxiety that is also associated with ASD symptoms (Alfano, Ginsburg, & Kingery, 2007; Schreck, Mulick, & Smith, 2004; Veatch et al., 2017). Poor sleep is known to contribute to challenging behaviours across the autism spectrum (Cohen, Conduit, Lockley, Rajaratnam, & Cornish, 2014; Cohen et al., 2018; May, Cornish, Conduit, Rajaratnam, & Rinehart, 2015; Richdale & Schreck, 2009; Rzepecka, McKenzie, McClure, & Murphy, 2011) leaving us wondering if sleep disturbances might also be an important characteristic of children with AHDN. Thus as previous literature has documented a relationship between anxiety and sleep quality (Alfano et al., 2007), and anxiety and ASD (Vasa et al., 2014), we set out to investigate the relationships between all three variables of anxiety, autism behaviours and sleep quality in children with AHDN.

We have chosen to use parent answered questionnaires as an accepted way (Eisert, Sturner, & Mabe, 1991) to identify common experiences of anxiety and associated autism traits and sleep behaviours in AHDN children. We also acknowledge that parents of children with disorders such as ASD are likely to be better at identifying overtly observable, rather than internally experienced, symptoms of anxiety due to the child's difficulty expressing and accurately communicating emotions (Magiati, Chan, Tan, & Poon, 2014). Thus, the aims of this study were to investigate the relationship between parent perceived childhood anxiety, sleep problems and autism traits across clinical diagnostic categories in AHDN children, and to identify which aspect of anxiety is most associated with sleep and autism-like behaviours. An associated aim of this study was to determine whether increased anxiety is associated with a neurodevelopmental disorder diagnosis.

We hypothesised that children who have high levels of parent rated anxiety will have greater parent reported severity of autism traits and sleep disturbance than children with

lower levels of anxiety regardless of diagnosis. Given that we propose anxiety as a common biomarker in AHDN children, it is anticipated that our overall sample will have higher anxiety scores than normal controls found in previous research despite their differing diagnoses (Nauta et al., 2004). Furthermore, we anticipated that children with a diagnosis of ASD would have even greater levels of parent reported anxiety compared to other groups, consistent with past research reporting high comorbidity (van Steensel, Bögels, & Perrin, 2011)

Methods

Participants

A total of 90 children aged between five and thirteen years participated in this study (see Table 4.1 for demographics). Participants were recruited from a school holiday therapy program for children experiencing social, emotional and academic difficulties in Melbourne, Australia and were identified as having AHDN due to requiring more support than their peers (McPherson et al., 1998). Inclusion criteria for the study aligned with children attending the therapy program and included clinical diagnoses of Attention Deficit Hyperactive Disorder (ADHD); Auditory Processing Impairments and Disorders; Communicative Social Deficits; Confidence & Self- Esteem Difficulties; ASD; Language Delay; Language Impairment; Language Disorders; Specific Language Impairment; Anxiety; Reading Delay, Impairment or Disorder; Dyslexia, Semantic and Pragmatic Disorders; Sensory Processing Disorders; Speech Sound Disorders and Dyspraxia; Spelling Delay or Impairment; Writing Delay, Impairment or Disorder; and Dysgraphia. Children with physical disability, intellectual disability, medical issues, or major mental health concerns related to trauma were excluded.

As the majority of children had been previously diagnosed with ASD or a Speech and Language disorder, the remaining children were categorised as a miscellaneous ‘Other’ diagnostic group for the purpose of statistical analyses. The ‘Other’ diagnostic group was

created to include participants in the analysis who had a minority diagnosis and consisted of children with a reported primary diagnosis of ADHD (seven participants), a chromosomal condition (two participants) or who were undiagnosed however experienced difficulties with social skills (thirteen participants). Children had up to five comorbid diagnoses from various health professionals, with an average of 1.48 comorbidities. Seven children were diagnosed with a comorbid anxiety disorder. Six participants were excluded as they were deemed to have an intellectual disability on the Ravens Coloured Progressive Matrices (Raven, 1990) screening measure of nonverbal intelligence, leaving a total sample 84. Parents were made aware of the aims of the study prior to providing written consent for participation. Written informed parental consent was obtained for all participants. This study was conducted with approval from the La Trobe University Human Ethics Committee and the Victorian Department of Education Human Ethics Committee.

Our sample was compared to data previously published by Nauta et al. (2004). Their Anxiety Group (N = 484) consisted of 220 females (45%) and 264 males (55%) aged 6-17 years (M = 10.4, SD = 2.5) who had between 0-5 co-morbid diagnoses (M = 1.6, SD = 1.3). By comparison, their control group (N = 261) had 136 females (52%) and 125 males (48%) aged between 6 – 18 years (M = 11.5, SD = 2.0).

Table 4.1

Demographic Variables of Current Sample

N = 84

			N	%
Age	*M* (SD)	9.22 (1.85)	-	-
	Range	5 - 13	-	-
Gender	Female	-	26	31.00
	Male	-	58	69.00
Primary Diagnosis	ASD	-	25	29.80
	Speech and Language	-	37	44.00
	Other Diagnosis	-	22	26.20
Co-morbid diagnoses	*M* (SD)	1.48 (1.16)	-	-
	Range	0 -5	-	-

Materials

Screening Measures

Children were screened for normal or corrected to normal vision and hearing and assessed to exclude Intellectual Disability on the Raven's Coloured Progressive Matrices (RCPM). The RCPM is a widely used measure of fluid intelligence in children (Raven, 1990), and consists of 36 incomplete matrix puzzles (three sets of twelve) of increasing difficulty. Children were asked to identify the missing piece of the puzzle from six possible segments in order to best complete the matrix design. The task was not time limited.

Anxiety

Anxiety was assessed using the Spence Children's Anxiety Scale- Parent Version (SCAS-P) (Nauta et al., 2004). The SCAS-P is a 38-item questionnaire consisting of six

subscales: ‘Panic Attack and Agoraphobia’, ‘Separation Anxiety’, ‘Physical Injury Fears’, ‘Social Phobia’, ‘Obsessive Compulsive’ and ‘Generalised Anxiety Disorder’. Parents were asked to rate each statement in terms of the frequency of an anxiety-related behaviour observed in their child from ‘Never’, ‘Sometimes’, ‘Often’ or ‘Always’ with no specified time period. These responses were scored on a Likert scale from 0 (‘Never’) through to 3 (‘Always’) with a maximum possible score of 144. Higher scores indicated greater parent perceived childhood anxiety.

Autism Traits

Autism traits were measured using the Autism Spectrum Quotient- Child Version (AQ-Child) (Auyeung, Baron-Cohen, Wheelwright, Allison, 2008). The AQ-Child is a 50-item parent report questionnaire examining autism-like behaviours in five subscales: ‘Social Skills’, ‘Attention Switching’, ‘Attention to Detail’, ‘Communication’ and ‘Imagination’. Each question asked parents to rate the degree their child exhibited autism-like behaviours by responding ‘Definitely Agree’, ‘Slightly Agree’, ‘Slightly Disagree’ or ‘Definitely Disagree’. Responses were scored from 0 (‘Definitely Agree’) to 3 (‘Definitely Disagree’) to a maximum score of 150, with higher scores indicating higher level of autism-like traits.

Sleep

Sleep behaviours were assessed using the Sleep Disturbance Scale for Children (SDSC) (Bruni et al., 1996). The SDSC is a 27-item questionnaire for parents to rate their child’s sleep pattern over the past six months across six subscale domains: ‘Disorders of Initiating and Maintaining Sleep’, ‘Sleep Breathing Disorders’, ‘Disorders of Arousal’, ‘Sleep Wake Transition Disorders’, ‘Disorders of Excessive Somnolence’ and ‘Sleep Hyperhydrosis’. Questions were rated from ‘Never’, ‘Occasionally’ (up to once or twice per month), ‘Sometimes’ (once or twice per week), ‘Often’ (three to five times per week) to ‘Always’ (daily). These responses were scored on a Likert scale from 0 (‘Never’) to 5

('Always') with a maximum total score of 130. Higher scores were associated with increased sleep disturbance.

Procedure

At the commencement of the three-week school holiday program, parents were greeted by the researchers and provided with a verbal and written explanation of the research. Informed written consent was obtained prior to the commencement of data collection. Parents were invited to complete pen and paper versions of the AQ- Child, SCAS-P and SDSC about their child as well as a demographics questionnaire asking for the child's medical history and any clinical diagnosis, school grade and age. Parents were asked to complete and return all questionnaires within a one-week timeframe. All participants were screened for visual and hearing impairments. A subsample of participants completed the RCPM where time was permitted amongst other activities at the holiday program.

Data Analysis

All data was entered into the computer program SPSS (Version 23) and descriptive statistics were performed on all variables. Data screening was conducted for all measures to inspect for missing data, outliers and potential violations to assumptions of normality and homogeneity. Missing data was excluded from the analyses. The data was assessed using standard skewness and kurtosis measures, the Kolmogorov-Smirnov, and the Shapiro-Wilko test. These results indicated that the assumption of normality was violated, as expected given the atypical sample used in this study. Therefore, a nonparametric approach to data analysis was used. A Levene's test revealed assumptions of homogeneity were also violated.

Participants were split into High and Low Anxiety groups associated with the top and bottom third of SCAS-P total score, and their means and standard deviations compared to previously published scores for Anxiety Disordered and Normal Control children. A

Kruskall's Wallis analysis was performed in order to examine any difference between diagnostic groups. The relationship between all variables was assessed using Spearman's Rho.

Relationship with Nonverbal Intelligence

A subsample of participants *(N* = 48) completed the Raven's Standard Progressive Matrices. A Spearman's rank order correlation analysis found no significant relationship between Raven's performance and anxiety (SCAS- P) total score, $r_s(46) = .08$, $p = .58$. The relationship between Raven's performance and total sleep (SDSC) score approached significance, $r_s(46) = .28$, $p = .06$. A weak to moderate significant relationship was found between Raven's Standard Score and autism traits (AQ – Child) total score $r_s(46) = .35$, $p = .01$.

Results

Descriptive Statistics on Anxiety

Descriptive statistics associated with the sample and their scores on the SCAS-P total and subscales, as a measure of overall anxiety in the current sample are recorded and compared to previously published data (Nauta et al., 2004) in Table 4.2. Comparison of groups demonstrates that the participants in our study had higher levels of anxiety compared to normal controls from previous research (Cohen's d = 0.86). The High Anxiety group demonstrated moderately higher anxiety than the Nauta et al. anxiety disordered group (Cohen's d = 0.44), whilst the Low Anxiety group demonstrated a smaller effect with lower anxiety compared with the normal controls from Nauta et al. (Cohen's d = 0.34).

Table 4.2

Means and Standard Deviations for Anxiety (Spence, SCAS-P) for current sample and published data

	The Current Sample			Published Data (Nauta et al., 2004)	
SCAS- P Subscale	Total Sample (N = 84)	High Anxiety (N = 28)	Low Anxiety (N = 28)	Anxiety Disordered (N = 484)	Normal Controls (N = 261)
Age (M, SD)	9.22 (1.85)	9.41 (1.59)	9.29 (2.34)	10.4 (2.5)	11.5 (2.0)
Ravens	N = 48 107.35 (10.02)	N = 14 105.71 (12.75)	N =17 107.47 (8.60)	-	-
Separation Anxiety	4.86 (3.39)	8.29 (2.90)	1.82 (1.34)	6.9 (4.1)	2.6 (2.8)
Generalised Anxiety	4.51 (2.91)	7.79 (2.29)	1.89 (1.25)	6.6 (3.1)	2.7 (2.0)
Social Phobia	6.14 (3.66)	8.71 (3.45)	3.71 (2.89)	7.7 (3.8)	4.2 (2.8)
Panic/Agoraphobia	1.80 (2.10)	3.64 (2.56)	0.50 (1.04)	3.6 (3.9)	1.0 (1.6)
Physical Injury Fears	3.85 (2.65)	5.82 (2.87)	2.11 (1.45)	4.1 (2.8)	2.6 (2.3)
Obsessive Compulsive	2.12 (2.13)	3.71 (2.56)	1.00 (1.22)	3.0 (3.1)	1.1 (1.7)
Total	23.27 (12.78)	37.96 (9.80)	11.04 (4.05)	31.8 (14.1)	14.2 (9.7)

Note: Published data reported only to one decimal place. Ravens scores indicated are standardised (Cotton et al., 2005

Total Scores by Diagnostic Category

Descriptive statistics for total SCAS-P, AQ-Child and SDSC and scores for the ASD (*N* = 25), Speech and Language (*N* = 37), and Mixed Diagnosis (*N* = 22), groups can be found in Table 4.3.

Table 4.3

Total Scores of Anxiety, Autism Traits, Sleep and Ravens by Sample Diagnostic Categories

	ASD (*N* = 25)		Speech and Language (*N* = 37)		Mixed Diagnosis (*N* = 22)		Total Sample (*N* = 84)	
	M (SD)	Range	*M* (SD)	Range	*M* (SD)	Range	*M* (SD)	Range
SCAS-P	29.76 (12.17)	9 - 53	19.35 (11.65)	3 - 59	22.50 (12.89)	7 - 52	23.27 (12.78)	3 - 59
AQ-Child	91.28 (13.73)	62 - 115	55.35 (16.08)	22 - 99	60.95 (24.36)	27 - 122	67.51 (23.75)	22 - 122
SDSC	48.72 (10.07)	33- 71	39.92 (7.64)	26 - 58	44.00 (10.38)	32 - 72	43.61 (9.79)	26 - 72
Ravens	*N* = 14 112.36 (8.62)	94 - 123	*N* = 21 102.14 (8.78)	89- 120	*N* = 13 110.38 (9.87)	94-125	*N* = 48 107.35 (10.02)	89 - 125

Note: Ravens scores indicated are standardised (Cotton et al., 2005).

Diagnostic Group Comparison on Anxiety, Autism Traits, Sleep

A Kruskall-Wallis H Test was run to determine if there were differences in anxiety (SCAS –P), autism traits (AQ- Child) and sleep behaviours (SDSC) between the three diagnostic groups. Where significant group differences were established, post hoc pairwise comparisons were performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons. The distribution of questionnaire scores was similar for all diagnostic groups, as assessed by visual inspection.

Anxiety

Median Anxiety (SCAS- P) total scores were statistically significant between groups, χ^2 (2) = 11.76, p = .003. Post hoc analysis revealed statistically significant differences in SCAS- P total score between the ASD (*Mdn* = 28.00) and the Speech and Language (*Mdn* = 17.00) diagnostic groups (p = .002). There was no statistically significant difference in SCAS- P total score between the ASD and Mixed Diagnosis (*Mdn* = 20.00) groups, or Speech and Language and Mixed Diagnosis groups combinations.

Autism Traits

Median Autism Traits (AQ – Child) total scores were statistically significant between groups, χ^2 (2) = 37.85 p <.001. Post hoc analysis revealed statistically significant differences in AQ – Child total score between the ASD (*Mdn* = 92.00) and Speech and Language (*Mdn* = 56.00) diagnostic groups (p <.001), and ASD and the Mixed Diagnosis (*Mdn* = 59.50) groups (p <.001). There was no statistically significant difference in AQ – Child total score between the Speech and Language and Mixed Diagnosis groups.

Sleep Behaviours

Median Sleep Behaviour (SDSC) total scores were statistically significant between groups, χ^2 (2) = 11.04, p = .004. Post hoc analysis revealed statistically significant differences

in SDSC Total Score between ASD (*Mdn* = 49.00) and Speech and Language (*Mdn* = 40.00) diagnostic groups (*p* =.003). There was no statistically significant difference in SDSC total score between the ASD and Mixed Diagnosis (*Mdn* = 42.50), or the Speech and Language, or Mixed Diagnosis groups combinations.

Relationship between Anxiety, Autism Traits and Sleep Across Diagnoses

A series of Spearman's Rho rank correlations were conducted in order to examine the relationship between anxiety (SCAS-P), autism traits (AQ- Child) and sleep (SDSC) questionnaires for all participants. Preliminary analyses showed all relationships to be monotonic, as assessed by visual inspection of scatterplots. Table 4.4 demonstrates that there was a moderate positive relationship between the SCAS- P total score and the AQ- Child total score, as well as SDSC total score. There was a weak positive relationship between SCAS-P total score and SDSC total score.

Table 4.4

Correlation between Total Scores for Anxiety (SCAS- P), Autism Traits (AQ – Child) and Sleep (SDSC) for Total Sample (N = 84).

	SCAS- P	AQ- Child	SDSC
SCAS- P	-	.37**	.44**
AQ- Child		-	.28**
SDSC			-

Note. **p <.01

Anxiety Scale (SCAS-P)

A Spearman's rank order correlation was run to assess the relationship between SCAS-P subscales (Table 4.5). There was a strong positive correlation between Total SCAS-P score and Separation Anxiety, Generalised Anxiety, Social Phobia and Panic/ Agoraphobia subscales. There was a moderate positive correlation between Total SCAS-P score and Physical Injury Fear and Obsessive Compulsive subscales.

Anxiety (SCAS-P) and Autism Traits (AQ- Child)

A Spearman's rank order correlation was run to assess the relationship SCAS-P and AQ-Child Subscales (Table 4.6). There was a moderate positive correlation between the Obsessive Compulsive subscale and AQ- Child total score. The Obsessive Compulsive subscale had weak to moderate positive correlations with Social Skills, Attention Switching, Attention to Detail, Communication and Imagination subscales of the AQ- Child, as well as total score. There were weak positive correlations between Separation Anxiety, Generalised Anxiety, Social Phobia, Panic/ Agoraphobia, and SCAS-P Total score to AQ- Child total score.

Anxiety (SCAS-P) and Sleep (SDSC)

A Spearman's rank order correlation was run to assess the relationship between subscales of the SCAS-P and SDSC (Table 4.7). The SDSC total score demonstrated weak to moderate positive correlations with Separation Anxiety, Generalised Anxiety, and Social, Panic / Agoraphobia, Physical Injury Fears, and Obsessive Compulsive subscales from the SCAS-P. There was a moderate positive correlation between SCAS- P Total score and SDSC Total score.

Table 4.5

Intercorrelations of the Spence Children's Anxiety Scale subscales for total sample (N = 84)

SCAS- P Subscale	Separation Anxiety	Generalised Anxiety	Social Phobia	Panic/Agoraphobia	Physical Injury Fears	Obsessive Compulsive	Total
Separation Anxiety	-	.78**	.44**	.42**	.54**	.43**	.82**
Generalised Anxiety		-	.50**	.60**	.55**	.48**	.88**
Social Phobia			-	.42**	.25**	.30**	.68**
Panic/Agoraphobia				-	.42**	.48**	.73**
Physical Injury Fears					-	.20	.63**
Obsessive Compulsive						-	.59**

Note. $^{**}p < .01$

Table 4.6

Correlation between Spence Anxiety Scale and Autism Spectrum Quotient for total sample (N = 84)

AQ- Child	Social Skills	Attention Switching	Attention to Detail	Communication	Imagination	AQ- C Total
SCAS- P						
Separation Anxiety	.30*	.30*	.13	.28*	.17	.30**
Generalised Anxiety	.31*	.37**	.07	.27*	.15	.30**
Social Phobia	.25*	.27*	.01	.22	.14	.20
Panic/Agoraphobia	.26*	.28*	.12	.24*	.05	.26*
Physical Injury Fears	.14	.16	-.05	.09	.08	.12
Obsessive Compulsive	.51**	.52**	.29**	.53**	.25*	.51**
SCAS- P Total	.38**	.40**	.10	.35**	.20	.37**

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

Table 4.7

Correlation between Spence Anxiety Scale and Sleep Disturbance Scale for Children for total sample (N = 84)

SDSC SCAS- P	DIMS	SBD	DA	SWTD	DOES	SHY	SDSC Total
Separation Anxiety	.33**	-.01	.21	.26*	.21	.16	.38**
Generalised Anxiety	.29**	.05	.22*	.21	.16	.28**	.39**
Social Phobia	.11	.16	.09	.12	.15	.29**	.26*
Panic/Agoraphobia	.20*	.02	.14	.19	.10	.18	.25**
Physical Injury Fears	.24*	.11	.05	.12	.13	-.03	.24*
Obsessive Compulsive	.43**	.09	.20	.20	.34**	.14	.42**
SCAS- P Total	.35**	.06	.19	.25*	.25*	.21	.44**

Note. $*p < .05$, $**p < .01$; DIMS = Disorders of Initiating and Maintaining Sleep; SBD = Sleep Breathing Disorder; DA = Disorders of Arousal; SWTD = Sleep Wake Transition Disorder; DOES = Disorders of Excessive Somnolence; SHY = Sleep Hyperhidrosis.

Discussion

This study aimed to identify the relationship between anxiety, sleep problems and autism traits as a means of characterising the commonality of anxiety in children with additional social, emotional and academic needs across varying clinically diagnosed disorders. A secondary aim was to identify if there was an aspect of anxiety that would be most frequently associated with sleep and autism-like behaviours in our population sample. This was achieved by comparing parent-rated responses on measures of autism traits (AQ-Child), anxiety (SCAS –P), and sleep behaviours (SDSC) given that sleep and autism traits may represent observable behaviours driven by anxiety. It was hypothesised that higher parent perceived anxiety levels would be associated with more severe autism traits and poorer sleep quality in all children with identified AHDN, regardless of individual diagnoses. We anticipated that our overall sample would be more anxious compared to typically developing children regardless of diagnosis. We also hypothesised that children with ASD would have even greater levels of parent perceived anxiety than other diagnostic groups.

Overall, we found that our sample demonstrated higher levels of anxiety compared to a normal control population (Nauta et al., 2004), supporting the hypothesis that anxiety would be a common feature in children with AHDN and in particular when greater levels of autism traits were evident. Conceptualising anxiety as a continuum suggests that, despite this commonality, the experience of anxiety differs in individuals to a greater or lesser extent. Total scores on all measures were higher in our High Anxiety group compared to both Anxiety Disordered and Normal Control group overall (Nauta et al.). However only scores on the Physical Injury Fears and Obsessive-Compulsive subscales were higher than an Anxiety Disordered population, highlighting these as particularly prominent areas of worry in the current sample. Comparatively, our Low Anxiety group scores were lower than Normal Controls across all SCAS-P subscales which may be attributed to individual differences in the

sample, varied parent's perception, or measurement of anxiety at a trait rather than state level. These findings suggest that children with AHDN are a population at an increased risk of experiencing generally high levels of anxiety, and thus anxiety screening should form an integral part of assessment for teachers and mental health professionals.

Comparison between the ASD, Speech and Language, and Other Diagnosis groups on anxiety, autism and sleep measures revealed some differences between groups. The ASD group had significantly higher anxiety, autism traits and sleep difficulty when compared to the Speech and Language Impaired group, indicating that anxiety and sleep problems may be more pronounced in this group. As expected, the AQ –Child questionnaire also differentiated the ASD and Other Diagnosis groups. Despite differences noted in the ASD group, a key finding was that there was no significant difference in anxiety and sleep behaviours between the ASD and Other Diagnosis groups, or the Speech and Language and Mixed Diagnosis groups. It is important to note that high levels of anxiety were reported across groups, and that autism traits predicted anxiety and sleep difficulties regardless of diagnosis. While diagnostic classification may be useful in differentiating some aspects of behaviour, the relationship between anxiety, sleep and autism traits may ultimately contribute to a broader neurodevelopmental phenotype in children with AHDN.

A number of other factors challenged the usefulness of diagnoses in children in the current study. Questionnaire scores for each diagnostic category showed very large ranges, highlighting the potential of previous professional misdiagnosis due to either inaccurate parent reporting or variation in standardised testing and diagnosis across different medical and allied health professionals. One example is that the highest recorded score on the AQ-Child was in the Mixed Diagnosis group rather than the ASD group. Given that all children experienced social, emotional and academic difficulties, such variation highlights the

importance of recognising individual differences and functional impairment for the child and their family beyond a diagnostic label.

Correlational analyses allowed a further examination of the relationship between behavioural traits. Greater anxiety symptoms were positively correlated with more autism traits and worse sleep overall, supporting previous findings of this relationship (Austin, 2005; Green & Ben-Sasson, 2010; Grondhuis & Aman, 2012). This suggests that anxiety may result in greater functional impact towards the high end of the spectrum of neurodevelopmental symptoms. It can be expected that the increased experience of symptoms in this triad would be associated with greater social and behavioural impairments. Recognising that adverse early childhood experiences can lead to difficulties in adolescence and adulthood, such as increased risk of suicidal behaviour, highlights the importance of early intervention (Serafini et al., 2015).

The Obsessive Compulsive subscale was dominant across analyses of anxiety, sleep and autism trait measures, despite comprising only six out of fifty questions on the SCAS-P related to intrusive thoughts (e.g. the child experiences ‘bad’ or ‘silly’ thoughts) and subsequent behaviours (e.g. my child has to do things over and over again). The relationship of autism traits with obsessive compulsive behaviours across all AQ-Child subscales is reflective of a broader population comorbidity (van Steensel et al., 2011) that may be accounted for in part by shared pathophysiology and genetic factors (Meier et al., 2015). Although optimal levels of anxiety can be adaptive and increase performance (Arent & Landers, 2003), the chronicity of trait anxiety is reported to impact on overall biological functioning (Slattery et al., 2012).

The complexity of identifying factors associated with anxiety was exemplified by the high number of correlations identified across questionnaire total scores and subscales of the AQ-Child and SDSC with the SCAS-P questionnaire. Although total SCAS-P score was

significantly correlated with total scores on both the AQ-Child and the SDSC and the SCAS-P as anticipated. However these associations were not as pronounced as expected. While it could be considered that the AQ- Child and SCAS-P scales measure different constructs, we contend that anxiety and autism traits are inherently intertwined. However, the moderate relationship between anxiety and autism traits in the current sample may have been minimised due to our reliance on parent report.

Limitations of Current Study and Future Research

The accuracy of parent reporting may have been influenced by a social desirability bias due to stigma or their own internal experiences. It can be speculated that parents completing the questionnaires may have had higher than average anxiety themselves due to a genetic predisposition to aspects of the Neurodevelopmental Phenotype and potential stressors of parenting a child with AHDN (Ingersoll & Hambrick, 2011; Piven & Palmer, 1999). As identified in previous research (Magiati et al., 2014), it is possible that parent ratings are not entirely reflective of their child's anxiety due to a discrepancy between observable and internal experiences of anxiety attributed to difficulties in social skills, language ability and emotional expression in many children with AHDN.

The relationship between sleep behaviours and autism traits with anxiety in our correlational analyses suggest that using a sleep or autism behaviour scale may be a useful screening tool to identify an anxious child. Autism traits and sleep difficulties are likely to be more overtly recognised by parents and subsequently easier to report in the given questionnaires, possibly because these behaviours could more explicitly demand the responsiveness of caregivers. For example, a parent attending to a child during the night when they cannot sleep or noticing their child has difficulty developing friendships may be easier to identify as areas of concern compared to physical symptoms of anxiety that could be attributed to various other factors such as tiredness or shyness.

Lastly it is also important to consider our findings within the context of the population used in this study. The current sample was characterised by a gender ratio, around two thirds male, that is representative of the broader gender disparities noted in neurodevelopmental disorders (WHO, 2013a). While our aim was to investigate factors contributing to an anxious child with other associated behaviours in children with AHDN, our findings are limited by the absence of a comparative typically developing sample. Though we did address this by comparing the current sample to published norms, future research would ideally examine differences in anxiety between children with AHDN and typically developing peers beyond past research. The understanding of childhood anxiety would be enhanced by incorporating child, teacher and parent ratings as well as objective biological measures such as blood pressure and heart rate. Future research should also further investigate the relationship of obsessive-compulsive behaviours with autism traits and sleep.

Conclusion

The current study demonstrates the relationship between autism traits, sleep and anxiety in a sample of children experiencing difficulties at school. It provides evidence that autism-like behaviours and sleep difficulties may be identifiable expressions, and subsequently core biomarkers, of anxiety in children with AHDN. Although the ASD group had significantly higher anxiety compared to the Speech and Language group, the large range in scores across all groups highlights the importance of recognising the functional impact of anxiety on behaviours for any individual with AHDN irrespective of diagnosis. Importantly, these children with additional needs demonstrated greater overall anxiety when compared to previously published data for normal controls, suggesting that anxiety is a common general experience in this population. Our results support the use of questionnaires as a conventional means of identifying behaviours in children in order to guide early intervention and inform treatment in the assessment of children experiencing social, emotional and academic

difficulties. Although dual relationships between anxiety and autism-traits, as well as between anxiety and sleep have been demonstrated previously in primarily neurotypical populations, the current findings demonstrate that these interlinked relationships extend to children AHDN and may contribute to better characterisation of these children earlier in childhood.

References

Alfano, C. A., Ginsburg, G. S., & Kingery, J. N. (2007). Sleep-related problems among children and adolescents with anxiety disorders. *Journal of the American Academy of Child & Adolescent Psychiatry, 46*(2), 224-232. http://doi.org/10.1097/01.chi.0000242233.06011.8e

Alvaro, P. K., Roberts, R. M., & Harris, J. K. (2013). A systematic review assessing bidirectionality between sleep disturbances, anxiety, and depression. *Sleep, 36*(7), 1059-1068.http://doi.org/10.5665/sleep.2810

Arent, S. M., & Landers, D. M. (2003). Arousal, anxiety, and performance: A reexamination of the inverted-U hypothesis. *Research quarterly for exercise and sport, 74*(4), 436-444. http://doi.org/10.1080/02701367.2003.10609113

Atkins, M. S., Cappella, E., Shernoff, E. S., Mehta, T. G., & Gustafson, E. L. (2017). Schooling and children's mental health: Realigning resources to reduce disparities and advance public health. *Annual review of clinical psychology, 13*, 123-147. http://doi.org/10.1146/annurev-clinpsy-032816-045234

Austin, E. J. (2005). Personality correlates of the broader autism phenotype as assessed by the Autism Spectrum Quotient (AQ). *Personality and Individual Differences, 38*(2), 451-460. http://doi.org/10.1016/j.paid.2004.04.022

Auyeung, B., Baron-Cohen, S., Wheelwright, S., & Allison, C. (2008). The autism spectrum quotient: Children's version (AQ-Child). *J Autism Dev Disord, 38*(7), 1230-1240. https://doi.org./10.1007/s10803-007-0504-z

Baranne, M. L., & Falissard, B. (2018). Global burden of mental disorders among children aged 5–14 years. *Child and adolescent psychiatry and mental health, 12*(1), 19.http://doi.org/10.1186/s13034-018-0225-4

Barrett, P. M., Farrell, L. J., Ollendick, T. H., & Dadds, M. (2006). Long-term outcomes of an Australian universal prevention trial of anxiety and depression symptoms in children and youth: an evaluation of the friends program. *Journal of clinical child and adolescent psychology, 35*(3), 403-411. http://doi.org/10.1207/s15374424jccp3503_5

Bayer, J. K., Rapee, R. M., Hiscock, H., Ukoumunne, O. C., Mihalopoulos, C., & Wake, M. (2011). Translational research to prevent internalizing problems early in childhood. *Depression and anxiety, 28*(1), 50-57. http://doi.org/10.1002/da.20743

Bethell, C. D., Read, D., Stein, R. E., Blumberg, S. J., Wells, N., & Newacheck, P. W. (2002). Identifying children with special health care needs: development and evaluation of a short screening instrument. *Ambulatory Pediatrics, 2*(1), 38-48.http://doi.org/10.1367/1539-4409(2002)002%3C0038:ICWSHC%3E2.0.CO;2

Bracha, H. S. (2004). Freeze, flight, fight, fright, faint: Adaptationist perspectives on the acute stress response spectrum. *CNS spectrums, 9*(9), 679-685. http://doi.org/10.1017/S1092852900001954

Brand, S., Kirov, R., Kalak, N., Gerber, M., Schmidt, N. B., Lemola, S., . . . Holsboer-Trachsler, E. (2016). Poor sleep is related to lower emotional competence among adolescents. *Behavioral sleep medicine, 14*(6), 602-614. http://doi.org/10.1080/15402002.2015.1048450

Bruni, O., Ottaviano, S., Guidetti, V., Romoli, M., Innocenzi, M., Cortesi, F., & Giannotti, F. (1996). The Sleep Disturbance Scale for Children (SDSC) Construct ion and validation of an instrument to evaluate sleep disturbances in childhood and adolescence. *Journal of sleep research, 5*(4), 251-261. https://doi.org/10.1111/j.1365-2869.1996.00251.x

Cohen, S., Conduit, R., Lockley, S. W., Rajaratnam, S. M., & Cornish, K. M. (2014). The relationship between sleep and behavior in autism spectrum disorder (ASD): a review.

Journal of Neurodevelopmental Disorders, 6(1), 44. http://doi.org/10.1186/1866-1955-6-44

Cohen, S., Fulcher, B. D., Rajaratnam, S. M., Conduit, R., Sullivan, J. P., St Hilaire, M. A., . . . McConnell, K. (2018). Sleep patterns predictive of daytime challenging behavior in individuals with low-functioning autism. *Autism Research, 11*(2), 391-403. http://doi.org/10.1002/aur.1899

Cotton, S. M., Kiely, P. M., Crewther, D. P., Thomson, B., Laycock, R., & Crewther, S. G. (2005). A normative and reliability study for the Raven's Coloured Progressive Matrices for primary school aged children from Victoria, Australia. *Personality and Individual Differences, 39*(3), 647-659. http://doi.org/10.1016/j.paid.2005.02.015

Curcio, G., Ferrara, M., & De Gennaro, L. (2006). Sleep loss, learning capacity and academic performance. *Sleep medicine reviews, 10*(5), 323-337.http://doi.org/10.1016/j.smrv.2005.11.001

Dempsey, I., & Davies, M. (2013). National test performance of young Australian children with additional educational needs. *Australian Journal of Education, 57*(1), 5-18. https://doi.org/10.1177/0004944112468700

Dunn, O. J. (1964). Multiple comparisons using rank sums. Technometrics 6, 241–252. https://doi.org/10.1080/00401706.1964.10490181

Eisert, D. C., Sturner, R. A., & Mabe, P. A. (1991). Questionnaires in behavioral pediatrics: guidelines for selection and use. *Journal of Developmental and Behavioral Pediatrics*. http://doi.org/10.1097/00004703-199102000-00009

Fisak, B. J., Richard, D., & Mann, A. (2011). The prevention of child and adolescent anxiety: A meta-analytic review. *Prevention Science, 12*(3), 255-268. http://doi.org/10.1007/s11121-011-0210-0

Fischer, R. L., Anthony, E. R., Lalich, N., & Blue, M. (2014). Addressing the Early Childhood Mental Health Needs of Young Children: Evaluating Child and Family Outcomes. *Journal of Social Service Research, 40*(5), 721-737. http://doi.org/10.1080/01488376.2014.930947

Fletcher, F. E., Conduit, R., Foster-Owens, M. D., Rinehart, N. J., Rajaratnam, S. M., & Cornish, K. M. (2016). The association between anxiety symptoms and sleep in school-aged children: A combined insight from the Children's Sleep Habits Questionnaire and actigraphy. *Behavioral sleep medicine*, 1-16. http://doi.org/10.1080/15402002.2016.1180522

Freeth, M., Bullock, T., & Milne, E. (2013). The distribution of and relationship between autistic traits and social anxiety in a UK student population. *Autism, 17*(5), 571-581. http://doi.org/10.1177/1362361312445511

Goldfeld, S., O'Connor, M., Sayers, M., Moore, T., & Oberklaid, F. (2012). Prevalence and correlates of special health care needs in a population cohort of Australian children at school entry. *Journal of Developmental & Behavioral Pediatrics, 33*(4), 319-327. http://doi.org/10.1097/DBP.0b013e31824a7b8e

Goldfeld, S., O'Connor, M., Quach, J., Tarasuik, J., & Kvalsvig, A. (2015). Learning trajectories of children with special health care needs across the severity spectrum. *Academic pediatrics, 15*(2), 177-184.http://doi.org/10.1016/j.acap.2014.09.001

Gotham, K., Bishop, S. L., Hus, V., Huerta, M., Lund, S., Buja, A., . . . Lord, C. (2013). Exploring the relationship between anxiety and insistence on sameness in autism spectrum disorders. *Autism Research, 6*(1), 33-41. http://doi.org/10.1002/aur.1263

Green, S. A., & Ben-Sasson, A. (2010). Anxiety disorders and sensory over-responsivity in children with autism spectrum disorders: is there a causal relationship? *J Autism Dev Disord, 40*(12), 1495-1504. http://doi.org/10.1007/s10803-010-1007-x

Grisham, J., Fullana, M., Mataix-Cols, D., Moffitt, T., Caspi, A., & Poulton, R. (2011). Risk factors prospectively associated with adult obsessive-compulsive symptom dimensions and obsessive-compulsive disorder. *Psychological medicine, 41*(12), 2495. http://doi.org/10.1017/S0033291711000894

Grondhuis, S. N., & Aman, M. G. (2012). Assessment of anxiety in children and adolescents with autism spectrum disorders. *Research in Autism Spectrum Disorders, 6*(4), 1345-1365. http://doi.org/10.1016/j.rasd.2012.04.006

Howell-Meurs, S., O'Connor, M., Kvalsvig, A., & Goldfeld, S. . (2014). T*he school functioning of children with additional health and developmental care needs in the primary years: A literature review.* Melbourne, Australia: Centre for Community Child Healt*h*.

Ingersoll, B., & Hambrick, D. Z. (2011). The relationship between the broader autism phenotype, child severity, and stress and depression in parents of children with autism spectrum disorders. *Research in Autism Spectrum Disorders, 5*(1), 337-344.http://doi.org/10.1016/j.rasd.2010.04.017

Irwin, L. G., Siddiqi, A., & Hertzman, G. (2007). *Early child development: a powerful equalizer*: Human Early Learning Partnership (HELP) Vancouver, BC.

James, S., & Hale, L. (2017). Sleep Duration and Child Well-Being: A Nonlinear Association. *Journal of Clinical Child & Adolescent Psychology, 46*(2), 258-268. http://doi.org/10.4324/9781351008921-9

Kahn, M., Sheppes, G., & Sadeh, A. (2013). Sleep and emotions: bidirectional links and underlying mechanisms. *International Journal of Psychophysiology, 89*(2), 218-228. http://doi.org/10.1016/j.ijpsycho.2013.05.010

Kerns, C. M., & Kendall, P. C. (2014). Autism and anxiety: Overlap, similarities, and differences. In *Handbook of autism and anxiety* (pp. 75-89): Springer.

http://doi.org/10.1007/978-3-319-06796-4_6. http://doi.org/10.1007/978-3-319-06796-4_6

Koenen, K. C., Moffitt, T. E., Roberts, A. L., Martin, L. T., Kubzansky, L., Harrington, H., . . . Caspi, A. (2009). Childhood IQ and adult mental disorders: a test of the cognitive reserve hypothesis. *American Journal of Psychiatry, 166*(1), 50-57. http://doi.org/10.1176/appi.ajp.2008.08030343

Kovacs, M., & Lopez-Duran, N. (2010). Prodromal symptoms and atypical affectivity as predictors of major depression in juveniles: implications for prevention. *Journal of Child Psychology And Psychiatry, 51*(4), 472-496. http://doi.org/10.1111/j.1469-7610.2010.02230.x

Limoges, E., Mottron, L., Bolduc, C., Berthiaume, C., & Godbout, R. (2005). Atypical sleep architecture and the autism phenotype. *Brain, 128*(5), 1049-1061. http://doi.org/10.1093/brain/awh425

Magiati, I., Chan, J. Y., Tan, W.-L. J., & Poon, K. K. (2014). Do non-referred young people with Autism Spectrum Disorders and their caregivers agree when reporting anxiety symptoms? A preliminary investigation using the Spence Children's Anxiety Scale. *Research in Autism Spectrum Disorders, 8*(5), 546-558. http://doi.org/10.1016/j.rasd.2014.01.015

Maron, E., & Nutt, D. (2017). Biological markers of generalized anxiety disorder. *Dialogues in clinical neuroscience, 19*(2), 147. http://doi.org/10.1176/appi.focus.16205

Martin, L. T., Kubzansky, L. D., LeWinn, K. Z., Lipsitt, L. P., Satz, P., & Buka, S. L. (2007). Childhood cognitive performance and risk of generalized anxiety disorder. *International Journal of Epidemiology, 36*(4), 769-775. http://doi.org/10.1093/ije/dym063

Martinsen, K. D., Neumer, S.-P., Holen, S., Waaktaar, T., Sund, A. M., & Kendall, P. C. (2016). Self-reported quality of life and self-esteem in sad and anxious school children. *BMC psychology, 4*(1), 45. http://doi.org/10.1186/s40359-016-0153-0. http://doi.org/10.1186/s40359-016-0153-0

May, T., Cornish, K., Conduit, R., Rajaratnam, S. M., & Rinehart, N. J. (2015). Sleep in high-functioning children with autism: longitudinal developmental change and associations with behavior problems. *Behavioral sleep medicine, 13*(1), 2-18. http://doi.org/10.1080/15402002.2013.829064

McDowell, M., & O'Keeffe, M. (2012). Public services for children with special needs: discrimination by diagnosis? *Journal of paediatrics and child health, 48*(1), 2-5. http://doi.org/10.1111/j.1440-1754.2011.02394.x

McGorry, P. D. (2013). Early clinical phenotypes, clinical staging, and strategic biomarker research: building blocks for personalized psychiatry. *Biol Psychiatry, 74*(6), 394-395. 395. http://doi.org/10.1016/j.biopsych.2013.07.004

McPherson, M., Arango, P., Fox, H., Lauver, C., McManus, M., Newacheck, P. W., . . . Strickland, B. (1998). A new definition of children with special health care needs. *Pediatrics, 102*(1), 137-139. https://doi.org/10.1542/peds.102.1.137

Meier, S. M., Petersen, L., Schendel, D. E., Mattheisen, M., Mortensen, P. B., & Mors, O. (2015). Obsessive-compulsive disorder and autism spectrum disorders: longitudinal and offspring risk. *PLoS One, 10*(11), e0141703.http://doi.org/10.1371/journal.pone.0141703

Meyer, A. (2017). A biomarker of anxiety in children and adolescents: a review focusing on the error-related negativity (ERN) and anxiety across development. *Developmental cognitive neuroscience, 27,* 58.http://doi.org/10.1016/j.dcn.2017.08.001

Nauta, M. H., Scholing, A., Rapee, R. M., Abbott, M., Spence, S. H., & Waters, A. (2004). A parent-report measure of children's anxiety: psychometric properties and comparison with child-report in a clinic and normal sample. *Behav Res Ther, 42*(7), 813-839. http://doi.org/10.1016/S0005-7967(03)00200-6

Neil, A. L., & Christensen, H. (2009). Efficacy and effectiveness of school-based prevention and early intervention programs for anxiety. *Clinical Psychology Review, 29*(3), 208-215. http://doi.org/10.1016/j.cpr.2009.01.002

Noam, G. G., & Hermann, C. A. (2002). Where education and mental health meet: Developmental prevention and early intervention in schools. *Dev Psychopathol, 14*(4), 861-875. https://doi.org/10.1017/s0954579402004108

O'Connor, M., O'Connor, E., Quach, J., Vashishtha, R., & Goldfeld, S. (2019). Trends in the prevalence and distribution of teacher-identified special health-care needs across three successive population cohorts. *Journal of paediatrics and child health, 55*(3), 312-319. 319. http://doi.org/10.1111/jpc.14192

O'Connor, M., Quach, J., Goldfeld, S., Gold, L., Aston, R., Beatson, R., & Hopkins, D. (2015). *Approaches to the provision of educational support for children and young people with additional health and developmental needs: Autism Spectrum Disorders.* Centre for Community Child Health, Melbourne, Victoria.

Piven, J., & Palmer, P. (1999). Psychiatric disorder and the broad autism phenotype: evidence from a family study of multiple-incidence autism families. *American Journal of Psychiatry, 156*(4), 557-563. http://doi.org/10.1176/ajp.156.4.557

Rapee, R. M. (2012). Anxiety disorders in children and adolescents: Nature, development, treatment and prevention. Anxiety disorders in children and adolescents: Nature, development, treatment and prevention. In Rey JM (ed), I*ACAPAP e-Textbook of*

Child and Adolescent Mental Health. Geneva: International Association for Child and Adolescent Psychiatry and Allied Professions.

Raven, J. (1990). Court, JH, & Raven, J.(1990). Coloured progressive matrices. *Manual for Raven's Progressive Matrices and Vocabulary Scales*.

Richdale, A. L., & Schreck, K. A. (2009). Sleep problems in autism spectrum disorders: prevalence, nature, & possible biopsychosocial aetiologies. *Sleep Med Rev, 13*. http://doi.org/j.smrv.2009.02.003

Rosbrook, A., & Whittingham, K. (2010). Autistic traits in the general population: What mediates the link with depressive and anxious symptomatology? *Research in Autism Spectrum Disorders, 4*(3), 415-424. http://doi.org/10.1016/j.rasd.2009.10.012

Rzepecka, H., McKenzie, K., McClure, I., & Murphy, S. (2011). Sleep, anxiety and challenging behaviour in children with intellectual disability and/or autism spectrum disorder. *Res Dev Disabil, 32*. http://doi.org/10.1016/j.ridd.2011.05.034

Schreck, K., Mulick, J. A., & Smith, A. F. (2004). Sleep problems as possible predictors of intensified symptoms of autism. *Res Dev Disabil, 25*. http://doi.org/10.1016/j.ridd.2003.04.007

Segerstrom, S. C., & Miller, G. E. (2004). Psychological stress and the human immune system: a meta-analytic study of 30 years of inquiry. *Psychol Bull, 130*(4), 601. http://doi.org/10.1037/0033-2909.130.4.601

Serafini, G., Muzio, C., Piccinini, G., Flouri, E., Ferrigno, G., Pompili, M., . . . Amore, M. (2015). Life adversities and suicidal behavior in young individuals: a systematic review. *European child & adolescent psychiatry, 24*(12), 1423-1446. http://doi.org/10.1007/s00787-015-0760-y

Shadli, S., Glue, P., McIntosh, J., & McNaughton, N. (2015). An improved human anxiety process biomarker: characterization of frequency band, personality and

pharmacology. *Translational psychiatry, 5*(12), e699. http://doi.org/10.1038/tp.2015.188

Simola, P., Liukkonen, K., Pitkäranta, A., Pirinen, T., & Aronen, E. T. (2014). Psychosocial and somatic outcomes of sleep problems in children: a 4-year follow-up study. *Child: care, health and development, 40*(1), 60-67. http://doi.org/10.1111/j.1365-2214.2012.01412.x http://doi.org/10.1111/j.1365-2214.2012.01412.x

Slattery, D. A., Uschold, N., Magoni, M., Bär, J., Popoli, M., Neumann, I. D., & Reber, S. O. (2012). Behavioural consequences of two chronic psychosocial stress paradigms: anxiety without depression. *Psychoneuroendocrinology, 37*(5), 702-714. http://doi.org/10.1016/j.psyneuen.2011.09.002

van Os, J. (2013). The dynamics of subthreshold psychopathology: implications for diagnosis and treatment. *American Journal of Psychiatry, 170* (7), 695.http://doi.org/10.1176/appi.ajp.2013.13040474

van Steensel, F. J., Bögels, S. M., & Perrin, S. (2011). Anxiety disorders in children and adolescents with autistic spectrum disorders: a meta-analysis. *Clinical child and family psychology review, 14*(3), 302. http://doi.org/10.1007/s10567-011-0097-0

Vasa, R. A., Carroll, L. M., Nozzolillo, A. A., Mahajan, R., Mazurek, M. O., Bennett, A. E., . . . Bernal, M. P. (2014). A systematic review of treatments for anxiety in youth with autism spectrum disorders. *J Autism Dev Disord, 44*(12), 3215-3229. http://doi.org/10.1007/s10803-014-2184-9

Veatch, O. J., Sutcliffe, J. S., Warren, Z. E., Keenan, B. T., Potter, M. H., & Malow, B. A. (2017). Shorter sleep duration is associated with social impairment and comorbidities in ASD. *Autism Research, 10*(7), 1221-1238. http://doi.org/10.1002/aur.1765

Werner-Seidler, A., Perry, Y., Calear, A. L., Newby, J. M., & Christensen, H. (2017). School-based depression and anxiety prevention programs for young people: A systematic review and meta-analysis. *Clinical Psychology Review*, *51*, 30-47. http://doi.org/10.1016/j.cpr.2016.10.005

World Health Organsiation. (2013a). *Autism spectrum disorders & other developmental disorders: From raising awareness to building capacity: Meeting report*. Geneva, Switzerland

World Health Organsiation (2013b). Mental health action plan 2013–2020. In: WHO Geneva.

Chapter 5- A Role for Anxiety and Autism Traits in Facilitating Attentional Focus: Local and Global Visual Processing Bias in Children with Additional Health and Developmental Needs

Abstract

A local perceptual bias has previously been associated with neurodevelopmental disorders, subthreshold autism-like traits and chronic trait anxiety, but has not been investigated in a population of children with Additional Health and Developmental Needs (AHDN). Accordingly, the aims of this study were to explore local and global processing in children with AHDN and to determine whether a local/global bias using a Navon- style task is associated with anxiety traits as measured by the Spence Children's Anxiety Scale- Parent Report, or autism-like traits on the Autism Spectrum Quotient- Child Version. It was hypothesised that higher levels of anxiety would be associated with greater autism traits in children with AHDN and that both autism traits and anxiety would be more associated with a local bias in children with AHDN on a Navon Task. It was also expected that when compared to a small sample of Typically Developing (TD) participants, children with AHDN would perform better on local rather than global Navon tasks. Although there was a moderately positive relationship found between autism traits and anxiety, our results did not find evidence of a local processing bias or relationship between Navon task performance and anxiety or autism traits among the children with AHDN. However, a trend towards significance was demonstrated when comparing an age matched (9-10 years) sample of AHDN and TD children on the global congruency accuracy condition. This suggests that the relationship between anxiety and perceptual biases in children with AHDN is likely to be complex, and future research should consider the influence of acute state anxiety in local/global biases in this population.

A Role for Anxiety and Autism Traits in Facilitating Attentional Focus: Local and Global Visual Processing Bias in Children with Additional Health and Developmental Needs

Most people in the general population initially view the outdoor world as a whole visual scene (e.g., when walking or driving a car) and only when a more salient aspect of the scene attracts interest, selectively attend to the single local aspects of the interesting stimulus. This common general perceptual bias is termed 'global precedence' and selective to a particular stimulus is known as a local bias (Navon, 1977). Navon's idea of 'global precedence' facilitates a coarse-to-fine level of visual analysis over time (Crewther, Lawson, & Crewther, 2007; Lawson, Crewther, Junghans, & Crewther, 2003; Lawson, Crewther, Junghans, Crewther, & Kiely, 2005). Indeed, a global perceptual bias would be expected in terms of need to move safely through a real world environment where objects can be randomly scattered (e.g., toys on floor) and/or moving at varying speeds towards or away from one (e.g., while crossing a road) and need to be avoided.

By comparison, a local bias infers a preference for attention to objects close by which usually necessitates application of visual accommodation and convergence, and requiring time to achieve and neural effort to maintain (Crewther, Lawson, & Crewther, 2007; Lawson, Crewther, Junghans, & Crewther, 2003; Lawson, Crewther, Junghans, Crewther, & Kiely, 2005) and hence is less common than global preferences. However local biases in perception have long been associated with anxiety (Tyler & Tucker, 1982) and more recently such a local bias has been reported in populations with neurodevelopmental disorders, including Autism Spectrum Disorder (ASD) (Bernardino et al., 2012). Hence a bias toward local processing may be expected in children with AHDN, given that this group appears more vulnerable to chronic anxiety (as demonstrated in Chapter 4) and likely to experience diagnosed or clinically undiagnosed behaviours associated with neurodevelopment and the

autism spectrum (as discussed in Chapter 2). Local biases in this population may indeed partially account for much of their school-based deficits, given that such biases are likely to impact on the ability to communicate, interact socially and process facial features (Tanaka & Sung, 2016; Vlamings, Jonkman, van Daalen, van der Gaag, & Kemner, 2010; Zhao, Uono, Yoshimura, Kubota, & Toichi, 2017).

The extent to which an individual prioritises local or global visual information is also known to be affected by emotional states, including anxiety (Shi, Sharpe, & Abbott, 2019). Thus variation in affect is suggested to influence the saliency of what is attended to in the environment (Barrett & Bar, 2009), such as a local bias to fear and threatening information (Ellenbogen & Schwartzman, 2009) when anxious. In fact, more recent evidence suggests that emotional states can determine the content of perception (Vuilleumier, 2015). Negative emotional states such as social anxiety (Yoon, Vidaurri, Joormann, & De Raedt, 2015), depressed and sad moods, and chronic anxiety (Basso, Schefft, Ris, & Dember, 1996; de Fockert & Cooper, 2014; Derryberry & Reed, 2002; Gasper & Clore, 2002) tend to narrow the scope of attention to focus on details so that it can be difficult to integrate information globally.

High trait or chronic anxiety (as discussed in more detail in Chapters 1 and 2) has been associated with reduced global processing in clinical disorders, with eating disorders being an example (Becker et al., 2017). Participants from the general population but with high trait anxiety have also been shown to perform worse on a measure of global perception when under high situational stress, whereas those with low trait anxiety showed improved global perception under the same conditions (Tyler & Tucker, 1982) suggesting that positive affect increases cognitive flexibility (Baumann & Kuhl, 2005; Huntsinger, Clore, & Bar-Anan, 2010; Tan, Jones, & Watson, 2009).

Although global and local visual attention have been investigated in a number of neurodevelopmental disorders (Ballantyne, Núñez, & Manoussaki, 2017; Bernardino et al., 2012), whether an atypical local bias in visual attention extends to children with heterogeneous diagnoses classified as having AHDN has not yet been established. Nonetheless, sensory variability is now considered central to the diagnosis of ASD (Baum, Stevenson, & Wallace, 2015; Behrmann, Thomas, & Humphreys, 2006; Robertson & Baron-Cohen, 2017; Simmons et al., 2009), with superior local perceptual bias skills being exemplified by faster and more accurate visual detection during visual search (Kaldy, Giserman, Carter, & Blaser, 2016). This has been demonstrated by using several paradigms including the Embedded Figures Task (Dillen, Steyaert, De Beeck, & Boets, 2015), block design (Shah & Frith, 1993) and the Navon task (Mottron, Burack, Iarocci, Belleville, & Enns, 2003; Oi & Dairoku, 2018; Soriano, Ibáñez-Molina, Paredes, & Macizo, 2017), and appears on the basis of a meta-analysis to be a reliable finding in ASD (Muth, Hönekopp, & Falter, 2014). Importantly, children with ASD tend to perform better and make fewer errors on tasks requiring the identification of local details (Plaisted, Swettenham, & Rees, 1999) though this does not necessarily imply only local perceptual biases. Indeed a recent meta-analysis has also found that individuals with ASD do not show enhanced local or impaired global processing capacity in general, but rather present with a visual perceptual style characterised by slower global perception and more automatic local processing (Van der Hallen, Evers, Brewaeys, Van den Noortgate, & Wagemans, 2015).

A bias towards local visual information is also thought to extend to those with subthreshold autism traits, but who do not necessarily meet criteria for a clinical diagnosis of ASD (Almeida, Dickinson, Maybery, Badcock, & Badcock, 2013; Bayliss & Tipper, 2005; Hayward, Fenerci, & Ristic, 2018; Sutherland & Crewther, 2010) and may contribute to commonly reported social deficits including emotional recognition (English, Maybery, &

Visser, 2017). In fact, a marked difference in local-global processing between participants with high and low autism traits has been demonstrated with neurophysiological evidence (Crewther, Crewther, Bevan, Goodale, & Crewther, 2015; Vilidaite et al., 2018). Of note, Sutherland and Crewther (2010) found significant differences between neurotypical adults with high and low autism traits on both performance on a version of the Navon Task and in the corresponding Visual Evoked Potentials.

It has therefore been contended that a superior ability to detect details is part of the cognitive profile of ASD (Kéïta, Guy, Berthiaume, Mottron, & Bertone, 2014; Simmons et al., 2009) and to a lesser extent the broader non-clinical autism phenotype (DiCriscio & Troiani, 2018). This local bias in ASD appears to be present from early in development (Guy, Mottron, Berthiaume, & Bertone, 2016; Oi & Dairoku, 2018), though it is important to highlight that much of the literature examining visual perception and ASD has used high functioning participants (Brown, Chouinard, & Crewther, 2017).

There have been several theoretical and experimental explanations proposed to account for the atypical perceptual biases often observed in ASD and other neurodevelopmental disorders. From a visual system perspective, the magnocellular pathway (predominantly projecting through the brainstem to superior colliculus and cortical dorsal stream, as outlined in Goodale & Milner, 1992) is involved in the global analysis of a visual scene (Bullier, 2001) in a rapid process referred to as the ‘magnocellular advantage’ that helps activate attention and processing of the ‘gist’ of a scene prior to more detailed processing (Laycock, Crewther, & Crewther, 2007). Conversely, the parvocellular pathway projecting through ventral stream is best suited to local visual information such as the recognition of objects (Nassi & Callaway, 2009). However, the ventral stream is a composite visual pathway receiving information from both the magnocellular and the parvocellular pathways (Cloutman, 2013). As alluded to in Chapter 2, the dorsal stream is thought to be

impaired in neurodevelopmental disorders including ASD and dyslexia (Pellicano, Gibson, Maybery, Durkin, & Badcock, 2005; Pellicano & Gibson, 2008; Spencer et al., 2000). An impairment in the magnocellular system contribution through the dorsal stream – a 'magnocellular *dis*advantage' – would impact on the ability to integrate global visual information (Laycock, Crewther, & Crewther, 2007) and thus could contribute to difficulties in global face perception.

At least two prominent cognitive theories have been proposed to account for the bias towards detecting local details in ASD from childhood (Guy et al., 2016). The Weak Central Coherence theory (WCC) contends that this processing style is due to difficulty extracting global form and meaning (Burnette et al., 2005; Frith & Happé, 1994; Happé & Frith, 2006) whilst the Enhanced Perceptual Functioning (EPF) model proposes an enhanced ability to process local information but not at the expense of integrating global features (Hadad & Ziv, 2015; Mottron & Burack, 2001; Mottron, Dawson, Soulieres, Hubert, & Burack, 2006; Wang, Mottron, Peng, Berthiaume, & Dawson, 2007). This this study seeks to investigate perceptual bias in children with AHDN.

The Current Study

Although it has been well documented that ASD is often co-morbid with anxiety (Kanner 1943; Kerns & Kendall, 2014), and that both disorders are associated with a bias towards local perception, this relationship has not yet been investigated in children with AHDN. Children with AHDN have been shown (see Chapter 4), to have higher autistic traits and anxiety (Cross et al., 2019). Thus, the primary aim of this study was to investigate local and global processing biases in children with AHDN. In addition, we aimed to establish whether perceptual biases are associated with social and emotional difficulties frequently experienced in this population regardless of diagnosis.

It was hypothesised that higher levels of anxiety would be associated with greater autism traits in children with AHDN. Based on visual theories of autism proposing that autism behaviours are associated with a bias to detect local visual information (Happé & Frith, 2006; Mottron & Burack, 2001), along with past research suggesting that there is a local bias associated with anxiety (Huntsinger et al., 2010; Yoon et al., 2015), it was expected that autism traits and anxiety would be more associated with a local bias in children with AHDN on a Navon Task. Finally, it was hypothesised that children with AHDN would perform better than Typically Developing (TD) children on local compared to global Navon Tasks.

Methods

Participants

A total of 70 children (22 female and 48 male) aged between seven and thirteen years (M = 9.58, SD = 1.76) with normal or corrected to normal vision and hearing participated in this study. Sixty-one participants were recruited to the AHDN group (19 females and 42 males) (M = 9.58, SD = 1.89) from a school holiday therapy program for children experiencing social, emotional and academic difficulties. Nine Grade 3-4 participants aged between nine and ten years (three females and six males) (M = 9.56, SD = 0.53) were recruited to the TD group from a mainstream primary school in Melbourne, Australia prior to the COVID-19 outbreak. The AHDN sample included 19 children primarily diagnosed with ASD, 24 diagnosed with a Speech and Language Disorder and another 18 participants with various other diagnoses including ADHD (five participants), a chromosomal condition (one participant), experienced social skill difficulties (six participants), or other undiagnosed problem identified by parents and teachers (six participants). Children with AHDN had up to five reported comorbid diagnoses (M = 1.69, SD = 1.29). There were six participants with a

co-morbid anxiety disorder, comprised of three participants with ASD, one with a Speech and Language Disorder, and two participants with social skill difficulties.

Participants were included in the AHDN group if they attended the school holiday therapy program due to being at risk of ongoing chronic difficulties and requiring more support than their peers, in accordance with the definition of AHDN (McPherson et al., 1998). In the TD group, participants were included in the study if they had no formal clinical neurodevelopmental, intellectual disability or other mental health diagnosis and were not identified as having AHDN by teachers or parents alike. Participants were excluded from the study if they had physical disability or major medical or other mental health concerns, such as those related to trauma. See Chapter 3 for more detail on inclusion and exclusion criteria for this study. In order to assess AHDN performance on the Navon task in comparison to the TD group, a final age-matched subsample (N = 16) of 9- 10-year-old children (M = 9.56, SD = 2.37) of children with AHDN were selected for this analysis. Further data collection was planned for 2020 but COVID-19 meant all school-based research has been terminated in schools for this year. As the year has progressed all school age children in the State of Victoria have shifted to online learning at home, making completion of data collection impossible and unlikely to be possible for some time.

Participants' parents or guardians were made aware of the study aims (verbally and in written form) prior to providing written consent and withdrawal information for participation in accordance with the Declaration of Helsinki. Children also provided verbal consent prior to participation. This study was conducted with approval from the La Trobe University Human Ethics Committee, the Victorian Department of Education Human Ethics Committee and the Victorian Catholic Education Ethics Committee.

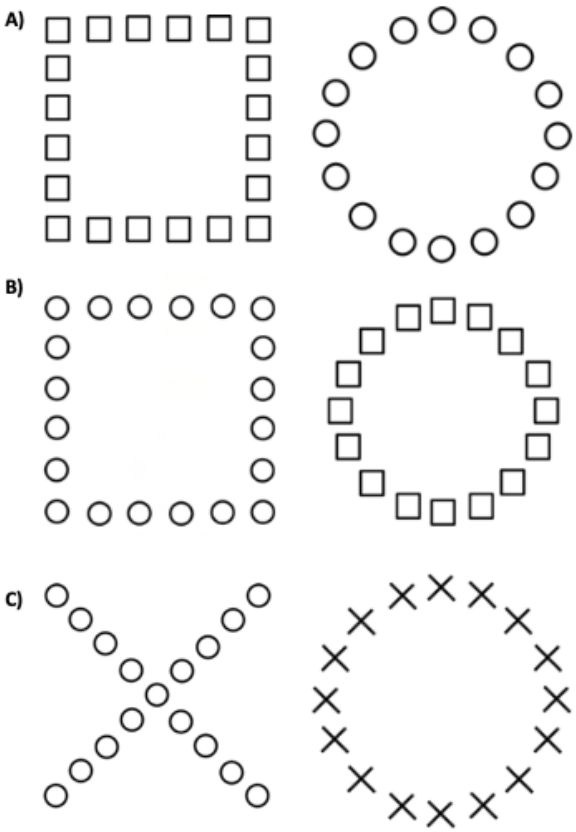
Materials

Screening Measures

Participants were screened for normal or corrected to normal vision and hearing. All students with parental permission completed a measure of nonverbal intelligence using a pen and paper version of the Raven's Coloured Progressive Matrices (RCPM) (Raven et al, 1990). Given our interest in children with AHDN all children have been included in the analysis even though that this was likely to contribute to the variability of results. There were no children with a formal diagnosis of Intellectual Disability. However, there were four children in the AHDN group with RCPM scores below the 25th percentile. Mean Raven's standard score for the AHDN group was 104.10 (*SD* = 14.39), while the mean scores for the TD group was 107.86 (*SD* = 8.82).

Local and Global Processing

Local and global processing was measured using a computerised Navon Task modelled on previous research (Bialystok, 2010) and developed using VPixx software. Prior to the commencement of each trial, a 500ms fixation cross appeared on the screen. This was followed by a Navon shape that remained on the screen until the participant responded. The hierarchical stimuli consisted of a number of small, local shapes (circles, squares, or X's) that made up the outline of a larger, global shape (circle, square or an X). Shapes were presented as congruent (for example, local circles arranged to form a global circle) or incongruent (for example, local squares arranged to form a global circle) (see Figure 5.1).



.

Figure 5.1. Navon Task with A) Congruent, B) Incongruent and C) Neutral Stimuli

There were also neutral global and local stimuli consisting of a circle or square formed from the arrangement of X's (neutral global stimulus) and an X formed from the arrangement of circles or squares (neutral local stimuli) (Plaisted et al., 1999). The global figures used were 6 degrees in height, and 6 degrees in width in degree of visual angle, whilst the local elements had a height and width of approximately 0.8 degrees of visual angle.

In the global task, participants were asked to identify the global shape, whereas in the local task, they were asked to identify the local shape. Their response was provided by pressing a keyboard button (marked with a sticker) which corresponded to each shape. There were 48 trials in each task, consisting of 16 incongruent trials, 16 congruent trials and 16 neutral trials. Reaction time and accuracy were recorded. Reaction Time data is for correct trials only.

Anxiety

The Spence Children's Anxiety Scale- Parent Version (SCAS-P) was used to measure anxiety (Nauta et al., 2004). The SCAS-P includes subscales of 'Panic and Agoraphobia', 'Separation Anxiety', 'Physical Injury Fears', 'Social Phobia', 'Obsessive Compulsive' and 'Generalised Anxiety Disorder'. On each of the 38 items, parents were asked to rate the frequency of anxiety in their child from 'Never', 'Sometimes', 'Often' or 'Always' without any specified time period. Each item was scored between 0 ('Never') and 3 ('Always'). There was a maximum score of 144, with high scores indicating greater levels of anxiety.

Autism Traits

The Autism Spectrum Quotient- Child Version (AQ-Child) was used to measure autism traits (Auyeung, Baron-Cohen, Wheelwright, & Allison, 2008). Parents completed the 50-item questionnaire in pen and paper form and rated the extent that they observed an autism-like behaviour in their child as 'Definitely Agree', 'Slightly Agree', 'Slightly Disagree' or 'Definitely Disagree'. Responses to each item was scored between 0 ('Definitely Agree') to 3 ('Definitely Disagree'). There was a maximum total score of 150, so that high scores are associated with greater autism traits.

Procedure

Parents were provided with verbal and written information about the research, and written informed consent was required prior to testing. Parent packs for completion prior to participation included a form asking for demographic and/or medical information, and the AQ- Child and SCAS-P questionnaires. Parents were asked to return questionnaires to the researchers within one week. Screening for vision, hearing and nonverbal intelligence were completed on all participants. Participants completed the Navon Task in a quiet room with 2 researchers and 2-3 other children on a Mac computer with a screen refresh rate of 80Hz and

a screen resolution of 1152 x 864, while they were seated approximately 40-45cm away. Researchers provided an explanation of the task to participants until it was evident that the instructions were clearly understood by the child. Participants were asked to indicate the "small shape" (local) or the "big shape" (global) as a square or a circle by pressing the appropriately identifiable keyboard button as quickly and as accurately as possible and the order of tasks was counterbalanced to control for fatigue and practice effects. Participants were provided with a small reward (e.g. a sticker or small piece of stationary item of their choice) following participation.

Data Analysis

Missing Data and Exclusion Criteria

Data was entered and analysed in Version 23 of SPSS. The data set was inspected for outliers, and all missing data was excluded from the analyses (Tabachnick & Fidel, 2007). Fifteen AQ- Child and 11 SCAS-P questionnaires were either not returned to researchers or had missing data, with these participants excluded from the correlational analyses. Three extreme outliers above or below 3 SD from the mean for the AHDN group were also excluded (one participant based on the local neutral reaction time condition, one participant on the global congruency effect condition, and one on the local reaction time condition) (Howitt & Cramer, 2007). In the age matched sample, two AHDN participants were identified as extreme outliers and therefore excluded. Seven AHDN participants (two on the local task, three on the global task, and two on both tasks) and one TD participant (global task) performed with accuracy below 75% accuracy and were excluded.

Assumption Testing

Violations to the assumptions of normality and homogeneity in the data were assessed using standard skewness and kurtosis measures, Kolmogorov-Smirnov, the Shapiro- Wilko

test and the Levene's test. The results of these assessments indicated that both of the assumptions of normality and homogeneity were not met, and so nonparametric analyses were employed (Tabachnick & Fidel, 2007).

Statistical Approach

The median reaction time (RT) score for each participant for each condition (i.e., congruent, incongruent, neutral) was calculated for both tasks, and the mean of these scores across participants was calculated and utilised for the analyses. The 'congruency effect' was calculated for each participant by subtracting Congruent RT from Incongruent RT separately for each task. Spearman's Rho partial correlational analyses controlling for age were conducted in order to assess the relationship between anxiety, autism-like traits and local and global Navon tasks amongst AHDN participants. Mann-Whitney U tests were used to compare performance between AHDN and TD participants. A more conservative alpha level of .001 was used to reduce the risk of Type I error on correlational analyses, given the number of subscales in the SCAS-P and AQ- Child questionnaires. For all other analyses, an alpha level of .05 was adopted.

Results

Descriptive Statistics on Anxiety and Autism Traits

Descriptive statistics for SCAS-P and AQ- Child scores are stated below in Table 5.1.

Table 5.1

Autism Traits and Anxiety of the AHDN and TD Groups and Total Sample

		AHDN	TD	Total Sample of AHDN and TD
AQ- Child	*M* (SD)	66.73 (24.14)	45.00 (9.43)	63.97 (23.89)
	Range	22- 128	36 – 59	22- 128
SCAS- P	*M* (SD)	24.54 (12.75)	8.75 (6.07)	22.66 (13.17)
	Range	4- 52	0 - 18	0 – 52

Descriptive Statistics on Local and Global Navon Task Performance

Descriptive statistics for Local and Global Navon Task performance are presented in Table 5.2 for the total AHDN and TD sample, and for the age-matched AHDN subsample group.

Relationship between Anxiety and Autism-Like Traits in AHDN

Amongst AHDN participants, there was a moderate positive relationship between the SCAS-P (anxiety) and the AQ- Child (autism- like traits) as assessed by Spearman's rank-order correlation, r_s (53) = .56**, $p < .001$.

Relationship of Local /Global Visual Processing to Autism- Like Traits in AHDN

A Spearman's partial rank-order correlation controlling for age was run to assess the relationship between autism-like traits and global and local Navon task performance in participants with AHDN. Preliminary analysis showed the relationships to be monotonic, as assessed by visual inspection of a scatterplot. There were no significant relationships found between AQ- Child subscales or total score and the Global Navon Task (Table 5.3) or Local Navon Task (Table 5.4) outcome variable, when testing against an adjusted alpha = .001.

Table 5.2

Means and Standard Deviations of Reaction Time and Accuracy for Additional Health and Developmental Needs (AHDN) Total Sample (N = 61), AHDN Age-Matched Subsample (N = 16) and Typically Developing (TD) (N = 8) Groups on Navon Local and Global Tasks

	AHDN Total Sample		AHDN Age-Matched Subsample		TD Total Sample	
	Navon Global	Navon Local	Navon Global	Navon Local	Navon Global	Navon Local
	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)
Median Reaction Time						
- Congruent	897.56 (307.47)	983.29 (303.29)	912.90 (246.88)	997.70 (238.31)	870.19 (216.50)	843.41 (208.19)
- Incongruent	920.26 (291.53)	1117.07 (360.39)	929.54 (281.310	1127.29 (321.23)	855.73 (116.67)	959.37 (304.06)
- Neutral	855.58 (224.56)	1014.37 (265.54)	913.85 (253.49)	1072.12 (283.05)	882.79 (279.93)	842.24 (406.83)
- Congruency Effect	23.43 (96.36)	110.17 (118.15)	16.64 (107.89)	55.26 (123.99)	24.97 (143.22)	178.03 (229.36)
Accuracy						
- Congruent	95.23 (6.25)	96.49 (5.91)	92.58 (6.52)	95.70 (5.91)	97.66 (4.66)	96.53 (5.51)
- Incongruent	94.66 (6.06)	93.50 (7.18)	94.92 (7.29)	94.53 (7.86)	92.97 (7.04)	88.89 (10.72)
- Neutral	95.45 (5.31)	96.57 (6.65)	96.88 (3.95)	96.48 (7.20)	96.09 (6.63)	97.92 (3.13)

Table 5.3

Correlation between AQ- Child and Navon Global Task for Additional Health and Developmental Needs Group Controlling for Age

AQ- Child	Social Skills	Attention Switching	Attention to Detail	Communication	Imagination	Total Score
Median Reaction Time						
- Congruent	.03	.02	.08	.15	03	.08
- Incongruent	-.13	-.11	-.11	-.09	-.04	-.12
- Neutral	-.06	-.10	-.009	-.03	-.04	-.07
- Congruency Effect	-.22	-.21	-.27	-.27	-.23	-.29
Accuracy						
- Congruent	.33	.31	-.16	.38	.27	.32
- Incongruent	.31	.24	.35	.24	.19	.31
- Neutral	.25	.07	-.07	.23	.29	.13

Table 5.4

Correlation between AQ- Child and Navon Local Task for Additional Health and Developmental Needs Group Controlling for Age

AQ- Child	Social Skills	Attention Switching	Attention to Detail	Communication	Imagination	Total Score
Median Reaction Time						
- Congruent	-.03	-.02	.10	.04	-.15	-.009
- Incongruent	.12	.11	.06	.18	.03	.14
- Neutral	.01	.01	.12	.07	-.03	.04
- Congruency Effect	.17	.05	.03	.16	.27	.20
Accuracy						
- Congruent	.26	.27	.22	.39	.30	.39
- Incongruent	.26	.27	.14	.31	.22	.27
- Neutral	.32	.34	.42	.23	.11	.32

Relationship of Local and Global Visual Processing to Anxiety in AHDN

A Spearman's rank-order correlation was run to assess the relationship between anxiety and local and global Navon tasks amongst AHDN participants. Preliminary analysis showed the relationships to be monotonic, as assessed by visual inspection of a scatterplot. There were no significant relationships found between the SCAS- P total score or subscales and the Global Navon Task (Table 5.5) or Local Navon Task (Table 5.6) after adjusting alpha to a more conservative .001 to account for risk of Type 1 error.

Comparison of Navon Task Performance Between Age-Matched Additional Health and Developmental Needs and Typically Developing Children

A series of Mann Whitney U tests were run to determine if there were differences in Navon task performance between a subsample of age matched children (9 – 10 years old) with AHDN (N = 16) and TD (N = 8) children on Navon task performance. Visual inspection of the Mann Whitney U histograms for Navon performance indicated that both groups were similar. Statistical analyses on Navon performance demonstrated there was no statistically significant difference between the age-matched subsample of AHDN and TD groups on the Global Navon task (Table 5.7) nor the Local Navon Task (Table 5.8).

Table 5.5

Correlation between SCAS-P and Navon Global Task for Additional Health and Developmental Needs Group Controlling for Age

SCAS-P	Separation Anxiety	Generalised Anxiety	Social Phobia	Panic/ Agoraphobia	Physical Injury Fears	Obsessive Compulsive	Total
Median Reaction Time							
- Congruent	.10	-.08	.10	-.06	-.12	-.07	-.01
- Incongruent	-.06	-.18	-.08	-.21	-.11	-.15	-.18
- Neutral	-.03	-.18	-.08	-.19	-.18	-.06	-.15
- Congruency Effect	-.27	-.23	-.25	-.17	-.10	.02	-.27
Accuracy							
- Congruent	.01	.04	.10	-.003	.02	.10	.05
- Incongruent	-.002	.10	.10	.17	.21	.21	.17
- Neutral	.11	.03	.23	.007	.04	.08	.09

Table 5.6

Correlation between SCAS-P and Navon Local Task for Additional Health and Developmental Needs Group Controlling for Age

SCAS-P	Separation Anxiety	Generalised Anxiety	Social Phobia	Panic/ Agoraphobia	Physical Injury Fears	Obsessive Compulsive	Total
Median Reaction Time							
- Congruent	-.15	-.15	.05	-.05	-.28	-.07	-.13
- Incongruent	-.20	-.18	-.04	-.10	-.34	-.09	-.18
- Neutral	-.11	-.20	-.04	-.08	-.24	-.12	-.15
- Congruency Effect	-.03	.02	-.04	-.17	-.26	.08	-.07
Accuracy							
- Congruent	.08	.03	.21	-.13	-.05	.30	.11
- Incongruent	.08	.15	.22	.14	.22	.40	.27
- Neutral	-.009	.04	.12	-.02	-.06	.44	.10

Table 5.7

Mann Whitney U Analyses of Global Navon Task Performance Between Age Matched (9- 10 Years) Additional Health and Developmental Needs (N=16) and Typically Developing (N=8) Groups.

		Group	*Median*	*U*	*Z*	*p*
Median RT						
	Congruent	AHDN	906.00	54.00	-.61	.57
		TD	885.95			
	Incongruent	AHDN	911.72	59.00	-.31	.79
		TD	882.32			
	Neutral	AHDN	830.80	59.00	-.31	.79
		TD	873.23			
	Congruency Effect	AHDN	.02	63.00	-47	.67
		TD	32.75			
Accuracy						
	Congruent	AHDN	93.75	93.50	1.93	.07
		TD	100.00			
	Incongruent	AHDN	96.86	51.50	-.82	.45
		TD	93.75			
	Neutral	AHDN	100.00	65.50	.11	.93
		TD	100.00			

Table 5.8

Mann Whitney U Analyses of Local Navon Task Performance Between Age Matched (9- 10 Years) Additional Health and Developmental Needs (N=16) and Typically Developing Groups (N=8).

		Group	*Median*	*U*	*Z*	*p*
Median RT						
	Congruent	AHDN	985.35	46.00	-.90	.39
		TD	919.25			
	Incongruent	AHDN	1081.30	49.00	-.92	.38
		TD	940.23			
	Neutral	AHDN	1022.92	46.00	-1.10	.29
		TD	902.93			
	Congruency Effect	AHDN	62.53	87.00	1.41	.17
		TD	146.07			
Accuracy						
	Congruent	AHDN	100.00	66.50	.17	.88
		TD	100.00			
	Incongruent	AHDN	100.00	48.00	-1.05	.35
		TD	93.75			
	Neutral	AHDN	100.00	60.50	-.27	.83
		TD	100.00			

Discussion

This study aimed to examine the relationship between anxiety and autism traits and local and global visual processing in a group of children with AHDN. It also aimed to explore whether there is a difference in perceptual bias to local or global stimuli in these children with AHDN compared to a sample of TD children. The aims of this study were achieved by asking a group of children recruited from either a school holiday therapy program (AHDN group) or a general primary school (TD group) to complete Navon style tasks and examining the relationship with parent-report anxiety (SCAS-P) and autism trait (AQ- Child) measures. It was hypothesised that for children with AHDN, there would be a positive relationship between anxiety and autism traits, and that these would be more associated with local Navon task performance compared to global task performance. It was also predicted that when compared to TD children, children with AHDN would perform better on the local Navon task.

Although there was a moderate positive relationship between anxiety and autism traits, as expected, the overall findings did not support the hypotheses relating to perceptual bias. There were no significant correlations found in the children with AHDN with performance (accuracy and reaction time) on the Navon task (global or local), suggesting that the current results do not support that there is a bias towards local visual information associated with higher autism traits, chronic anxiety, or neurodevelopmental diagnosis within our AHDN sample as has previously been reported in other studies that investigated specific neurodevelopmental disorders such as Fragile X (Ballantyne, Núñez, & Manoussaki, 2017), Williams Syndrome (Bernardino et al., 2012), and ASD (Plaisted et al., 1999), as well as in subclinical populations with higher autism traits (Sutherland and Crewther, 2010) or associated with anxiety (Tyler & Tucker, 1982). Additionally, there were no significant differences between the AHDN and TD age-matched groups. There was a trend towards

significance between age matched AHDN and TD groups on the global congruent accuracy condition, suggesting that TD children may be better at identifying congruent trials on the Navon task.

These findings subsequently do not provide clear evidence that theories of WCC (Firth & Happé, 1994) or EPF (Mottron et al., 2006) extend to AHDN beyond ASD in our sample, despite the greater number of reported autism-like traits compared with TD children. It has been recently proposed that the literature regarding ASD and local biases using a Navon paradigm overall does not provide adequate support for either the WCC or EPF theories (Baisa, Mevorach, & Shalev, 2018). This may be due to the level of variability in the physical design of the Navon task affecting the saliency of the stimuli, including exposure time and visual angle (Baisa et al., 2018). Although much of the research using a Navon task uses letters (small letters to make a large letters), shapes were used to comprise Navon stimuli in the current study as they are known to be more familiar than letters to children and controls for children who may have difficulty reading (Bialystok, 2010; Dukette & Stiles, 1996). Additionally, it is difficult to compare to past research more generally given the previous bias to include higher functioning children in research, particularly in the ASD and visual perception literature (Brown et al., 2017).

There are several explanations to consider why the effect of a local processing bias was not found in the current sample of children with AHDN. Although the aim of the current study was to investigate a group of children with diverse symptoms and complex needs, particularly given that there are no known prior studies examining individual traits and local/global visual processing in this population, this diversity also presents an inherent difficulty. The sample broadly included multiple diagnoses considered to be neurodevelopmental in origin resulting in a heterogenous sample likely to increase variability in the data. Performance on the Navon task was measured by keyboard responses requiring

fine motor skills, which likely added variability in responses for individuals and diagnostic groups and may have been a confounding factor. This may have led to the unique nuances of each disorder being minimised in the results, however the small comparative TD group also likely contributed to the non-significant difference between groups.

The local bias assumption in neurodevelopmental disorders has also been challenged recently. As Muth and colleagues (2014) pointed out in their meta-analysis, the difference between ASD and TD performance on Navon tasks may indeed be smaller than is often suggested across the literature. Similarly, the meta-analysis conducted by Van der Hallen et al. (2015) found no clear local or global bias in ASD but rather a tendency for slower RT during global processing when there was task-irrelevant local information also present (e.g. local incongruent stimuli).

Inconsistent findings of a local/global bias are further evidenced in the ADHD literature, where some research has proposed that children with ADHD are unaffected by the WCC (Booth, Charlton, Hughes, & Happé, 2003) while others have found evidence for a tendency to process local before global visual information (Song & Hakoda, 2012). Additionally, some children included in the AHDN group in the current study were considered to have 'additional [social] needs' but did not have a formal clinical diagnosis. Furthermore, difficulties such as 'social skill' deficits may not necessarily be associated with local/ global attention processes, again indicating that although children with AHDN are an under studied population, the heterogeneity of this group creates objective difficulties.

In addition to the complexity of the population used, another aspect of this study design that may have impacted the results is the materials used to conceptualise both anxiety and attention. The questionnaires assessed chronic anxiety related to long term behaviours, rather than acute state-level anxiety. Our results did not support findings in the literature about the relationship of trait anxiety to a local processing bias as has previously been

reported in some populations (Becker et al., 2017; Tyler & Tucker, 1982). However, past research findings have generally referred to adult populations and it may be that the role of trait anxiety on attention becomes more solidified throughout development. As in other studies within this thesis, the subjectivity of parent- rated questionnaires may have resulted in a discrepancy between observable and internal experiences of anxiety, particularly for children with diagnosis such as ASD (Magiati, Chan, Tan, & Poon, 2014). Rather, local and global attention may be more sensitive to acute states of emotion including anxiety (objectively measured by physiological measures such as heart rate and blood pressure), given that these states are often associated with the need to rapidly allocate attention (Shilton, Laycock, & Crewther, 2019). The Navon task itself did not require a rapid allocation of attention via the magnocellular pathway, and therefore may not have been dependent on a rapid 'magnocellular advantage' (Laycock et al., 2007)

It is also important to acknowledge that a limitation of the current study is that the sample size of the comparative TD sample was small, and the use of a non-parametric statistical approach likely resulted in some reduced power to detect significant effects (Field, 2009). Future research should further explore the relationship between acute anxiety in children in facilitating a bias towards local or global visual information. Further understanding of anxiety and local/global visual attention in children who experience AHDN is imperative to the development of a cognitive profile of these children in relation to social and emotional behaviours.

Conclusions

The current study did not find a significant relationship between local or global Navon processing in a population of children with AHDN and anxiety or autism traits. There was also no significant difference in local or global Navon task performance between 9-10-year-old AHDN and TD children. There is no known prior research examining the

relationship of local/global attention and anxiety within this population. These findings do not necessarily suggest that a relationship between anxiety, autism traits and perceptual bias does not exist, but rather may be related to acute state anxiety rather than chronic anxiety, highlighting the need for further research to identify common behavioural patterns in children with AHDN.

References

Almeida, R. A., Dickinson, J. E., Maybery, M. T., Badcock, J. C., & Badcock, D. R. (2013). Visual search targeting either local or global perceptual processes differs as a function of autistic-like traits in the typically developing population. *J Autism Dev Disord, 43*(6), 1272-1286. http://doi.org/10.1007/s10803-012-1669-7

Auyeung, B., Baron-Cohen, S., Wheelwright, S., & Allison, C. (2008). The autism spectrum quotient: Children's version (AQ-Child). *J Autism Dev Disord, 38*(7), 1230-1240. https://doi.org./10.1007/s10803-007-0504-z

Baisa, A., Mevorach, C., & Shalev, L. (2018). Can Performance in Navon Letters among People with Autism be Affected by Saliency? Reexamination of the Literature. *Review Journal of Autism and Developmental Disorders*, 1-12. http://doi.org/10.1007/s40489-018-0150-8

Ballantyne, C. J., Núñez, M., & Manoussaki, K. (2017). Visuo-spatial construction trajectories in Fragile X Syndrome (FXS) and Autism Spectrum Disorders (ASD): Evidence of cognitive heterogeneity within neurodevelopmental conditions. *Res Dev Disabil, 70*, 113-125. http://doi.org/10.1016/j.ridd.2017.08.005

Barrett, L. F., & Bar, M. (2009). See it with feeling: affective predictions during object perception. *Philosophical Transactions of the Royal Society B: Biological Sciences, 364*(1521), 1325-1334. http://doi/org/10.1098/rstb.2008.0312

Basso, M. R., Schefft, B. K., Ris, M. D., & Dember, W. N. (1996). Mood and global-local visual processing. *Journal of the International Neuropsychological Society, 2*(3), 249-255. http://doi.org/10.1017/S1355617700001193

Baum, S. H., Stevenson, R. A., & Wallace, M. T. (2015). Behavioral, perceptual, and neural alterations in sensory and multisensory function in autism spectrum disorder. *Progress in neurobiology, 134*, 140-160. http://doi.org/10.1037/0278-6133.1.3.217

Baumann, N., & Kuhl, J. (2005). Positive affect and flexibility: Overcoming the precedence of global over local processing of visual information. *Motivation and Emotion, 29*(2), 123-134. http://doi.org/10.1007/s11031-005-7957-1

Bayliss, A. P., & Tipper, S. P. (2005). Gaze and arrow cueing of attention reveals individual differences along the autism spectrum as a function of target context. *British Journal of Psychology, 96*(1), 95-114. http://doi.org/10.1348/000712604X15626

Becker, K. R., Plessow, F., Coniglio, K. A., Tabri, N., Franko, D. L., Zayas, L. V., . . . Eddy, K. T. (2017). Global/local processing style: Explaining the relationship between trait anxiety and binge eating. *International Journal of Eating Disorders, 50*(11), 1264-1272. http://doi.org/10.1002/eat.22772

Behrmann, M., Thomas, C., & Humphreys, K. (2006). Seeing it differently: visual processing in autism. *Trends Cogn Sci, 10*(6), 258-264. http://doi.org/10.1016/j.tics.2006.05.001

Bernardino, I., Mouga, S., Almeida, J., van Asselen, M., Oliveira, G., & Castelo-Branco, M. (2012). A direct comparison of local-global integration in autism and other developmental disorders: implications for the central coherence hypothesis. *PLoS One, 7*(6), e39351. http://doi.org/10.1371/journal.pone.0039351

Bialystok, E. (2010). Global–local and trail-making tasks by monolingual and bilingual children: Beyond inhibition. *Developmental psychology, 46*(1), 93. http://doi.org/10.1037/a0015466

Booth, R., Charlton, R., Hughes, C., & Happé, F. (2003). Disentangling weak coherence and executive dysfunction: Planning drawing in autism and attention–deficit/hyperactivity disorder. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences, 358*(1430), 387-392.http://doi.org/10.1098/rstb.2002.1204

Brown, A. C., Chouinard, P. A., & Crewther, S. G. (2017). Vision research literature may not represent the full intellectual range of autism spectrum disorder. *Front Hum Neurosci, 11*, 57. http://doi.org/10.3389/fnhum.2017.00057

Bullier, J. (2001). Integrated model of visual processing. *Brain research reviews, 36*(2-3), 96-107. http://doi.org/10.1016/S0165-0173(01)00085-6

Burnette, C. P., Mundy, P. C., Meyer, J. A., Sutton, S. K., Vaughan, A. E., & Charak, D. (2005). Weak central coherence and its relations to theory of mind and anxiety in autism. *J Autism Dev Disord, 35*(1), 63-73. http://doi.org/10.1007/s10803-004-1035-5

Cloutman, L. L. (2013). Interaction between dorsal and ventral processing streams: where, when and how? *Brain and Language, 127*(2), 251-263. http://doi.org/10.1016/j.bandl.2012.08.003

Crewther, D. P., Crewther, D., Bevan, S., Goodale, M. A., & Crewther, S. G. (2015). Greater magnocellular saccadic suppression in high versus low autistic tendency suggests a causal path to local perceptual style. *Royal Society Open Science, 2*(12), 150226. http://doi.org/10.1098/rsos.150226

Crewther, D. P., Lawson, M. L., & Crewther, S. G. (2007). Global and local attention in the attentional blink. *Journal of Vision, 7*(14), 9-9. http://doi.org/10.1167/7.14.9

Cross, A. J., Goharpey, N., Laycock, R., & Crewther, S. G. (2019). Anxiety as a Common Biomarker for School Children With Additional Health and Developmental Needs Irrespective of Diagnosis. *Frontiers in Psychology, 10*, 1420. http://doi.org/10.3389/fpsyg.2019.01420

de Fockert, J. W., & Cooper, A. (2014). Higher levels of depression are associated with reduced global bias in visual processing. *Cogn Emot, 28*(3), 541-549. http://doi.org/10.1080/02699931.2013.839939

Derryberry, D., & Reed, M. A. (2002). Anxiety-related attentional biases and their regulation by attentional control. *Journal of abnormal psychology, 111*(2), 225. http://doi.org/10.1037/0021-843X.111.2.225

DiCriscio, A. S., & Troiani, V. (2018). The broader autism phenotype and visual perception in children. *J Autism Dev Disord*, 1-12. http://doi.org/10.1007/s10803-018-3534-9.

Dillen, C., Steyaert, J., De Beeck, H. P. O., & Boets, B. (2015). Visual processing in adolescents with autism spectrum disorder: evidence from embedded figures and configural superiority tests. *J Autism Dev Disord, 45*(5), 1281-1290. http://doi.org/10.1007/s10803-014-2288-2

Dukette, D., & Stiles, J. (1996). Children's analysis of hierarchical patterns: Evidence from a similarity judgment task. *Journal of experimental child psychology, 63*(1), 103-140. http://doi.org/10.1006/jecp.1996.0044

Ellenbogen, M. A., & Schwartzman, A. E. (2009). Selective attention and avoidance on a pictorial cueing task during stress in clinically anxious and depressed participants. *Behav Res Ther, 47*(2), 128-138. http://doi.org/10.1016/j.brat.2008.10.021

English, M. C., Maybery, M. T., & Visser, T. A. (2017). Modulation of Global and Local Processing Biases in Adults with Autistic-like Traits. *J Autism Dev Disord, 47*(9), 2757-2769. http://doi.org/10.1007/s10803-017-3198-x

Field, A. (2009). *Discopering Statistics Using SPSS, Thrid Edition.* Sage Publications.

Frith, U., & Happé, F. (1994). Autism: beyond “theory of mind”. *Cognition, 50*(1), 115-132. http://doi.org/10.1016/0010-0277(94)90024-8

Gasper, K., & Clore, G. L. (2002). Attending to the big picture: Mood and global versus local processing of visual information. *Psychol Sci, 13*(1), 34-40. http://doi.org/10.1111/1467-9280.00406

Goodale, M. A., & Milner, A. D. (1992). Separate visual pathways for perception and action. *Trends in Neuroscience, 15*(1), 20-25. http://doi.org/10.1016/0166-2236(92)90344-8

Guy, J., Mottron, L., Berthiaume, C., & Bertone, A. (2016). A developmental perspective of global and local visual perception in autism spectrum disorder. *J Autism Dev Disord*, 1-15. http://doi.org/10.1007/s10803-016-2834-1

Hadad, B.S., & Ziv, Y. (2015). Strong bias towards analytic perception in ASD does not necessarily come at the price of impaired integration skills. *J Autism Dev Disord, 45*(6), 1499-1512. http://doi.org/10.1007/s10803-014-2293-5

Happé, F., & Frith, U. (2006). The weak coherence account: detail-focused cognitive style in autism spectrum disorders. *J Autism Dev Disord, 36*(1), 5-25. https://doi.org/10.1007/s10803-005-0039-0

Hayward, D. A., Fenerci, C., & Ristic, J. (2018). An investigation of global-local processing bias in a large sample of typical individuals varying in autism traits. *Conscious Cogn, 65*, 271-279. http://doi.org/10.1016/j.concog.2018.09.002

Howitt, D., & Cramer, D. (2007). *Introduction to statistics in psychology*: Pearson education.

Huntsinger, J. R., Clore, G. L., & Bar-Anan, Y. (2010). Mood and global–local focus: Priming a local focus reverses the link between mood and global–local processing. *Emotion, 10*(5), 722. https://doi.org/10.1037/a0019356

Kaldy, Z., Giserman, I., Carter, A. S., & Blaser, E. (2016). The mechanisms underlying the ASD advantage in visual search. *J Autism Dev Disord, 46*(5), 1513-1527. http://doi.org/10.1007/s10803-013-1957-x

Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous child, 2*(3), 217-250.

Kéïta, L., Guy, J., Berthiaume, C., Mottron, L., & Bertone, A. (2014). An early origin for detailed perception in Autism Spectrum Disorder: biased sensitivity for high-spatial frequency information. *Scientific Reports, 4*, 5475. http://doi.org/10.1038/srep05475

Kerns, C. M., & Kendall, P. C. (2014). Autism and anxiety: Overlap, similarities, and differences. In *Handbook of autism and anxiety* (pp. 75-89): Springer. http://doi.org/10.1007/978-3-319-06796-4_6

Lawson, M., Crewther, S., Junghans, B., & Crewther, D. (2003). The Role of Accommodation in Shifting Between Global and Local Attention. *Investigative Ophthalmology & Visual Science, 44*(13), 4098-4098.

Lawson, M. L., Crewther, S. G., Junghans, B. M., Crewther, D. P., & Kiely, P. M. (2005). Changes in ocular accommodation when shifting between global and local attention. *Clinical and Experimental Optometry, 88*(1), 28-32. http://doi.org/10.1111/j.1444-0938.2005.tb06660.x

Laycock, R., Crewther, S. G., & Crewther, D. P. (2007). A role for the 'magnocellular advantage' in visual impairments in neurodevelopmental and psychiatric disorders. *Neurosci Biobehav Rev, 31*(3), 363-376. http://doi.org/10.1016/j.neubiorev.2006.10.003

Magiati, I., Chan, J. Y., Tan, W.-L. J., & Poon, K. K. (2014). Do non-referred young people with Autism Spectrum Disorders and their caregivers agree when reporting anxiety symptoms? A preliminary investigation using the Spence Children's Anxiety Scale. *Research in Autism Spectrum Disorders, 8*(5), 546-558. http://doi.org/10.1016/j.rasd.2014.01.015

Mottron, L., & Burack, J. A. (2001). Enhanced perceptual functioning in the development of autism. n J. A. Burack, T. Charman, N. Yirmiya, & P. R. Zelazo (Eds.), *The development of autism: Perspectives from theory and research* (p. 131–148). Lawrence Erlbaum Associates Publishers.

Mottron, L., Burack, J. A., Iarocci, G., Belleville, S., & Enns, J. T. (2003). Locally oriented perception with intact global processing among adolescents with high-functioning

autism: evidence from multiple paradigms. *Journal of Child Psychology And Psychiatry, 44*(6), 904-913. http://doi.org/10.1111/1469-7610.00174

Mottron, L., Dawson, M., Soulieres, I., Hubert, B., & Burack, J. (2006). Enhanced perceptual functioning in autism: an update, and eight principles of autistic perception. *J Autism Dev Disord, 36*(1), 27-43. http://doi.org/10.1007/s10803-005-0040-7

Muth, A., Hönekopp, J., & Falter, C. M. (2014). Visuo-spatial performance in autism: a meta-analysis. *Journal of Autism and Developmental Disorders, 44(*12), 3245-3263.http://doi.org/10.1007/s10803-014-2188-5

Nassi, J. J., & Callaway, E. M. (2009). Parallel processing strategies of the primate visual system. *Nat Rev Neurosci, 10*(5), 360-372. doi:10.1038/nrn2619

Nauta, M. H., Scholing, A., Rapee, R. M., Abbott, M., Spence, S. H., & Waters, A. (2004). A parent-report measure of children's anxiety: psychometric properties and comparison with child-report in a clinic and normal sample. *Behav Res Ther, 42*(7), 813-839. http://doi.org/10.1016/S0005-7967(03)00200-6

Navon, D. (1977). Forest before trees: The precedence of global features in visual perception. *Cognitive psychology, 9*(3), 353-383. http://doi.org/10.1016/0010-0285(77)90012-3

Oi, A., & Dairoku, H. (2018). Local Processing Bias in Attention and Enhanced Local Processing in Perception in Children With Autism Spectrum Disorder. *Journal of Special Education Research, 6*(2), 59-69. http://doi.org/10.6033/specialeducation.6.59

Pellicano, E., Gibson, L., Maybery, M., Durkin, K., & Badcock, D. R. (2005). Abnormal global processing along the dorsal visual pathway in autism: a possible mechanism for weak visuospatial coherence? *Neuropsychologia, 43*(7), 1044-1053. http://doi.org/10.1016/j.neuropsychologia.2004.10.003

Pellicano, E., & Gibson, L. Y. (2008). Investigating the functional integrity of the dorsal visual pathway in autism and dyslexia. *Neuropsychologia, 46*(10), 2593-2596. http://doi.org/10.1016/j.neuropsychologia.2008.04.008

Plaisted, K., Swettenham, J., & Rees, L. (1999). Children with autism show local precedence in a divided attention task and global precedence in a selective attention task. *The Journal of Child Psychology and Psychiatry and Allied Disciplines, 40*(5), 733-742. http://doi.org/10.1111/1469-7610.00489

Robertson, C. E., & Baron-Cohen, S. (2017). Sensory perception in autism. *Nature Reviews Neuroscience, 18*(11), 671-684.http://doi.org/10.1038/nrn.2017.112

Shah, A., & Frith, U. (1993). Why do autistic individuals show superior performance on the block design task? *Journal of Child Psychology And Psychiatry, 34*(8), 1351-1364. http://doi.org/10.1111/j.1469-7610.1993.tb02095.x

Shi, R., Sharpe, L., & Abbott, M. (2019). A meta-analysis of the relationship between anxiety and attentional control. *Clinical psychology review*, *72*, 101754. http://doi.org/10.1016/j.cpr.2019.101754

Shilton, A. L., Laycock, R., & Crewther, S. G. (2019). Different effects of trait and state anxiety on global-local visual processing following acute stress. *Cognition, Brain, Behavior, 23*(3), 155-170. http://doi.org/10.24193/cbb.2019.23.09

Simmons, D. R., Robertson, A. E., McKay, L. S., Toal, E., McAleer, P., & Pollick, F. E. (2009). Vision in autism spectrum disorders. *Vision Res, 49*(22), 2705-2739. http://doi.org/10.1016/j.visres.2009.08.005

Song, Y., & Hakoda, Y. (2012). The interference of local over global information processing in children with attention deficit hyperactivity disorder of the inattentive type. *Brain and Development, 34*(4), 308-317. http://doi.org/10.1016/j.braindev.2011.07.010

Soriano, M. F., Ibáñez-Molina, A. J., Paredes, N., & Macizo, P. (2017). Autism: Hard to Switch from Details to the Whole. *Journal of abnormal child psychology*, 1-13. http://doi.org/10.1007/s10802-017-0384-4

Spencer, J., O'Brien, J., Riggs, K., Braddick, O., Atkinson, J., & Wattam-Bell, J. (2000). Motion processing in autism: evidence for a dorsal stream deficiency. *Neuroreport, 11*(12), 2765-2767. http://doi.org/10.1097/00001756-200008210-00031

Sutherland, A., & Crewther, D. P. (2010). Magnocellular visual evoked potential delay with high autism spectrum quotient yields a neural mechanism for altered perception. *Brain, 133*(7), 2089-2097. http://doi.org/10.1093/brain/awq122

Tabachnick, B., & Fidel, S. (2007). *Using Multivariate Statistic*s. Pearson Education, Inc., Boston.

Tan, H. K., Jones, G. V., & Watson, D. G. (2009). Encouraging the perceptual underdog: Positive affective priming of nonpreferred local–global processes. *Emotion, 9*(2), 238.http://doi.org/10.1037/a0014713

Tanaka, J. W., & Sung, A. (2016). The “eye avoidance” hypothesis of autism face processing. *J Autism Dev Disord, 46*(5), 1538-1552. http://doi.org/10.1007/s10803-013-1976-7

Tyler, S. K., & Tucker, D. M. (1982). Anxiety and perceptual structure: Individual differences in neuropsychological function. *Journal of Abnormal Psychology, 91*(3), 210. https://doi.org/10.1037/0021-843X.91.3.210

Van der Hallen, R., Evers, K., Brewaeys, K., Van den Noortgate, W., & Wagemans, J. (2015). Global processing takes time: A meta-analysis on local–global visual processing in ASD. *Psychol Bull, 141*(3), 549. http://doi.org/10.1037/bul0000004

Vilidaite, G., Norcia, A. M., West, R. J., Elliott, C. J., Pei, F., Wade, A. R., & Baker, D. H. (2018). Autism sensory dysfunction in an evolutionarily conserved system.

Proceedings of the Royal Society B, 285(1893), 20182255. http://doi.org/10.1098/rspb.2018.2255

Vlamings, P. H. J. M., Jonkman, L. M., van Daalen, E., van der Gaag, R. J., & Kemner, C. (2010). Basic abnormalities in visual processing affect face processing at an early age in autism spectrum disorder. *Biol Psychiatry, 68*(12), 1107-1113. http://doi.org/10.1016/j.biopsych.2010.06.024

Vuilleumier, P. (2015). Affective and motivational control of vision. *Current opinion in neurology, 28*(1), 29-35. http://dx.doi.org/10.1097/WCO.0000000000000159

Wang, L., Mottron, L., Peng, D., Berthiaume, C., & Dawson, M. (2007). Local bias and local-to-global interference without global deficit: A robust finding in autism under various conditions of attention, exposure time, and visual angle. *Cognitive Neuropsychology, 24*(5), 550-574. http://doi.org/10.1080/13546800701417096

Yoon, K. L., Vidaurri, D. N., Joormann, J., & De Raedt, R. (2015). Social anxiety and narrowed attentional breadth toward faces. *Emotion, 15*(6), 682. http://doi.org/10.1037/emo0000070

Zhao, S., Uono, S., Yoshimura, S., Kubota, Y., & Toichi, M. (2017). Atypical gaze cueing pattern in a complex environment in individuals with ASD. *J Autism Dev Disord, 47*(7), 1978-1986. http://doi.org/10.1007/s10803-017-3116-2

Chapter 6- Interactions of Chronic Anxiety and Posner's Attention Networks in Children with Additional Health and Developmental Needs

Abstract

The Attention Network Task (ANT) is widely used to measure Posner's alerting, orienting and executive control attention networks. However, little is known about how chronic anxiety may impact on these attention networks in young school children, in particular, those with Additional Health and Developmental Needs (AHDN). Thus, this study aimed to investigate the relationship between chronic anxiety (measured by the Spence Children's Anxiety Scale-Parent report) and the alerting, orienting and executive control networks in children with AHDN using a child version of the ANT. It was hypothesised that anxiety would be most strongly associated with the executive control network in children with AHDN, and that children with AHDN would show impairments across all three attention networks when compared to Typically Developing (TD) peers. Our results, however, found that chronic anxiety was most correlated with the alerting network overall. Regression analyses demonstrated that anxiety explained 7% of the variance for the alerting network score in the AHDN group. When compared to a small sample of age-matched TD controls (9-10 years), there was only a significant difference between groups on the executive control network. Our results provide a novel finding of the role that the alerting network plays in children with AHDN.

Interactions of Chronic Anxiety and Posner's Attention Networks in Children with Additional Health and Developmental Needs

Acute stress responses are intended as an adaptive reaction aimed at rapid detection, identification, and active response to a particular immediate threat (Brosschot, Verkuil, & Thayer, 2016). However unlike these state-based responses, more chronic trait-based anxiety, such as the prolonged worry about the inability to do well at school, is maladaptive, with continuing anxiety absorbing cognitive reserves, and being associated with overall behavioural and cognitive rigidity (Kashdan & Rottenberg, 2010). Thus, the relationship between attention and anxiety would be expected to impact significantly on the social and emotional wellbeing of an individual (Bystritsky & Kronemyer, 2014; Cornish & Wilding, 2010). As noted earlier (Chapter 2), chronic anxiety interferes with the efficiency and effectiveness of completing a task by increasing the allocation of attention towards the perceived threatening stimuli (Eysenck & Calvo, 1992; Eysenck, Derakshan, Santos, & Calvo, 2007).

Thus, unsurprisingly, chronically anxious children are reported to have attentional problems leading to difficulty with staying on task and concentrating on school work for prolonged periods and hence difficulty attending to new information, learning and consolidating information in memory in the context of an educational setting (Alesi, Rappo, & Pepi, 2014; Eysenck & Calvo, 1992; Martin et al., 2007). Attention difficulties in young children are also associated with worse academic performance (Dally, 2006; Rabiner, Carrig, & Dodge, 2016) and overall life success at school (Razza, Martin, & Brooks-Gunn, 2010). Accordingly, poor academic performance characterises many DSM-5 defined childhood disorders of neurodevelopmental origin including Language Disorder, Speech Sound Disorder, Specific Learning Disorders and ADHD (APA, 2013). Clinically, it is important to note that concentration

(i.e., sustained attention) difficulties (Cornish & Wilding, 2010) and anxiety (Duvekot et al., 2016; Kerns & Kendall, 2014) have been identified as common symptoms across a range of neurodevelopmental disorders but that the relationship between attention and anxiety (Kirk et al., 2013; Arnsten & Rubia, 2012; van der burgh) is not adequately reflected in DSM-5 diagnostic criteria.

Despite the known relationship between attention and anxiety, there has been surprisingly little investigation examining anxiety in the context of cognitive models that seek to go beyond a conceptualisation of attention as simply describing the ability to sustain concentration (i.e., sustained attention). One such influential model that has been investigated in depth generally but seldomly in relation to anxiety is Posner's theory of alerting, orienting and executive control attention networks (Landry, Johnson, Fleming, Crewther, & Chouinard, 2019; Petersen & Posner, 2012; Posner, 2011a; Posner, 2014; Posner & Petersen, 1990; Posner & Rothbart, 2007b, 2009; Posner, Rothbart, Sheese, & Voelker, 2012). Determining whether features of prolonged anxiety do indeed interact with the three specific attention mechanisms Posner alluded to above, should be important to understanding the cognitive, emotional and behavioural functioning of any child (Guy, Rogers, & Cornish, 2013; Posner & Rothbart, 2005, 2007b). However, it is particularly important for children who require additional support at school, known as Additional Health and Developmental Needs (AHDN) (McPherson et al., 1998), given that this thesis has shown that chronic anxiety is a common biomarker of this population (see Chapter 4).

Three Attention Networks

In Posner and colleagues' theory of three attention networks, the alerting network acts as a warning system to potential environmental threats, the orienting network directs attention to stimuli in the environment, and the executive control network functions to sustain and resolve

conflicts of attention (see Figure 6.1) (Berger & Posner, 2000; Posner, Rothbart, & Digirolamo, 1999; Posner, 2011b; Posner, 2014; Posner & Dehaene, 1994; Posner et al., 2012; Rueda et al., 2004).

The anatomical basis of Posner's attention networks has been investigated, with the literature associating the prefrontal cortex and anterior cingulate gyrus with the executive attention network, the right frontal lobe and the superior parietal lobe with the alerting network, and the superior colliculus and pulvinar via the visual system in the orienting network (Posner & Rothbart, 2007a; Posner, Rothbart, & Rueda, 2014; Raz, 2004).

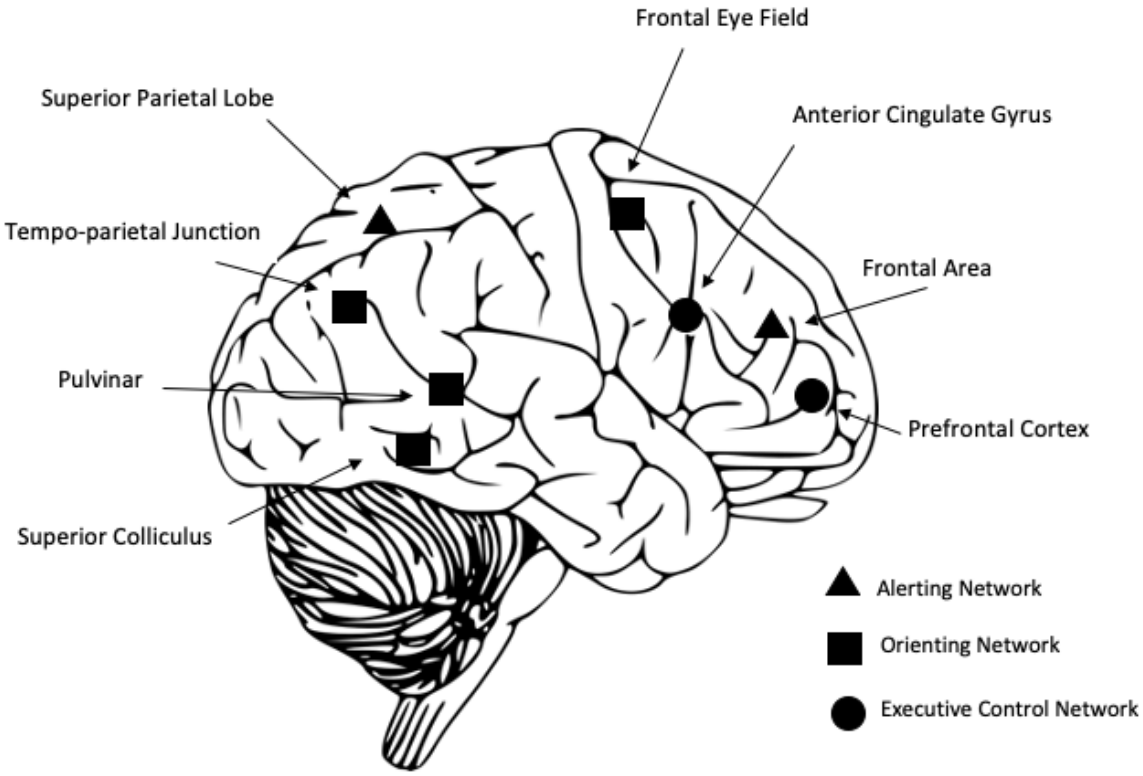


Figure 6.1. Anatomical representation of Posner's alerting, orienting and executive control networks. Adapted from (Posner & Rothbart, 2007a pg.51).

From a developmental point of view, these attention networks undergo a distinct period of maturation in childhood (Best & Miller, 2010; Landry et al., 2019; Raz, 2004; Rothbart, Sheese, Rueda, & Posner, 2011; Rueda et al., 2004; Rueda, Posner, & Rothbart, 2005), becoming more definitive in their functions across the lifespan (Konrad et al., 2005). More specifically in children, all three attention networks are thought to be largely stabilised by the age of seven (Johnson, Lewis, & Cornish, 2020; Lewis, Reeve, & Johnson, 2018). Historically each attention network has been considered to be separate but interrelated (Fan, McCandliss, Sommer, Raz, & Posner, 2002), however more recent evidence suggests that this view may be too simplistic and that there is likely overlap in the networks under particular conditions such as the need to visually detect a threat (orienting) and make decisions for survival (executive control) (Ghassemzadeh, Rothbart, & Posner, 2019; Sarapas, Weinberg, Langenecker, & Shankman, 2017; Trautwein, Singer, & Kanske, 2016).

Acknowledging that attention difficulties are often characteristic of neurodevelopmental disorders (Arnsten & Rubia, 2012), findings from Autism Spectrum Disorder (ASD) research suggests that the networks may be even less independent in atypical development (Keehn, Lincoln, Müller, & Townsend, 2010). When considering the networks in the context of children with ASD, an impairment in the orienting network has usually been reported, and as noted by Landry and Parker (2013) such visual orienting impairments in ASD increase with age. Other networks have also been implicated with ASD, for instance Mutreja et al. (2016) concluded that children with ASD have ‘less efficient’ orienting and executive control attention networks compared to typically developing children. In an adult ASD population, Fan et al. (2012) reported deficits in alerting and executive control networks but not the orienting network, which they attributed to the fact that cues utilised in their Attention Network Task (ANT) were not

social in nature, whereas some evidence suggests that orienting deficits in ASD are specific to social cues (Greene et al., 2011).

Attention network deficits have also been reported in other child clinical populations, including ADHD. Both Abramov et al. (2019) and Johnson et al. (2008) found impaired alerting and executive control networks in children with ADHD but not the orienting network. Adólfsdóttir, Sørensen, and Lundervold (2008) compared children with ADHD to other psychiatric diagnoses and controls, and found no difference in attention networks between groups, however they did observe a greater variation in responses in the ADHD group only. Finally, there is some limited research on attention networks in genetic neurodevelopmental disorders. For instance a less efficient executive control network has been found in children with 22q11 deletion syndrome (Sobin et al., 2004).

Attention Networks and Anxiety

To date, there has been little investigation regarding how anxiety impacts on attention networks in childhood. Much of the literature has focused on effortful control, which is an important aspect of social-emotional childhood development referring to a child's ability to voluntarily allocate attention to self- regulating behaviours and is thought to be related to executive functioning (Bridgett, Oddi, Laake, Murdock, & Bachmann, 2013; Rothbart & Rueda, 2005; Rothbart et al., 2011). In terms of chronic anxiety, there is some evidence that trait anxiety is associated with deficits in the executive control attention network (Pacheco-Unguetti, Acosta, Marqués, & Lupiáñez, 2011) whereas acute or state anxiety leads to excess vigilance and hyperfunctioning of the alerting and orienting networks (Pacheco-Unguetti, Acosta, Callejas, & Lupiáñez, 2010). Further research has also suggested that children with high levels of anxiety

symptoms, but without an anxiety disorder, have poorer executive attention but no significant alerting or orienting deficits (Mogg et al., 2015).

In regards to clinical anxiety, past research has evidenced that the orienting network is associated with social anxiety symptoms but not necessarily with state or trait anxiety more broadly (Heeren, Maurage, & Philippot, 2015). Most recently, Ghassemzadeh et al. (2019) have concluded that the orienting network is most closely associated with social anxiety and post-traumatic stress disorder, arising from a propensity to overly orient towards fearful parts of the environment or away from social situations, while the executive control network is related to cognitive aspects of fear and rumination associated with generalised anxiety and obsessive compulsive disorders.

The Current Study

It is clear that research to date has demonstrated inconsistent findings regarding the functioning of attention networks in children that fall with the AHDN classification, although overall it has generally been reported that there is an orienting deficit in ASD (Landry and Parker, 2013; Mutreja et al.,2015) and an executive control deficit in ADHD (Abramov et al., 2019; Johnson et al., 2008). However past research has not examined the functioning of Posner's attention networks in terms of what may be common to children with AHDN regardless of their individual clinical diagnosis or presenting difficulty. Thus, the current study aimed to investigate the relationship between anxiety and Posner's attention network functioning in children with AHDN given the prevalence of anxiety in this population.

Given that past research has associated the executive control network with trait anxiety (Pacheco-Unguetti et al., 2010; Pacheco-Unguetti et al., 2011) and that children with AHDN are often characterised by high levels of anxiety (see Chapter 4), it was hypothesised that anxiety in

such children with AHDN would be most strongly associated with executive control network scores. Acknowledging that children characterised as having AHDN (e.g. ASD, ADHD) have demonstrated deficits in the alerting network (Fan et al., 2012), executive control network (Mutreja, Craig, & O'Boyle, 2016) and orienting networks (Landry & Parker, 2013), it was also hypothesised that children with AHDN would show greater impairments compared to Typically Developing (TD) children across all three attention networks.

Methods

Participants

A total of 63 children (23 females and 40 males) aged between 7 and 13 years (M = 9.62 SD = 1.74) with normal or corrected to normal vision participated in this study. Fifty-four participants (20 females and 34 males) (M = 9.64, SD = 1.86) were recruited from a school holiday therapy program for children experiencing social, emotional and academic difficulties and so were deemed to have AHDN in line with the definition of AHDN as requiring more support than other children generally and being at risk of chronic difficulties (McPherson et al., 1998) (refer to Chapter 3). In the AHDN group, there were 12 participants with a diagnosis of ASD, 28 participants with a Speech and Language Disorder, five participants with ADHD and nine participants showing social skill difficulties. There were seven participants (two participants with ASD, three participants with a Speech and Language disorder, one participant with ADHD and one with social skill deficits) with co-morbid anxiety as reported by their parents. Indeed, many participants in the AHDN group were reported to show between 0 and 5 comorbid diagnoses (M = 1.72, SD = 1.20). A subsample from the AHDN group (N = 16) were selected to provide an age matched subsample of 9-10 year old children (M = 9.32, SD = 0.54) to allow comparison in attention network performance with a Typically Developing group.

A small sample of 9 participants (3 females and 6 males) in the TD group aged between 9-10 years (M = 9.54, SD = 0.64) were recruited from a general primary school population in Melbourne, Australia. The TD sample was recruited before the COVID-19 virus outbreak in Australia in early February 2020 mandated the end of data collection. Children in the TD group were excluded if they were reported by parents or teachers to require additional support at school or had a diagnosis of an intellectual disability, neurodevelopmental or mental health disorder. Refer to Chapter 3 for further participant information and exclusion and inclusion criteria.

Parents were provided with written information about the research and were required to provide written consent prior to any child participating. Parents were also informed that they could withdraw their child from the study at any stage as per the Declaration of Helsinki. Verbal consent was also obtained from children prior to the commencement of testing. Researchers were available to answer questions or provide assistance to parents and children as needed. This study was conducted with approval from the La Trobe University Human Ethics Committee, the Victorian Department of Education Human Ethics Committee, and the Victorian Catholic Schools Ethics Committee.

Materials

Screening Measures

All participants were screened for normal or corrected to normal vision and hearing. Participants also completed a pen and paper version Raven's Coloured Progressive Matrices (Raven, 1990) as a screen for nonverbal intelligence. Given that this study aimed to include children with varied AHDN, participants of all Raven's scores were included in the sample. It is acknowledged that this may contribute to variability of results in the AHDN group. There were

no participants who had a formal diagnosis of an Intellectual Disability. However, there were five children in the AHDN group with Raven's scores below the 25th percentile. In the AHDN group, the mean Raven's score was 106.08 (*SD* = 11.13) and in the TD group the mean Raven's score was 107.86 (*SD* = 8.82).

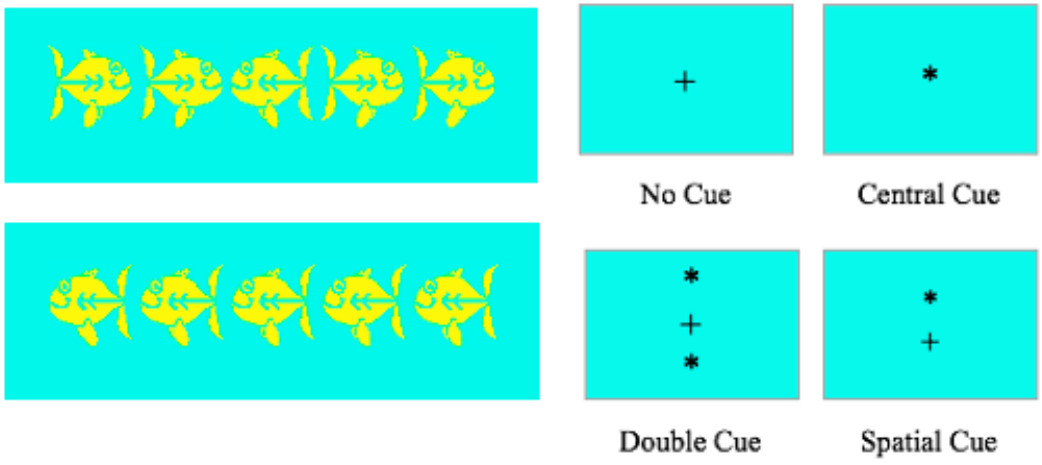
Attention Networks

Attention networks were assessed using a computerised replicated stimulus of the child version of the Attention Network Task (ANT) (Rueda et al., 2004) using VPixx software, in order to measure the alerting, orienting and executive control attention networks. The stimuli consisted of five yellow fish appearing on a blue-green background (see Figure 6.2). Consistent with Rueda and colleagues (2004), each fish subtended 1.6 degrees of visual angle, and fish targets were presented at one degree above fixation. Participants were asked to help feed the fish by identifying which way the middle fish (target) was facing (swimming) and to press the corresponding left or right arrow key and to respond as quickly and as accurately as possible. Participants were presented with a warning cue which followed the presentation of a fixation cross for between 400-1600ms. The warning cue (a black asterisk) appeared on the screen for a period of 150ms and was presented as a central cue, double cue, spatial cue or no cue (see Figure 6.2 for details). Across the four different cue conditions, the target fish was presented above or below fixation on half of the trials and faced left or right on half of the trails.

Targets were presented with two flanker fish on each side and were either congruent with the target (facing the same direction) or incongruent (facing the opposite direction). The fish remained on the screen until a response was given. Auditory and visual feedback was provided on each trial. Following a correct response, the target fish blew bubbles and a corresponding sound of blowing bubbles was played. An incorrect response resulted in a tone sound and no

change to the target fish. There were two blocks of 32 trials completed with four trials per flanker/ cue condition. A smaller number of trials per sub-condition were included compared to previous research (Rueda et al., 2004) due to our observation that children with AHDN were in general unable to tolerate the previous length of the task.

The score for the alerting network was calculated by subtracting the Median Reaction Time for Double Cue trials from the Median Reaction Time for No Cue trials. The orienting network was calculated by subtracting the Median Reaction Time for Central Cue from the Median Reaction Time for Spatial Cue trials, and the executive control was calculated by subtracting the Median Reaction Time for Incongruent from the Median Reaction Time for Congruent Trials (see Figure 6.2).



Attention Network	Subtraction Calculation
Alerting	Reaction Time No Cue – Reaction Time Double Cue
Orienting	Reaction Time Central Cue – Reaction Time Spatial Cue
Executive Control	Reaction Time Incongruent – Reaction Time Congruent

Figure 6.2. Representation of the Attention Network Task- Child Version (based on Rueda et al., 2004). Left panel: Flankers- Congruent (bottom) or Incongruent (top). Right panel: Cue

conditions. Bottom panel: the three network scores were calculated by subtracting median reaction time for different cueing and flanker conditions.

Anxiety

Trait or chronic anxiety was measured using the pen and paper form of the Spence Children's Anxiety Scale- Parent Version (SCAS-P) (Nauta et al., 1997) The SCAS-P is a 38-item questionnaire consisting of six subscales measuring different types of anxiety: 'Panic and Agoraphobia', 'Separation Anxiety', 'Physical Injury Fears', 'Social Phobia', 'Obsessive Compulsive' and 'Generalised Anxiety Disorder'. There was no specified or limited time period for rated behaviours, meaning that the questionnaire is designed to measure prolonged, trait-level anxiety, rather than acute state-like anxiety. Parent responses were scored on a Likert scale from 0 ('Never') through to 3 ('Always') with a maximum total score of 144, with higher scores indicating greater level of anxiety.

Procedure

Parents were asked to complete paper and pen version of the SCAS-P as well as a form about demographic information, including school grade and age, and any medical history or clinical diagnoses, and return to researchers within one week. Prior to the commencement of the ANT task, researchers provided the child with a verbal explanation of the task and sought verbal consent. Children completed screening measures for vision, hearing and nonverbal intelligence. If a child did not wish to engage in the task, or appeared distressed by the task, then they did not participate. Participants completed the ANT seated approximately 40- 45cm away from a Mac computer with a screen refresh rate of 80Hz and a screen resolution of 1152 x 864. The task was completed by 2-3 children at the same time (one researcher per child) in a quiet room. An explanation and demonstration of the ANT was provided to each participant using consistent

verbal instructions until the child demonstrated that they clearly understood the instructions of the task. The child was informed that the aim of the task was to feed the fish, and were asked to answer the question, “which way is the middle fish facing?”. All children were instructed to focus on the fixation cross throughout the task and to respond as quickly and as accurately as possible and to make their best guess if unsure of their response. Children received a small reward for their participation (i.e., a sticker or small piece of stationary).

Data Analysis

Missing Data and Exclusion Criteria

Participant data was entered into SPSS (Version 23) prior to analysis. Data screening was performed on all variables in order to identify any missing data, outliers and any violations to the assumptions of normality and homogeneity. Missing data was excluded from the analyses. Five extreme outliers +/- 3SD from the mean were also excluded from the analyses (Howitt & Cramer, 2007), including three participants based on their reaction time score in the Incongruent Central Cue condition and two based on the Incongruent Double Cue condition. If participants had accuracy rates below 50% on any condition, then they were excluded from the analysis. This resulted in eleven AHDN participants being excluded, all based on low performance on the incongruent flanker conditions (No Cue: $N = 3$, Spatial Cue: $N = 3$, Central Cue: $N = 2$, and Double Cue: $N = 1$). There were no TD children whose performance met exclusion criteria. Thirteen AQ- Child and 9 SCAS-P questionnaires from the AHDN group were either not returned to researchers or had missing data and so were excluded from the correlational analyses.

Assumption Testing

Skewness and kurtosis and assumptions of normality were assessed and shown to be violated using the Kolmogorov-Smirnov and the Shapiro-Wilko tests. The assumptions of homogeneity were also found to be violated by a Levene's test, and so data was analysed using a nonparametric statistical approach (Tabachnick & Fidel, 2007).

Statistical Analyses

Descriptive statistics were performed on all variables for the total (AHDN and TD) sample. Median reaction times of a chronological age matched subsample (N = 16) of 9 and 10-year-old children from the AHDN and TD groups were compared on the alerting, orienting and executive control attention networks from the ANT using a Mann-Whitney-U analysis. Given our interest in children with AHDN in this study, a Spearman's Rho correlation analysis controlling for age was also used to examine the relationship between anxiety (SCAS- P measure) and performance on the alerting, orienting and executive control conditions of the ANT across the entire AHDN group. To further explore the relationship between anxiety and the ANT, a hierarchical multiple regression controlling for age was then used to assess the contribution of anxiety to attention networks.

Descriptive Statistics on Anxiety and Autism Traits

Descriptive statistics for SCAS-P and AQ- Child scores are stated below in Table 6.1.

Table 6.1

Autism Traits and Anxiety of the AHDN and TD Groups and Total Sample

		AHDN *N* = 54	TD *N* = 9	Total Sample *N* = 63
AQ- Child	*M* (SD)	63.34 (23.44)	45.00 (9.43)	61.67 (22.9)
	Range	22- 128	36- 59	22-128
SCAS- P	*M* (SD)	24.43 (14.24)	8.75 (6.07)	22.40 (14.44)
	Range	4-75	0-18	0- 75

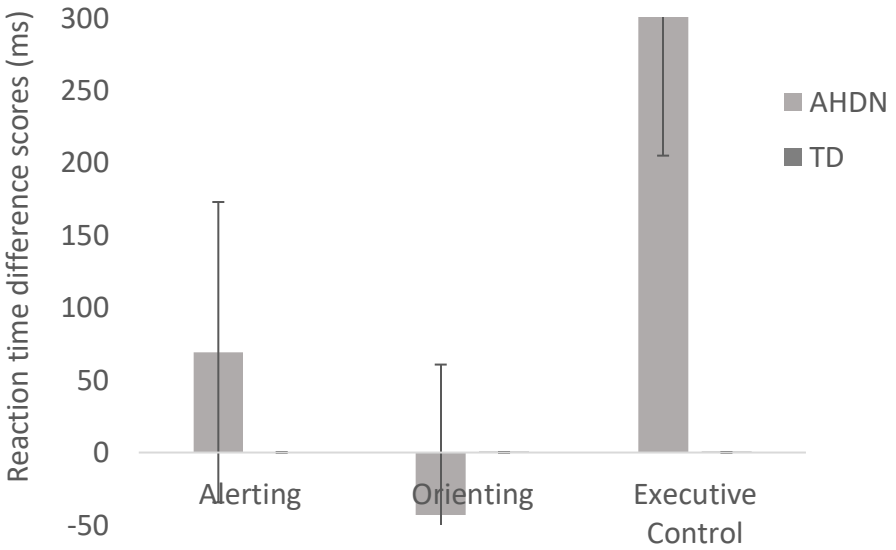
Descriptive Statistics on Attention Network Task Performance in Additional Health and Developmental Needs

Descriptive statistics for AHDN and TD groups for reaction time performance on ANT Flanker/ Cue Conditions are shown below. Accuracy descriptive statistics are shown in Table 6.2. ANT Network Scores are shown in Figure 6.3.

Table 6.2

Mean Accuracy for ANT Flanker/ Cue Conditions

	AHDN	TD
Congruent No Cue	91.36	97.22
Congruent Central Cue	83.58	98.61
Congruent Double Cue	89.71	91.67
Congruent Spatial Cue	91.67	97.22
Incongruent No Cue	83.82	95.83
Incongruent Central Cue	86.52	97.22
Incongruent Double Cue	85.54	97.22
Incongruent Spatial Cue	85.54	95.83



Note. TD Alerting (*M* = -0.02, *SE*= 0.13), Orienting (*M* = 0.03, *SE* = 0.18, Conflict (*M* = 0.21, *SE* = 0.09). The differences in each Orienting, Alerting and Executive Control trial the group means were small and variation so slight that the error bars cannot be seen.

Figure 6.3. Group means (± Standard Error of the mean) for Reaction Time Difference Scores (ms) for AHDN and TD groups.

Relationship of Attention Networks to Anxiety in Additional Health and Developmental Needs

A Spearman's partial rank order analysis was run to assess the relationship between the SCAS-P questionnaire and alerting, orienting and executive control scores of the ANT while controlling for age in the AHDN group (Table 6.3). Preliminary analysis showed the relationships to be monotonic, as assessed by visual inspection of a scatterplot.

Alerting

There were moderate negative correlations between alerting scores and Separation Anxiety (r_s (49) = -.49, p < .001), Generalised Anxiety r_s (49) = -.29, p = .04, Social Phobia, r_s (49) = -.40, p = .003, Panic/ Agoraphobia (r_s (49) = -.36, p = .008), Physical Injury Fears (r_s (49) = -.45 p = .001), and Total Score (r_s (49) = -.43, p = .001).

Orienting

There was a moderate negative correlation between orienting scores and Physical Injury Fears (r_s (49) = -.29 p = .03).

Executive Control

There were no significant correlations between the SCAS-P and executive control network scores.

Table 6.3

Spearman's Partial Correlation between ANT Network Scores and Anxiety Controlling for Age in AHDN (N = 54)

SCAS-P	Separation Anxiety	Generalised Anxiety	Social Phobia	Panic/Agoraphobia	Physical Injury Fears	Obsessive Compulsive	Total
ANT							
Alerting	-.49**	-.29*	-.40**	-.36**	-.45**	-.05	-.43**
Orienting	.24	-.13	-.10	-.23	-.29*	.03	-.20
Executive Control	-.01	-.15	-.15	.13	.11	-.09	-.05

Note. *p <.05, **p <.005

Anxiety as a Predictor of ANT Performance in Additional Health and Developmental Needs

Hierarchical multiple regression was used to assess the contribution of anxiety to ANT performance in the AHDN group, after controlling for age. Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity and homoscedasticity. See Table 6.4 for full details of the regression model. From a theoretical point of view, correlations between anxiety and the orienting and the executive control networks were not high enough to warrant further investigation. Furthermore, the assumptions required for a regression analyses were not met for either the orienting or executive control networks. For the alerting network regression, all assumptions were met.

Anxiety as a Predictor of Alerting Network Score

The full model of age and anxiety (SCAS-P) total score to predict alerting network score (Model 2) was statistically significant, $R^2 = .12$, $F(2, 51) = 3.42$, $p = .04$, adjusted $R^2 = .08$ (Table 6.4). In Step 1, age explained 5% of variance for the alerting network score in the AHDN group. The addition of anxiety (SCAS-P Total Score) led to an increase in R^2 of .07, and this addition lead to a significant change in the model, F Change (1, 51) = 4.20, $p = .046$. After the entry of anxiety at Step 2 the total variance explained by the model as a whole was 12%, with anxiety explaining 7% of the variance in alerting score.

Table 6.4

Hierarchical Multiple Regression Analysis for Variables Predicting Alerting Network Score

	Alerting MDRT			
	Model 1		Model 2	
Variable	B	β	B	β
Constant	308.14		445.07*	
Age	-24.76	-.21	-28.04	-.24
SCAS-P Total			-4.21	-.27
R^2	.05		.12	
Adjusted R^2	.03		.08	
F	2.45		3.42	
$R^2\Delta$	.05		.07	
F Δ	2.49		4.20	

Note. $R^2\Delta = R^2$ change. *F* Δ = F change. Total Alerting Network Score model = R^2 = .12, $F(1, 51) = 3.42$, $p = .04$, adjusted R^2 = .08.

Comparison of Attention Networks in Age Matched Additional Health and Developmental Needs and Typically Developing Children

Mann-Whitney-U analyses were performed to compare between age matched 9-10-year-old participants in the AHDN sample (*N* = 16 and TD children (*N* = 9) to determine if there were differences in Reaction Time on the alerting, orienting and executive control networks using an exact sampling distribution for *U* (Dineen & Blakesley, 1973). Distributions of Mean Reaction

Times for both groups were similar though the AHDN group demonstrated far greater variance, as assessed by visual inspection. AHDN (*Mdn* = 29.23) and TD (*Mdn* = -.008) groups did not differ on the alerting network, $U = 54.00$, $z = -1.21$, $p = .24$. Similarly, the AHDN (*Mdn* = -.8.33) and TD (*Mdn* = 0.091) groups did not differ on the orienting network, $U = 81.00$, $z = .24$, $p = .83$. However, the AHDN group (*Mdn* = 189.98) compared with the TD group (*Mdn* = 0.18) demonstrated a significantly higher executive control network score (i.e. the difference in ms between RT scores for congruent and incongruent conditions), $U = 0.00$, $z = -3.96$, $p < .001$.

Discussion

The aim of this study was to investigate the relationship between Posner's theory of cognitive attention networks and chronic anxiety in children with AHDN and to examine attention network performance in these children when compared with a control group of TD children. This was accomplished by recruiting children with AHDN from a school holiday therapy program and TD children from a general primary school population to complete a child version of the ANT, and having parents rate their anxiety levels (SCAS-P). It was hypothesised that anxiety would be most strongly associated with executive control network scores in our population of children with AHDN. It was also hypothesised that when compared to TD children, children with AHDN would demonstrate greater impairments across the alerting, orienting and executive control attention networks.

The prediction that anxiety would be most associated with the executive control network was not supported. In fact, when controlling for age, there were no significant correlations between anxiety (SCAS-P) and executive control on the ANT. There was one significant negative correlation between physical injury fears and orienting. However, it was the alerting

network that was negatively associated with anxiety overall in children with AHDN with moderate negative correlations found with Separation Anxiety, Generalised Anxiety, Social Phobia, Panic/Agoraphobia, and Physical Injury and Fears subscales and total anxiety score on the SCAS-P. There was no correlation found between alerting and Obsessive-Compulsive behaviours. These results thus indicate that anxiety was associated with less efficient alerting. However, when controlling for chronological age, regression analyses of the AHDN only group indicated that anxiety explained 7% of the variance for the alerting network score in the AHDN group. Although it was expected that children with AHDN would show impairments across all three attention networks compared to TD controls, our analysis of age-matched (9-10 years) AHDN and TD children showed that there was only a significant difference between groups on the executive control network.

The current findings differ from past research associating subclinical levels of anxiety in children (Mogg et al., 2015) and adults with chronic trait anxiety (Pacheco-Unguetti et al., 2010; Pacheco-Unguetti et al., 2011) with the executive control network. No such relationship was demonstrated in the current sample of children with AHDN. Previous studies have also highlighted that the alerting network, in addition to the orienting network, is thought to over function during periods of state-based anxiety (Pacheco-Unguetti, 2010) which experimental conditions may have created for our AHDN group. Instead, the current results found a negative correlation between anxiety and alerting scores, such that greater anxiety was associated with poorer alerting performance. It may be the case that if a child is chronically anxious then they may not show excessive activation of the alerting network as is associated with acute *state* anxiety, although unfortunately state anxiety was not measured directly in this study. Indeed, Mogg et al. (2015) found that children without an anxiety disorder but who had high anxiety

symptoms showed no impairment in the alerting network. It remains possible that chronic anxiety interacts with other difficulties faced by the current sample of children with AHDN to result in an alerting system that is not only lacking the hyperresponsiveness associated with state anxiety, but is in fact under-responsive. Thus, we readily acknowledge that the relationship between anxiety and the attention networks in our study may be further confounded by the inclusion of children with clinical anxiety disorders in the broader AHDN group.

The evidence base examining individual diagnostic groups and attention networks remains mixed. Of note however, is that the orienting network was not found to be impaired in the AHDN group in this study as is often reported across the ASD literature (Keehn et al. (2010; 2013, Mutreja et al., 2015, & Landry & Parker, 2013). Similar to our findings, reduced efficiency of the executive control network has also been reported in ASD (Fan et al., 2012) and ADHD populations (Ambrov et al., 2019; Johnson et al., 2008) and the current research suggests that this may extend to the broader AHDN population as a common cognitive attention process. The executive control network is associated with both emotional and cognitive self-regulation, often referred to as 'effortful control' (Rothbart et al., 2011), which is thought to be implicated in AHDN such as in ASD (Uljarević, Richdale, Evans, Cai, & Leekam, 2017) and ADHD (Wiersema & Roeyers, 2009). This executive control is also associated with social and academic skills (Liew, 2012).

The results of our study may have also been impacted by the design of the ANT itself. As Rueda et al. (2004) note, the range of scores and large Standard Deviations in the child ANT may be attributable to the inclusion of a wide range of ages in the sample. The finding of a negative or very small positive orienting network score has also been reported in past research and is thought to be potentially explained by a limitation in the child ANT design to accurately

measure the orienting network (Ishigami & Klein, 2015). Ishigami and Klein (2015) also note the potential for extraneous variables such as boredom to impact on the reliability of the ANT in young children. More recently, Johnson et al. (2020) highlight that the auditory feedback used in most child versions of the ANT may inadvertently activate the alerting network and possibly impede on the accuracy of network performance data.

Further limitations to the current study include the moderate small sample size of TD participants, restricting on the generalisability of our results. The exclusion of participants based on low accuracy with incongruent flakers may have also corresponded a loss of power, and perhaps may have contributed to the lack of findings associating anxiety with executive control In terms of broader sample characteristics, we did not include demographic factors such as socioeconomic status previously thought to impact on the development of attention networks (Mezzacappa, 2004). Future research should more strongly consider the clinical application of computer-based tasks targeting sustained attention, including the ANT, to children with AHDN. In particular, there is ongoing need to investigate the evidence base of interventions for children with AHDN, including the implementation of attention training (Posner & Rothbart, 2005).

Conclusion

The evidence base of the ANT in the assessment of cognitive attention in children with AHDN is in its infancy and requires further investigation. The current study provides evidence that the alerting network is negatively correlated with anxiety in AHDN regardless of age, and may indeed be under-responsive or have reduced efficiency in these children. Furthermore, the findings of the current study suggest that for 9-10 year old children with AHDN there is a greater impairment in the executive control network than in the alerting or orienting networks compared to TD peers.

References

Abramov, D. M., Cunha, C. Q., Galhanone, P. R., Alvim, R. J., de Oliveira, A. M., & Lazarev, V. V. (2019). Neurophysiological and behavioral correlates of alertness impairment and compensatory processes in ADHD evidenced by the Attention Network Test. *PloS one, 14*(7), e0219472. http://doi.org/10.1371/journal.pone.0219472

Adólfsdóttir, S., Sørensen, L., & Lundervold, A. J. (2008). The attention network test: a characteristic pattern of deficits in children with ADHD. *Behavioral and Brain Functions, 4*(1), 9. http://doi.org/10.1186/1744-9081-4-9

Alesi, M., Rappo, G., & Pepi, A. (2014). Depression, anxiety at school and self-esteem in children with learning disabilities. *Journal of Psychological Abnormalities*, 1-8. http://doi.org/10.4172/2329-9525.1000125

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (DSM-5®)*: American Psychiatric Pub.

Arnsten, A. F., & Rubia, K. (2012). Neurobiological circuits regulating attention, cognitive control, motivation, and emotion: disruptions in neurodevelopmental psychiatric disorders. *Journal of the American Academy of Child & Adolescent Psychiatry, 51*(4), 356-367. http://doi.org/10.1016/j.jaac.2012.01.008

Berger, A., & Posner, M. (2000). Pathologies of brain attentional networks. *Neuroscience & Biobehavioral Reviews, 24*(1), 3-5. http://doi.org/10.1016/S0149-7634(99)00046-9

Best, J. R., & Miller, P. H. (2010). A developmental perspective on executive function. *Child Dev, 81*(6), 1641-1660. http://doi.org/10.1111/j.1467-8624.2010.01499.

Bridgett, D. J., Oddi, K. B., Laake, L. M., Murdock, K. W., & Bachmann, M. N. (2013). Integrating and differentiating aspects of self-regulation: Effortful control, executive

functioning, and links to negative affectivity. *Emotion, 13*(1), 47. http://doi.org/10.1037/a0029536

Brosschot, J. F., Verkuil, B., & Thayer, J. F. (2016). The default response to uncertainty and the importance of perceived safety in anxiety and stress: An evolution-theoretical perspective. *Journal of anxiety disorders, 41*, 22-34. http://doi.org/10.1016/j.janxdis.2016.04.012

Bystritsky, A., & Kronemyer, D. (2014). Stress and Anxiety. *Psychiatric Clinics, 37*(4), 489-518. http://doi.org/10.1016/j.psc.2014.08.002

Callejas, A., Lupiáñez, J., & Tudela, P. (2004). The three attentional networks: On their independence and interactions. *Brain and cognition, 54*(3), 225-227. http://doi.org/10.1016/j.bandc.2004.02.012

Cornish, K., & Wilding, J. (2010). *Attention, genes, and developmental disorders*: Oxford University Press.

Dally, K. (2006). The influence of phonological processing and inattentive behavior on reading acquisition. *Journal of Educational Psychology, 98*(2), 420. http://doi.org/10.1037/0022-0663.98.2.420

Duvekot, J., Ende, J., Constantino, J. N., Verhulst, F. C., & Greaves-Lord, K. (2016). Symptoms of autism spectrum disorder and anxiety: shared familial transmission and cross-assortative mating. *Journal of Child Psychology And Psychiatry, 57*(6), 759-769. http://doi.org/10.1111/jcpp.12508

Eysenck, M. W., & Calvo, M. G. (1992). Anxiety and performance: The processing efficiency theory. *Cognition & Emotion, 6*(6), 409-434. http://doi.org/10.1007/978-3-642-68390-9_6

Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: attentional control theory. *Emotion, 7*(2), 336. http://doi.org/10.1037/1528-3542.7.2.336

Fan, J., Bernardi, S., Van Dam, N. T., Anagnostou, E., Gu, X., Martin, L., . . . Soorya, L. (2012). Functional deficits of the attentional networks in autism. *Brain and behavior*, *2*(5), 647-660. http://doi.org/10.1002/brb3.90

Fan, J., McCandliss, B. D., Sommer, T., Raz, A., & Posner, M. I. (2002). Testing the efficiency and independence of attentional networks. *Journal of cognitive neuroscience*, *14*(3), 340-347. http://doi.org/10.1162/089892902317361886

Fan, J., McCandliss, B. D., Fossella, J., Flombaum, J. I., & Posner, M. I. (2005). The activation of attentional networks. *Neuroimage*, *26*(2), 471-479. http://doi.org/10.1016/j.neuroimage.2005.02.004

Ghassemzadeh, H., Rothbart, M. K., & Posner, M. I. (2019). Anxiety and brain networks of attentional control. *Cognitive And Behavioral Neurology, 32*(1), 54-62. http://doi.org/10.1097/WNN.0000000000000181

Greene, D. J., Colich, N., Iacoboni, M., Zaidel, E., Bookheimer, S. Y., & Dapretto, M. (2011). Atypical neural networks for social orienting in autism spectrum disorders. *Neuroimage, 56*(1), 354-362. http://doi.org/10.1016/j.neuroimage.2011.02.031

Guy, J., Rogers, M., & Cornish, K. (2013). Age-related changes in visual and auditory sustained attention in preschool-aged children. *Child Neuropsychol, 19*(6), 601-614. http://doi.org/10.1080/09297049.2012.710321

Heeren, A., Maurage, P., & Philippot, P. (2015). Revisiting attentional processing of non-emotional cues in social anxiety: A specific impairment for the orienting network of

attention. *Psychiatry research, 228*(1), 136-142. http://doi.org/10.1016/j.psychres.2015.04.030

Howitt, D., & Cramer, D. (2007). *Introduction to statistics in psychology*: Pearson education.

Ishigami, Y., & Klein, R. M. (2015). Repeated measurement of the components of attention with young children using the Attention Network Test: Stability, isolability, robustness, and reliability. *Journal of Cognition and Development, 16*(1), 144-159. http://doi.org/10.1080/15248372.2013.803971

Johnson, K. A., Lewis, F. C., & Cornish, K. M. (2020). A child-focused version of the Attention Network Task designed to investigate interactions between the attention networks, including the endogenous orienting network. *Child Neuropsychology, 26*(5), 666-690. http://doi.org/10.1080/09297049.2019.1702635

Johnson, K. A., Robertson, I. H., Barry, E., Mulligan, A., Dáibhis, A., Daly, M., . . . Bellgrove, M. A. (2008). Impaired conflict resolution and alerting in children with ADHD: evidence from the Attention Network Task (ANT). *Journal of child psychology and psychiatry, 49*(12), 1339-1347. http://doi.org/10.1111/j.1469-7610.2008.01936.x

Kashdan, T. B., & Rottenberg, J. (2010). Psychological flexibility as a fundamental aspect of health. *Clinical Psychology Review, 30*(7), 865-878. http://doi.org/10.1016/j.cpr.2010.03.001

Keehn, B., Lincoln, A. J., Müller, R. A., & Townsend, J. (2010). Attentional networks in children and adolescents with autism spectrum disorder. *Journal of child psychology and psychiatry, 51*(11), 1251-1259. http://dx.doi.org/10.1111/j.1469-7610.2010.02257.x

Kerns, C. M., & Kendall, P. C. (2014). Autism and anxiety: Overlap, similarities, and differences. In *Handbook of autism and anxiety* (pp. 75-89): Springer, Cham. http://doi.org/10.1007/978-3-319-06796-4_6

Kirk, H. E., Hocking, D. R., Riby, D. M., & Cornish, K. M. (2013). Linking social behaviour and anxiety to attention to emotional faces in Williams syndrome. *Res Dev Disabil, 34*(12), 4608-4616. http://doi.org/10.1016/j.ridd.2013.09.042

Konrad, K., Neufang, S., Thiel, C. M., Specht, K., Hanisch, C., Fan, J., . . . Fink, G. R. (2005). Development of attentional networks: an fMRI study with children and adults. *Neuroimage, 28*(2), 429-439. http://doi.org/10.1016/j.neuroimage.2005.06.065

Landry, O., Johnson, K. A., Fleming, S. J., Crewther, S. G., & Chouinard, P. A. (2019). A new look at the developmental profile of visual endogenous orienting. *Journal of experimental child psychology, 183*, 158-171. http://doi.org/10.1016/j.jecp.2019.01.022

Landry, O., & Parker, A. (2013). A meta-analysis of visual orienting in autism. *Frontiers in human neuroscience, 7*, 833. http://dx.doi.org/10.3389/fnhum.2013.00833

Lewis, F. C., Reeve, R. A., & Johnson, K. A. (2018). A longitudinal analysis of the attention networks in 6-to 11-year-old children. *Child Neuropsychology, 24*(2), 145-165. http://doi.org/10.1080/09297049.2016.1235145

Liew, J. (2012). Effortful control, executive functions, and education: Bringing self-regulatory and social-emotional competencies to the table. *Child development perspectives, 6*(2), 105-111. http://doi.org/10.1111/j.1750-8606.2011.00196.x

Martin, L. T., Kubzansky, L. D., LeWinn, K. Z., Lipsitt, L. P., Satz, P., & Buka, S. L. (2007). Childhood cognitive performance and risk of generalized anxiety disorder. *International Journal of Epidemiology, 36*(4), 769-775. http://doi.org/10.1093/ije/dym063

McPherson, M., Arango, P., Fox, H., Lauver, C., McManus, M., Newacheck, P. W., . . . Strickland, B. (1998). A new definition of children with special health care needs. *Pediatrics, 102*(1), 137-139. https://doi.org/10.1542/peds.102.1.137

Mezzacappa, E. (2004). Alerting, orienting, and executive attention: Developmental properties and sociodemographic correlates in an epidemiological sample of young, urban children. *Child Dev, 75*(5), 1373-1386. http://doi.org/10.1111/j.1467-8624.2004.00746.x

Mogg, K., Salum, G., Bradley, B., Gadelha, A., Pan, P., Alvarenga, P., . . . Manfro, G. (2015). Attention network functioning in children with anxiety disorders, attention-deficit/hyperactivity disorder and non-clinical anxiety. *Psychological medicine, 45*(12), 2633-2646. http://doi.org/10.1017/S0033291715000586

Mutreja, R., Craig, C., & O'Boyle, M. W. (2016). Attentional network deficits in children with autism spectrum disorder. *Developmental neurorehabilitation, 19*(6), 389-397. http://doi.org/10.3109/17518423.2015.1017663

Nauta, M. H., Scholing, A., Rapee, R. M., Abbott, M., Spence, S. H., & Waters, A. (2004). A parent-report measure of children's anxiety: psychometric properties and comparison with child-report in a clinic and normal sample. *Behav Res Ther, 42*(7), 813-839. http://doi.org/10.1016/S0005-7967(03)00200-6

Pacheco-Unguetti, A. P., Acosta, A., Callejas, A., & Lupiáñez, J. (2010). Attention and anxiety: Different attentional functioning under state and trait anxiety. *Psychol Sci, 21*(2), 298-304. http://doi.org/10.1177/0956797609359624

Pacheco-Unguetti, A. P., Acosta, A., Marqués, E., & Lupiáñez, J. (2011). Alterations of the attentional networks in patients with anxiety disorders. *Journal of anxiety disorders, 25*(7), 888-895. http://doi.org/10.1016/j.janxdis.2011.04.010

Petersen, S. E., & Posner, M. I. (2012). The attention system of the human brain: 20 years after. *Annu Rev Neurosci, 35*, 73-89. http://doi.org/10.1146/annurev-neuro-062111-150525

Posner, M., Pothbart, M., & Digirolamo, G. (1999). Development of brain networks for orienting to novelty. *Zhurnal vysshei nervnoi deiatelnosti imeni IP Pavlova, 49*(5), 715-722.

Posner, M., & Rothbart, M. (2007a). *Educating the Human Brain*. American Psychological Association, Washington: DC.

Posner, M. I. (2011a). *Attention in a social world*: Oxford University Press.

Posner, M. I. (2011b). *Cognitive neuroscience of attention*: Guilford Press.

Posner, M. I. (2014). Orienting of attention: Then and now. *Q J Exp Psychol (Hove)*, 1-12. http://doi.org/10.1080/17470218.2014.937446

Posner, M. I., & Dehaene, S. (1994). Attentional networks. *Trends Neurosci, 17*(2), 75-79. http://doi.org/10.1016/0166-2236(94)90078-7

Posner, M. I., & Petersen, S. E. (1990). The attention system of the human brain. *Annu Rev Neurosci, 13*(1), 25-42. http://doi.org/10.1146/annurev.ne.13.030190.000325

Posner, M. I., & Rothbart, M. K. (2005). Influencing brain networks: implications for education. *Trends Cogn Sci, 9*(3), 99-103. http://doi.org/10.1016/j.tics.2005.01.007

Posner, M. I., & Rothbart, M. K. (2007b). Research on attention networks as a model for the integration of psychological science. *Annu. Rev. Psychol., 58*, 1-23. http://doi.org/10.1146/annurev.psych.58.110405.085516

Posner, M. I., & Rothbart, M. K. (2009). Toward a physical basis of attention and self-regulation. *Physics of life reviews, 6*(2), 103-120. http://doi.org/10.1016/j.plrev.2009.02.001

Posner, M. I., Rothbart, M. K., & Rueda, M. R. (2014). Developing attention and self-regulation in childhood. In A. C. Nobre & S. Kastner (Eds.), *Oxford Library of Psychology. The Oxford Handbook of Attention* (p. 541–569). Oxford University Press.

Posner, M. I., Rothbart, M. K., Sheese, B. E., & Voelker, P. (2012). Control networks and neuromodulators of early development. *Developmental psychology*, *48*(3), 827. http://doi.org/10.1037/a0025530

Rabiner, D. L., Carrig, M. M., & Dodge, K. A. (2016). Attention problems and academic achievement: Do persistent and earlier-emerging problems have more adverse long-term effects? *Journal of attention disorders*, *20*(11), 946-957http://doi.org/10.1177/1087054713507974

Raz, A. (2004). Anatomy of attentional networks. *The anatomical record*, *281*(1), 21-36. http://doi.org/10.1002/ar.b.20035

Razza, R. A., Martin, A., & Brooks-Gunn, J. (2010). Associations among family environment, sustained attention, and school readiness for low-income children. *Developmental psychology*, *46*(6), 1528. http://doi.org/10.1037/a0020389

Rothbart, M. K., & Rueda, M. R. (2005). *The Development of Effortful Control.* In U. Mayr, E. Awh, & S. W. Keele (Eds.), *Decade of behavior*. *Developing individuality in the human brain: A tribute to Michael I. Posner* (p. 167–188). American Psychological Association. https://doi.org/10.1037/11108-009

Rothbart, M. K., Sheese, B. E., & Posner, M. I. (2007). Executive attention and effortful control: Linking temperament, brain networks, and genes. *Child development perspectives*, *1*(1), 2-7. http://doi.org/10.1111/j.1750-8606.2007.00002.x

Rothbart, M. K., Sheese, B. E., Rueda, M. R., & Posner, M. I. (2011). Developing mechanisms of self-regulation in early life. *Emotion review, 3*(2), 207-213. http://doi.org/10.1177/1754073910387943

Rueda, M. R., Fan, J., McCandliss, B. D., Halparin, J. D., Gruber, D. B., Lercari, L. P., & Posner, M. I. (2004). Development of attentional networks in childhood. *Neuropsychologia, 42*(8), 1029-1040. http://doi.org/10.1016/j.neuropsychologia.2003.12.012

Rueda, M. R., Posner, M. I., & Rothbart, M. K. (2005). The development of executive attention: Contributions to the emergence of self-regulation. *Dev Neuropsychol, 28*(2), 573-594. http://doi.org/10.1207/s15326942dn2802_2

Sarapas, C., Weinberg, A., Langenecker, S. A., & Shankman, S. A. (2017). Relationships among attention networks and physiological responding to threat. *Brain Cogn, 111,* 63-72. http://doi.org/10.1016/j.bandc.2016.09.012

Sobin, C., Kiley-Brabeck, K., Daniels, S., Blundell, M., Anyane-Yeboa, K., & Karayiorgou, M. (2004). Networks of attention in children with the 22q11 deletion syndrome. *Developmental neuropsychology, 26*(2), 611-626. http://doi.org/10.1207/s15326942dn2602_5

Tabachnick, B., & Fidel, S. (2007). *Using Multivariate Statistics*. Pearson Education, Inc., Boston.

Trautwein, F.-M., Singer, T., & Kanske, P. (2016). Stimulus-driven reorienting impairs executive control of attention: Evidence for a common bottleneck in anterior insula. *Cereb Cortex, 26*(11), 4136-4147. http://doi.org/10.1093/cercor/bhw225

Uljarević, M., Richdale, A. L., Evans, D. W., Cai, R. Y., & Leekam, S. R. (2017). Interrelationship between insistence on sameness, effortful control and anxiety in adolescents and young adults with autism spectrum disorder (ASD). *Molecular Autism, 8*(1), 36. http://doi.org/10.1186/s13229-017-0158-4

Wiersema, J. R., & Roeyers, H. (2009). ERP correlates of effortful control in children with varying levels of ADHD symptoms. *Journal of abnormal child psychology, 37*(3), 327-336. http://doi.org/10.1007/s10802-008-9288-7

Chapter 7- General Discussion

The aim of this chapter is to summarise the overall findings of this thesis and to discuss the overarching strengths and limitations to the research. Practical and clinical implications, as well as further directions for future research, will be explored. The current thesis sought to investigate whether anxiety is a common experience in children classified as having Additional Health and Developmental Needs (AHDN) and to explore whether such anxiety was associated with perturbed sleep and autism-like traits, and perceptual bias using a Navon Global/Local task as well as impaired visual attention performance on the Posner Attention Network Task (ANT).

In the introductory chapters (Chapters 1 and 2), the theoretical background of anxiety and attention in children has been discussed. Current conceptualisations of psychiatric and neurodevelopmental diagnoses such as those aligned with the DSM-5 (APA, 2013) or ICD-11 (WHO, 2018) have been challenged on the grounds that categorical diagnostic approaches are inadequate to account for the complexities of anxiety and associated attentional differences in children (Eysenck, Derakshan, Santos, & Calvo, 2007), particularly in those with AHDN. An integrative approach to understanding anxiety accounting for biopsychosocial factors has been proposed as a way to make contemporary neuroscience and biological research (e.g. RDoC and HiTOP) more accessible for clinicians (Cuthbert, 2014; Kotov, Krueger, & Watson, 2018). Chapter 3 outlined methodological issues and considerations of population characteristics and study design, including the justification of the use of the term *Additional Health and Developmental Needs.*

In Chapter 4, the utility of parent-rated questions was explored by examining the relationship between anxiety (SCAS-P) (Nauta et al., 2004), sleep (SDSC) (Bruni et al., 1996)

and autism traits (AQ-Child) (Auyeung, Baron-Cohen, Wheelwright, & Allison, 2008) in an AHDN population. Chapter 5 explored whether anxiety or autism traits contributed more to a local or global processing bias using a Navon-style task (Navon, 1977) in children with AHDN and compared this local/global processing style to a small group of TD children. Finally, Chapter 6 investigated the relationship between anxiety and Posner's attention networks (Petersen & Posner, 2012; Posner & Petersen, 1990) in children with AHDN, using a child version of the ANT (Rueda et al., 2004) and examined differences in attention networks compared to a small sample of TD children.

Summary of Research Findings

The results of the first experimental study (Chapter 4) demonstrated that anxiety is indeed a common biomarker for children with school-based problems i.e. AHDN, regardless of their primary diagnosis. Children with AHDN also showed atypically high levels of anxiety (measured by the SCAS-P) and sleep problems (measured by the SDSC), and a positive association was also found between autism traits (measured by the AQ- Child) and anxiety. Despite behaviours appearing to be transdiagnostic, our findings suggest that anxiety, sleep disturbance and autism traits were particularly heightened in participants with ASD. In terms of the relationship between questionnaires, the SCAS-P had moderate to high positive intercorrelations and was also moderately associated with both the AQ-Child and the SDSC. The obsessive-compulsive subscale of the SCAS-P was also most associated with the AQ- Child.

The second experimental study (Chapter 5) did not find a local processing bias or any significant relationships between Navon task performance (time and accuracy) and anxiety or autism traits in children with AHDN as predicted. When compared to a small sample of age matched (9- 10 years) TD children, there was also no significant difference between groups on

Navon task performance. A trend towards significance was noted between age matched (9-10 years) AHDN and TD groups on the global congruent accuracy condition of the Navon that likely would have met significance if it had been possible to test a larger sample in the analysis.

The final empirical study (Chapter 6) demonstrated a difference between an age matched (9-10 years) sample of AHDN and TD groups on the executive control aspect of a child version of the ANT, but not on the trials relating to the alerting or orienting networks. Overall in the AHDN group, the alerting attention network, sometimes referred to as the vigilance network was negatively correlated with anxiety when accounting for age. On further regression analysis, anxiety was shown to explain 7% of the variance of the alerting network when controlling for age.

Theoretical Implications

Traditionally there has been very little research examining children with AHDN, particularly in an Australian context and thus the findings of this investigation of children with AHDN is theoretically and practically important. Until now, research regarding children experiencing social, emotional and/or academic difficulties has generally focussed on unique diagnostic groups rather than whether school-based problems induce common behavioural characteristics, amongst children meeting any medical or psychological clinical diagnostic criteria. Given that the findings of Chapter 4 provide evidence that anxiety is a core biomarker in our population group regardless of primary presenting concern, the current research lends support to the contention that there is overreliance on diagnosis in order to receive government funding for childhood interventions and advocates for the inclusion of all children experiencing school-based problems using non-categorical funding models (Macaulay, Deppeler, & Agbenyega, 2016; McDowell & O'Keeffe, 2012; O'Connor et al., 2015; Walker et al., 2018).

Although most research cites that the prevalence of anxiety disorders sits at around 7% (Goodsell et al., 2017; Polanczyk, Salum, Sugaya, Caye, & Rohde, 2015), the results of this thesis suggest that in fact clinical and subthreshold levels of anxiety are likely to be much greater in the general population given that at least 1 in 5 children in classrooms worldwide experience school based problems and so could be classified as having AHDN (Goldfeld, O'Connor, Sayers, Moore, & Oberklaid, 2012; O'Connor, Rosema, Quach, Kvalsvig, & Goldfeld, 2017) and therefore likely to experience high levels of anxiety (Cross, Goharpey, Laycock, & Crewther, 2019). Given this, the relationship between anxiety and children with AHDN is likely to be bidirectional. Our findings support past research that has associated anxiety with changes in sleep patterns (Alvaro, Roberts, & Harris, 2013; Kahn, Sheppes, & Sadeh, 2013) and autism-type behaviours (Freeth, Bullock, & Milne, 2013; Rosbrook & Whittingham, 2010; van Steensel, Bögels, & Perrin, 2011). More importantly our results highlight that such behaviours are likely to mask underlying chronic anxiety in children with AHDN, and thus an observation of sleep disturbances and impaired social skills should be recognised as warnings of underlying chronic anxiety in students. Accordingly, the need for extra support should be noted by clinicians, parents and educationalists, as well as for researchers conducting future work.

To our knowledge there is no prior research examining cognitive and visual attention in relation to chronic anxiety in children with AHDN. With regard to biased local/global perceptual processing, our findings (Chapter 5) did not support local bias previously associated with chronic trait anxiety (Becker et al., 2017; Tyler & Tucker, 1982) or in those with diagnosed with ASD or showing subthreshold autism traits such as proposed in the Weak Central Coherence (WCC) (Happé & Frith, 2006) and Enhanced Perceptual Functioning (EPF) (Mottron & Burack, 2001) theories. However, our findings provide further indication that a Navon-style task in ASD or

neurodevelopmentally vulnerable populations may not be the most adequate measure to assess either the WCC or EPF theories (Baisa, Mevorach, & Shalev, 2018). Acknowledging that most past research on visual processing in children has included only higher functioning participants (Brown, Chouinard, & Crewther, 2017), the current research once again highlights the need to include children experiencing difficulties of all levels of ability, in the literature moving forward.

When considering the role of Posner's alerting, orienting and executive control networks in an AHDN population, the current research provided evidence that the alerting network was negatively associated with chronic anxiety. Indeed, the negative correlation between alerting scores and anxiety overall suggested that the characterisation of chronic anxiety in children with AHDN may result in a less efficient attention alerting network. Although there is no known past research on attention networks with children with AHDN, our findings differ from past research associating subthreshold anxiety with the executive attention network (Mogg et al., 2015). From a neurodevelopmental perspective, our findings add to inconsistent literature surrounding attention networks in groups with neurodevelopmental disorders such as ASD whose behaviour have traditionally been most strongly associated with the orienting network (Keehn, Lincoln, Müller & Townsend, 2010; Landry & Parker, 2013). Rather our results suggest that children with AHDN are likely to be chronically anxious and more prone to an under-responsive attention network, especially with regard to vigilance .

Limitations of Current Research

It is important to acknowledge the overarching limitations pertaining to the experimental research conducted as part of this thesis. Although the main focus of the research was to investigate children with AHDN, the comparative generalisability of the results is limited by the small TD control group. It is unfortunate that a more comprehensive control sample was not able

to be obtained given data collection was expected to be completed in early 2020 but was not possible due to COVID-19 restrictions. However future research in our lab will continue to develop the evidence base of children with AHDN as soon as feasible.

Whilst research on what is common in AHDN is in its infancy, the current thesis has also been restrictive in not including any children with physical health problems such as asthma or diabetes (McPherson et al., 1998) under the umbrella term of AHDN. Further investigations should aim to expand the evidence base to account for variations in psychosocial factors for all children with AHDN including socioeconomic status (Fulda, Lykens, Bae, & Singh, 2009; Newacheck et al., 1998; Van Dyck, Kogan, McPherson, Weissman, & Newacheck, 2004) and racial or ethnic background (Ngui & Flores, 2007), which may contribute to anxiety and/or act as further barriers for children accessing relevant supports though little is known about these factors in an Australian context currently.

A further limitation of the current design was the use of current child and adult clinical psychological assessment procedures (i.e. evidence-based questionnaires) rather than use of a biological measure of state anxiety. Indeed utilisation of objective physiological measures such as heart rate and heart rate variability and blood pressure (Blechert & Wilhelm, 2014) would have added greatly to the objective assessment of anxiety and allowed for the monitoring of common physiological signs of stress and correlation with psychological factors and questionnaire data (Baum, Grunberg, & Singer, 1982). Unfortunately current clinical practice guidelines in Australia and internationally do not generally include any objective examination of biological measures of affective processes, or assessment of sleep or eating patterns (Andrews et al., 2018; Creswell, Waite, & Cooper, 2014). Our assessment of anxiety may have also been more comprehensive if we had examined broader family risk factors for childhood anxiety

including demographic information regarding parenting style (McLeod, Wood, & Weisz, 2007; Rapee, 1997; Segrin, Woszidlo, Givertz, & Montgomery, 2013) and parent's own mental health/anxiety state (Percy, Creswell, Garner, O'Brien, & Murray, 2016) as such factors are known to contribute to the emergence and maintenance of childhood anxiety.

Clinical Implications for Psychologists

Given that we have demonstrated that children with AHDN are likely to be characterised by greater levels of chronic anxiety, our findings highlight the important role of psychologists and allied health professionals in identifying and providing early intervention for children with AHDN. More broadly, this highlights the importance of recognising the potential for mental health concerns relating to anxiety in those who do experience additional school-based needs. Of note, the implementation of associated supports is vital, given that previous research suggests that these children and their families often do not receive adequate psychological services (Inkelas, Raghavan, Larson, Kuo, & Ortega, 2007; Simon, Pastor, Reuben, Huang, & Goldstrom, 2015). Given that psychologists are generally unable to provide individual psychological intervention to all children given time and resource constraints, it is important for psychologists to work in partnership with other medical, allied health and educational practitioners to ensure that mental health is recognised in larger numbers of children. The prioritisation of mental health in all children, but particularly for those with AHDN, is likely to be of even greater significance during the current global COVID-19 pandemic and for managing ongoing associated impacts in the years to come (Golberstein, Wen, & Miller, 2020; Lee, 2020).

The role of a psychologist within the education system includes, but is not limited to, conducting psychological and cognitive assessment, delivering therapy and intervention and providing mental health psychoeducation to students, teachers and families (Australian

Psychological Society, 2018). Accordingly, our findings suggest that a valuable psychological approach for children with developmental aetiology is a more recent reiteration (Basu & Parry, 2013; Selzer & Ellen, 2014) of the original Biopsychosocial Model (Engel, 1977). The Biopsychosocial Model contends that all three levels of conceptualisation of behaviour (biological, psychological and social) are inherent factors that play a role in understanding of the disorders. Currently, psychologists are more likely to actively consider psychological and social elements in their assessments and interventions, while tending to overlook biological contributions, as is reflected in clinical practice guidelines in Australia (Andrews et al., 2018; Creswell et al., 2014).

When assessing for anxiety, simple questions regarding sleep routines and social behaviours (such as in Chapter 4) are likely to be a time-effective addition to current practice that will contribute greatly to the provision of more comprehensive assessment and could go a long way to ensuring the anxious child will receive adequate recognition, support and therapy (Cross et al., 2019). Additionally, our results from Chapter 6 highlight that cognitive assessments in children with AHDN should readily consider the role of the alerting/vigilance attention network in addition to the assessment of executive functioning, which is usually considered important in understanding the performance of children at school (Best & Miller, 2010). It is clear that psychologists can and should be leaders in advocating for the importance of recognising biopsychosocial factors and in the developing contemporary evidence-based assessments and interventions for children with AHDN that extend beyond the current over-reliance on clinical diagnoses to access funding and support services for school children.

Future Directions

More broadly, there are important key issues that this thesis has identified as requiring the most urgent further investigation from the clinical and educational perspectives for children with AHDN, including:

- Prioritising the inclusion of children with varied diagnoses and also those with clinically undiagnosed difficulties (AHDN) in research. Indeed, until very recently such children have usually been excluded from experimental studies as the research literature has tended to only include homogeneously categorised populations, and hence children with AHDN have played little part in development of government policies, despite these children often experiencing substantial distress and adverse outcomes.
- Recognition of the presence of chronic anxiety, autism-like traits and sleep behaviours as important in characterising children with AHDN.
- Demonstration of the use of screening tools, such as parent-rated questionnaires, including information on sleep and eating routines and social behaviours early in a child's school life or even at enrolment as a way of increasing the identification of biological symptoms that are likely to be associated with levels of endogenous anxiety. It is acknowledged that schools may not have the capacity to respond to all children if screening tools were commonly used. Regardless, such screening tools would allow parent perspectives to be included in the assessment process from the moment a child arrives at a school and may be a brief way of screening children who may not necessarily come to the attention of teachers in the classroom environment (Rydz, Shevell, Majnemer, & Oskoui, 2005).
- Exploration of whether there is a brief and simple way to recognise a cognitive phenotype or profile of children likely to develop AHDN and initiate interventions as early as

possible. This includes further research regarding sustained attention, including the use of the child version of the ANT.

- Implementation and/or development of further assessment tools to account for the biological processes of anxiety, that are simple to incorporate into psychological practice and can provide data to enhance questionnaire/screening assessments. For instance, half an hour of wearing a smartwatch-type device that measures physiological functions such as heart rate and heart rate variability, skin temperature and blood pressure, would provide a more thorough and accurate representation of the experience of state anxiety, and may provide clinical information such as the likelihood that anxiety will impair the child's immune system (Ray, Gulati, & Rai, 2017) and their vulnerability to physical and mental health disorders.

Conclusions

This thesis has highlighted the importance of prioritising the recognition of chronic anxiety in children with both diagnosed and undiagnosed AHDN within the school system. For the first time, we have characterised chronic anxiety as a common biomarker for children with AHDN regardless of their primary presenting concern. We have shown that the cognitive attention profile of children with AHDN in terms of Posner's attention networks is likely to include a less efficient alerting network when associated with chronic and persistent anxiety. Our findings also suggest that local/global perceptual biases in children with AHDN are likely to be complex and confounded by chronic anxiety. Overall, this thesis has demonstrated that chronic anxiety and ability to sustain attention are of major importance for the educational and psychological assessment and intervention program for any child who experiences social, emotional and/or academic difficulties at school.

References

Alvaro, P. K., Roberts, R. M., & Harris, J. K. (2013). A systematic review assessing bidirectionality between sleep disturbances, anxiety, and depression. *Sleep, 36*(7), 1059-1068. http://doi.org/10.5665/sleep.2810

American Psychiatric Association, A. P. (2013). *Diagnostic and statistical manual of mental disorders (DSM-5®)*: American Psychiatric Pub.

Andrews, G., Bell, C., Boyce, P., Gale, C., Lampe, L., Marwat, O., . . . Wilkins, G. (2018). Royal Australian and New Zealand College of Psychiatrists clinical practice guidelines for the treatment of panic disorder, social anxiety disorder and generalised anxiety disorder. *Australian & New Zealand Journal of Psychiatry, 52*(12), 1109-1172. http://doi.org/10.1177/0004867418799453

Australian Psychological Society. (2018). *The framework for effective delivery of school psychology services: a practice guide for psychologists and school leaders*. Retrieved from: https://www.psychology.org.au/getmedia/249a7a14-c43e-4add-aa6b-decfea6e810d/Framework-schools-psychologists-leaders.pdf

Auyeung, B., Baron-Cohen, S., Wheelwright, S., & Allison, C. (2008). The autism spectrum quotient: Children's version (AQ-Child). *Journal of autism and developmental disorders, 38*(7), 1230-1240. https://doi.org./10.1007/s10803-007-0504-z

Baisa, A., Mevorach, C., & Shalev, L. (2018). Can Performance in Navon Letters among People with Autism be Affected by Saliency? Reexamination of the Literature. *Review Journal of Autism and Developmental Disorders*, 1-12. http://dx.doi.org/10.1007/s40489-018-0150-8

Basu, S., & Parry, P. (2013). The autism spectrum disorder ‘epidemic’: Need for biopsychosocial formulation. *Australian & New Zealand Journal of Psychiatry, 47*(12), 1116-1118. http://doi.org/10.1177/0004867413509694

Baum, A., Grunberg, N. E., & Singer, J. E. (1982). The use of psychological and neuroendocrinological measurements in the study of stress. *Health psychology, 1*(3), 217. http://doi.org/10.1037/0278-6133.1.3.217

Becker, K. R., Plessow, F., Coniglio, K. A., Tabri, N., Franko, D. L., Zayas, L. V., . . . Eddy, K. T. (2017). Global/local processing style: Explaining the relationship between trait anxiety and binge eating. *International Journal of Eating Disorders, 50*(11), 1264-1272. http://doi.org/10.1002/eat.22772

Best, J. R., & Miller, P. H. (2010). A developmental perspective on executive function. *Child development, 81*(6), 1641-1660. http://doi.org/10.1111/j.1467-8624.2010.01499.x

Blechert, J., & Wilhelm, F. H. (2014). Psychophysiology. *The Wiley handbook of anxiety disorders*, 274-294. http://doi.org/10.1002/9781118775349.ch17

Brown, A. C., Chouinard, P. A., & Crewther, S. G. (2017). Vision research literature may not represent the full intellectual range of autism spectrum disorder. *Front Hum Neurosci, 11*, 57. http://doi.org/10.3389/fnhum.2017.00057

Bruni, O., Ottaviano, S., Guidetti, V., Romoli, M., Innocenzi, M., Cortesi, F., & Giannotti, F. (1996). The Sleep Disturbance Scale for Children (SDSC) Construct ion and validation of an instrument to evaluate sleep disturbances in childhood and adolescence. *Journal of sleep research, 5*(4), 251-261. https://doi.org/10.1111/j.1365-2869.1996.00251.x

Creswell, C., Waite, P., & Cooper, P. J. (2014). Assessment and management of anxiety disorders in children and adolescents. *Archives of disease in childhood, 99*(7), 674-678. http://doi.org/10.1136/archdischild-2013-303768

Cross, A. J., Goharpey, N., Laycock, R., & Crewther, S. G. (2019). Anxiety as a Common Biomarker for School Children with Additional Health and Developmental Needs Irrespective of Diagnosis. *Frontiers in Psychology, 10*, 1420. http://doi.org/10.3389/fpsyg.2019.01420

Cuthbert, B. N. (2014). The RDoC framework: facilitating transition from ICD/DSM to dimensional approaches that integrate neuroscience and psychopathology. *World Psychiatry, 13*(1), 28-35. http://doi.org/10.1002/wps.20087

Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: attentional control theory. *Emotion, 7*(2), 336. http://doi.org/10.1037/1528-3542.7.2.336

Fan, J., McCandliss, B. D., Fossella, J., Flombaum, J. I., & Posner, M. I. (2005). The activation of attentional networks. *Neuroimage, 26*(2), 471-479.http://doi.org/10.1016/j.neuroimage.2005.02.004

Freeth, M., Bullock, T., & Milne, E. (2013). The distribution of and relationship between autistic traits and social anxiety in a UK student population. *Autism, 17*(5), 571-581. http://doi.org/10.1177/1362361312445511

Fulda, K. G., Lykens, K. K., Bae, S., & Singh, K. P. (2009). Unmet mental health care needs for children with special health care needs stratified by socioeconomic status. *Child and Adolescent Mental Health, 14*(4), 190-199. http://doi.org/10.1111/j.1475-3588.2008.00521.x

Golberstein, E., Wen, H., & Miller, B. F. (2020). Coronavirus disease 2019 (COVID-19) and mental health for children and adolescents. *JAMA pediatrics*. http://doi.org/10.1001/jamapediatrics.2020.1456

Goldfeld, S., O'Connor, M., Sayers, M., Moore, T., & Oberklaid, F. (2012). Prevalence and correlates of special health care needs in a population cohort of Australian children at school entry. *Journal of Developmental & Behavioral Pediatrics, 33*(4), 319-327. http://doi.org/10.1097/DBP.0b013e31824a7b8e

Goodsell, B. T., Lawrence, D. M., Ainley, J., Sawyer, M., Zubrick, S. R., & Maratos, J. (2017). *Child and adolescent mental health and educational outcomes: an analysis of educational outcomes from Young Minds Matter: the second Australian Child and Adolescent Survey of Mental Health and Wellbeing*. Perth: Graduate School of Education, The University of Western Australia.

Happé, F., & Frith, U. (2006). The weak coherence account: detail-focused cognitive style in autism spectrum disorders. *J Autism Dev Disord, 36*(1), 5-25. https://doi.org/10.1007/s10803-005-0039-0

Inkelas, M., Raghavan, R., Larson, K., Kuo, A. A., & Ortega, A. N. (2007). Unmet mental health need and access to services for children with special health care needs and their families. *Ambulatory Pediatrics, 7*(6), 431-438. http://doi.org/10.1016/j.ambp.2007.08.001

Kahn, M., Sheppes, G., & Sadeh, A. (2013). Sleep and emotions: bidirectional links and underlying mechanisms. *International Journal of Psychophysiology, 89*(2), 218-228. http://doi.org/10.1016/j.ijpsycho.2013.05.010

Keehn, B., Lincoln, A. J., Müller, R. A., & Townsend, J. (2010). Attentional networks in children and adolescents with autism spectrum disorder. *Journal of child psychology and psychiatry, 51*(11), 1251-1259. http://dx.doi.org/10.1111/j.1469-7610.2010.02257.x

Kotov, R., Krueger, R. F., & Watson, D. (2018). A paradigm shift in psychiatric classification: the Hierarchical Taxonomy Of Psychopathology (HiTOP). *World Psychiatry, 17*(1), 24. http://doi.org/10.1002/wps.20478

Landry, O., & Parker, A. (2013). A meta-analysis of visual orienting in autism. *Frontiers in human neuroscience, 7*, 833. http://dx.doi.org/10.3389/fnhum.2013.00833

Lee, J. (2020). Mental health effects of school closures during COVID-19. *The Lancet Child & Adolescent Health, 4*(6), 421. https://doi.org/10.1016/S2352-4642(20)30109-7

Macaulay, L., Deppeler, J., & Agbenyega, J. (2016). Access to quality education for students with disability. *Journal of Social Inclusion, 7*(2). http://doi.org/10.36251/josi.108

McDowell, M., & O'Keeffe, M. (2012). Public services for children with special needs: discrimination by diagnosis? *Journal of paediatrics and child health, 48*(1), 2-5. http://doi.org/10.1111/j.1440-1754.2011.02394.x

McLeod, B. D., Wood, J. J., & Weisz, J. R. (2007). Examining the association between parenting and childhood anxiety: A meta-analysis. *Clinical Psychology Review, 27*(2), 155-172. http://doi.org/10.1016/j.biopsych.2013.07.004

McPherson, M., Arango, P., Fox, H., Lauver, C., McManus, M., Newacheck, P. W., . . . Strickland, B. (1998). A new definition of children with special health care needs. *Pediatrics, 102*(1), 137-139. https://doi.org/10.1542/peds.102.1.137

Mogg, K., Salum, G., Bradley, B., Gadelha, A., Pan, P., Alvarenga, P., . . . Manfro, G. (2015). Attention network functioning in children with anxiety disorders, attention-

deficit/hyperactivity disorder and non-clinical anxiety. *Psychological medicine, 45*(12), 2633-2646. http://doi.org/10.1017/S0033291715000586

Mottron, L., & Burack, J. A. (2001). Enhanced perceptual functioning in the development of autism. n J. A. Burack, T. Charman, N. Yirmiya, & P. R. Zelazo (Eds.), *The development of autism: Perspectives from theory and research* (p. 131–148). Lawrence Erlbaum Associates Publishers.

Nauta, M. H., Scholing, A., Rapee, R. M., Abbott, M., Spence, S. H., & Waters, A. (2004). A parent-report measure of children's anxiety: psychometric properties and comparison with child-report in a clinic and normal sample. *Behaviour research and therapy, 42*(7), 813-839. http://doi.org/10.1016/S0005-7967(03)00200-6

Navon, D. (1977). Forest before trees: The precedence of global features in visual perception. *Cognitive psychology, 9*(3), 353-383. http://doi.org/10.1016/0010-0285(77)90012-3

Newacheck, P. W., Strickland, B., Shonkoff, J. P., Perrin, J. M., McPherson, M., McManus, M., . . . Arango, P. (1998). An epidemiologic profile of children with special health care needs. *Pediatrics, 102*(1), 117-123. https://doi.org/10.1542/peds.102.1.117

Ngui, E. M., & Flores, G. (2007). Unmet needs for specialty, dental, mental, and allied health care among children with special health care needs: are there racial/ethnic disparities? *Journal of Health Care for the Poor and Underserved, 18*(5), 931-949. http://doi.org/10.1353/hpu.2007.0102

O'Connor, M., Rosema, S., Quach, J., Kvalsvig, A., & Goldfeld, S. (2017). Special health care needs across the school and family contexts: implications for service utilization. *Academic pediatrics, 17*(6), 687-693. http://doi.org/10.1016/j.acap.2017.02.012

O'Connor, M., Quach, J., Goldfeld, S., Gold, L., Aston, R., Beatson, R., & Hopkins, D. (2015). *Approaches to the provision of educational support for children and young people with additional health and developmental needs: Autism Spectrum Disorder*s. Centre for Community Child Health, Melbourne, Victoria.

Percy, R., Creswell, C., Garner, M., O'Brien, D., & Murray, L. (2016). Parents' verbal communication and childhood anxiety: A systematic review. *Clinical child and family psychology review, 19*(1), 55-75. http://doi.org/10.1007/s10567-015-0198-2

Petersen, S. E., & Posner, M. I. (2012). The attention system of the human brain: 20 years after. *Annu Rev Neurosci, 35*, 73-89. doi:10.1146/annurev-neuro-062111-150525

Polanczyk, G. V., Salum, G. A., Sugaya, L. S., Caye, A., & Rohde, L. A. (2015). Annual research review: A meta-analysis of the worldwide prevalence of mental disorders in children and adolescents. *Journal of child psychology and psychiatry, 56*(3), 345-365. http://doi.org/10.1111/jcpp.12381

Posner, M. I., & Petersen, S. E. (1990). The attention system of the human brain. *Annu Rev Neurosci, 13*(1), 25-42. http://doi.org/10.1146/annurev.ne.13.030190.000325

Rapee, R. M. (1997). Potential role of childrearing practices in the development of anxiety and depression. *Clinical Psychology Review, 17*(1), 47-67. http://doi.org/10.1016/S0272-7358(96)00040-2

Ray, A., Gulati, K., & Rai, N. (2017). Stress, anxiety, and immunomodulation: a pharmacological analysis. In *Vitamins and hormones* (Vol. 103, pp. 1-25): Elsevier.

Rosbrook, A., & Whittingham, K. (2010). Autistic traits in the general population: What mediates the link with depressive and anxious symptomatology? *Research in Autism Spectrum Disorders, 4*(3), 415-424. http://doi.org/10.1016/j.rasd.2009.10.012

Rueda, M. R., Fan, J., McCandliss, B. D., Halparin, J. D., Gruber, D. B., Lercari, L. P., & Posner, M. I. (2004). Development of attentional networks in childhood. *Neuropsychologia, 42*(8), 1029-1040. http://doi.org/10.1016/j.neuropsychologia.2003.12.012

Rydz, D., Shevell, M. I., Majnemer, A., & Oskoui, M. (2005). Topical review: developmental screening. *Journal of child neurology, 20*(1), 4-21. http://doi.org/10.1177/08830738050200010201

Segrin, C., Woszidlo, A., Givertz, M., & Montgomery, N. (2013). Parent and child traits associated with overparenting. *Journal of Social and Clinical Psychology, 32*(6), 569-595. http://doi.org/10.1521/jscp.2013.32.6.569

Selzer, R., & Ellen, S. (2014). Formulation for beginners. *Australasian Psychiatry, 22*(4), 397-401. http://doi.org/10.1177/1039856214536240

Simon, A. E., Pastor, P. N., Reuben, C. A., Huang, L. N., & Goldstrom, I. D. (2015). Use of mental health services by children ages six to 11 with emotional or behavioral difficulties. *Psychiatric Services, 66*(9), 930-937. http://doi.org/10.1176/appi.ps.201400342

Tyler, S. K., & Tucker, D. M. (1982). Anxiety and perceptual structure: Individual differences in neuropsychological function. *Journal of Abnormal Psychology, 91*(3), 210. http://doi.org/10.1037/0021-843X.91.3.210

Van Dyck, P. C., Kogan, M. D., McPherson, M. G., Weissman, G. R., & Newacheck, P. W. (2004). Prevalence and characteristics of children with special health care needs. *Archives of pediatrics & adolescent medicine, 158*(9), 884-890. http://doi.org/10.1001/archpedi.158.9.884

van Steensel, F. J., Bögels, S. M., & Perrin, S. (2011). Anxiety disorders in children and adolescents with autistic spectrum disorders: a meta-analysis. *Clinical child and family psychology review, 14*(3), 302. http://doi.org/10.1007/s10567-011-0097-0

Walker, P. M., Carson, K. L., Jarvis, J. M., McMillan, J. M., Noble, A. G., Armstrong, D. J., . . . Palmer, C. D. (2018). How do educators of students with disabilities in specialist settings understand and apply the Australian Curriculum framework? *Australasian Journal of Special and Inclusive Education, 42*(2), 111-126. http://doi.org/10.1017/jsi.2018.13

World Health Organization. (2018). *International classification of diseases for mortality and morbidity statistics* (11th Revision). Retrieved from https://icd.who.int/browse11/l-m/en

Appendices

Abstract A

Manuscript- Editorial Paper of Key Thesis Outcomes

Abstract

At least 1 in 5 Australian children struggle at school due to various diagnosed or undiagnosed Additional Health and Developmental Needs, many of whom 'fall through the cracks' and do not receive sufficient recognition, funding or access to early intervention due to an over-reliance on clinical diagnoses. Contrary to this, evidence suggests that the individual characteristics of a child should be prioritised. We contend that psychologists should be leaders in advocating for these children through clinical case formulation approaches including the recognition of biomarkers, such as anxiety, contributing to a child's difficulties in the context of the Biopsychosocial Model. Acknowledging that evidence-based recommendations are likely to be most effective if they are brief and targeted, it is proposed that incorporating methods such as brief questionnaires regarding sleep and eating behaviours and fitness trackers to measure physiological markers of anxiety, will greatly contribute to the comprehensive assessment of children with Additional Health and Developmental Needs. Further research is needed to establish how psychologists can best recognise and support all children who struggle at school, even if they do not or meet particular diagnostic criteria or the threshold to receive government funding.

Key Words: Educational and Developmental Psychology, Learning Disorders, School-aged Children, School Based Problems

Falling Through the Cracks: Considerations for Psychologists Working with Children with Additional Health and Developmental Needs in Australian Schools

At least 1 in 5 children in Australia require extra support at school due to various diagnosed and undiagnosed developmental, behavioural and emotional difficulties (Goldfeld, O'Connor, Sayers, Moore, & Oberklaid, 2012). Hence the earliest possible identification of the specific nature of potential educational and/or mental health difficulties and the need for developmentally appropriate early interventions for such children is crucial (Atkins, Cappella, Shernoff, Mehta, & Gustafson, 2017; Noam & Hermann, 2002). These children may be characterised as having Special Health Care Needs, or as this group has more recently been classified, Additional Health and Developmental Needs (AHDN), commonly defined in Australia as "*those who have, or are at increased risk for a chronic physical, developmental, behavioural, or emotional condition and who also require health and related services of a type or amount beyond that required by children generally"* (McPherson et al., 1998). AHDN is a broad term that includes children with both diagnosed and undiagnosed needs (Goldfeld, O'Connor, Quach, Tarasuik, & Kvalsvig, 2015). The detection of such difficulties often first occurs at school, emphasising the role of the education system in supporting young people with AHDN (Lawrence et al., 2015). Psychological input is also likely necessary for a child who requires additional support (Cavanagh, 2017), given they are at a greater risk of being bullied, having poorer academic outcomes and displaying more disruptive behaviour (Forrest, Bevans, Riley, Crespo, & Louis, 2011). Children who struggle at school are more likely to experience anxiety, poor sleep and social difficulties (Rzepecka, McKenzie, McClure, & Murphy, 2011), and their families often sustain significant emotional and financial stressors (Elkins, Van Kraayenoord, & Jobling, 2003; Looman, O'Conner-Von, Ferski, & Hildenbrand, 2009; Van Dyck, Kogan, McPherson, Weissman, & Newacheck, 2004).

To date, there is limited research on Australian school children with AHDN meaning that potential shared characteristics of a cognitive profile (e.g., atypical attention), biological processes (e.g., sleep quality and eating patterns) and mental health co-morbidities (e.g., anxiety) are largely unknown. There is an urgency to expand the evidence base in this population so that assessment of difficulties can shift beyond a means to access funding and support services towards prioritising the identification of children requiring support and early intervention (O'Connor, O'Connor, Quach, Vashishtha, & Goldfeld, 2019).

Although inclusion and valuing of the diverse needs of students is a key principle for the Victorian State Government (State of Victoria Department of Education and Training, 2016), there appears to be a substantial portion of children who fall 'through the cracks' and do not receive adequate support. This is also evident in the allocation of funding and support in Australia, which is often restricted when children do not fit within diagnostic criteria, or when they do not present with a particular level of severity (McDowell & O'Keeffe, 2012). In fact, the educational and social outcomes for children who have additional needs in Australia are not yet known because they are often excluded from standardised testing such as the National Assessment Program- Literacy and Numeracy (NAPLAN) (Dempsey & Davies, 2013). Where academic literature and government policies have included AHDN, severe disabilities have been targeted meaning that children with undiagnosed or mild-moderate challenges have been largely overlooked, even though these children still appear to experience poor outcomes (Goldfeld et al., 2015; Newacheck et al., 1998). Furthermore the allocation of resources even for the same diagnosis is known to be highly variable under the National Disability Insurance Scheme (NDIS) federal funding scheme (Mavromaras, Moskos, & Mahuteau, 2016) with a child's problems sometimes being overstated by parents, schools and professionals in order to receive a diagnosis to access services (Skellern, Schluter, & McDowell, 2005).

Contrary to current system limitations, a non-categorical approach that focuses on the individual needs of the child along with parent involvement has been recommended (O'Connor et al., 2015) . For instance, research has shown that an emphasis on the functioning of the child, referred to as the ability or limitation to engage and participate in meaningful activities, rather than diagnosis has improved outcomes for the child and their families (Miller, Shen, & Mâsse, 2016; World Health Organisation, 2001).

The role of a psychologist within the education system includes, but is not limited to, conducting psychological and cognitive assessment, delivering therapy and intervention and providing mental health psychoeducation to students, teachers and families (Australian Psychological Society, 2018). A key skill that psychologists may be able to contribute to the understanding and treatment of children is '*clinical case formulation'* which is best understood as a process of developing evidence-based individualised hypotheses about a person's difficulties and consideration of contributing factors that may include interpersonal, biological and cultural aspects, and to inform therapeutic intervention where appropriate (British Psychological Society, 2011). Currently however there is little consensus regarding best theoretical approaches to this type of clinical case formulation (Ridley, Jeffrey, & Roberson, 2017).

Formulation has most recently been proposed as an alternative to diagnosis (Johnstone, 2018) that results in the individualized treatment of children and their families (Winters, Hanson, & Stoyanova, 2007). One *formulation* approach that is likely to be useful for children with developmental aetiology is the Biopsychosocial Model (Basu & Parry, 2013; Selzer & Ellen, 2014), which contends that biological, psychological and social factors contribute to disorders (Engel, 1977). Currently clinical psychologists are more likely to actively consider psychological and social elements in their assessments and interventions, while tending to overlook biological contributions. This is reflected in clinical practice

guidelines in Australia and internationally, where ‘gold-standard’ approaches to assessment of anxiety, for instance, do not generally include any objective examination of biological measures of affective processes (Andrews et al., 2018; Creswell, Waite, & Cooper, 2014), or assessment of sleep or eating patterns. Contemporary dimensional conceptualisations of disorders, such as the Research Domain Criteria (RDoC) framework, seek to establish new ways of classifying mental illnesses based on both observable behaviours and biological measures (Insel et al., 2010; Insel, 2014). For example, measurement of reward circuit activity in mood disorders (Cuthbert, 2014). Recent considerations propose that disruptive behaviour in developmental disorders is a symptom of a stressed biopsychosocial system that may be more meaningfully treated by prioritising areas of functional ability of an individual, including in visual-cognitive, social skills and self-regulation domains (Klein & Kraus de Camargo, 2018). For children with AHDN, a key consideration concerns any changes to sleep and eating patterns, which are known to disrupt the homeostatic process subsequently impacting on cognition and behaviour (Lundahl & Nelson, 2015).

Currently there are several barriers to psychologists implementing a comprehensive biopsychosocial approach to children with AHDN in Australia including limited time, conflicting demands and limited resources (O’Grady, 2017). This means that evidence-based recommendations for Australian school children are likely to be most useful if they are brief, targeted to high risk symptoms (which are yet to be established) and inclusive of family members or teachers who can provide information about a child’s behaviour and functioning across different environments. Although there are many means to measure physiological biomarkers of anxiety such as cortisol, blood pressure, heart rate and the galvanic skin response (Taylor & Epstein, 1967), these measures have previously been impractical for most psychologists to routinely include in their clinical practice. The utilisation of contemporary devices, such as fitness trackers acquired to measure variability in heart rate information

would add greatly to an educational assessment (Goessl, Curtiss, & Hofmann, 2017). . Indeed, although there is a gap in the literature about how psychologists can include current biological measures in the *formulation* and treatment of children with AHDN, simple questions regarding sleep routines and social behaviours are likely to a be a time-effective addition to current practice that will contribute greatly to the provision of more comprehensive assessment (Cross, Goharpey, Laycock, & Crewther, 2019). Hence, although more research is needed to comprehensively explore how psychologists can best manage and contribute to the education of children who struggle at school but may not necessarily have a clinical diagnosis or meet funding criteria, the addition of simple sleep and eating information could go a long way to ensuring the anxious child will receive adequate recognition, support and therapy. In particular, some areas that require further exploration in the literature include:

- Prioritising the inclusion of children with varied diagnosed and undiagnosed difficulties (AHDN) in research because they are often excluded in the literature and in government policies, despite these children often experiencing substantial distress and adverse outcomes.
- Investigating whether the use of screening tools, such as parent-rated questionnaires, including information on sleep and eating routines and social behaviours can be used at enrolment to identify biological symptoms such as atypical behaviours, anxiety or sleeping, eating and social difficulties. Importantly, this would allow parent perspectives to be included in an assessment from the moment a child arrives at a school and may be a brief way of screening children who may not necessarily come to the attention of teachers in the classroom environment (Rydz, Shevell, Majnemer, & Oskoui, 2005).

- Exploring if there is a brief and simple way to recognise a cognitive phenotype or profile of children with AHDN.

In summary, psychologists can and should play a more influential role in helping to develop flexible and rigorous means to identify and provide treatment to children with AHDN that extends beyond the current over-reliance on clinical diagnoses to access funding and support services for school children. Although there is a substantial need for further research and for both government and education systems to adequately recognise children with AHDN, psychologists can be leaders in advocating for the importance of recognising biopsychosocial factors and in the developing contemporary evidence-based clinical practice guidelines and individualised clinical formulation for children with AHDN.

References

Andrews, G., Bell, C., Boyce, P., Gale, C., Lampe, L., Marwat, O., . . . Wilkins, G. (2018). Royal Australian and New Zealand College of Psychiatrists clinical practice guidelines for the treatment of panic disorder, social anxiety disorder and generalised anxiety disorder. *Australian & New Zealand Journal of Psychiatry, 52*(12), 1109-1172. http://doi.org/10.1177/0004867418799453

Australian Psychlogical Society. (2018). *The framework for effective delivery of school psychology services: a practice guide for psychologists and school leaders*. Retrieved from https://psychology.org.au/APS/media/Resource-Finder/Framework-delivery-school-psych-services-practice-guide.pdf

Atkins, M. S., Cappella, E., Shernoff, E. S., Mehta, T. G., & Gustafson, E. L. (2017). Schooling and children's mental health: Realigning resources to reduce disparities and advance public health. *Annual review of clinical psychology, 13*, 123-147. http://doi.org/10.1146/annurev-clinpsy-032816-045234

Basu, S., & Parry, P. (2013). The autism spectrum disorder ‘epidemic’: Need for biopsychosocial formulation. *Australian & New Zealand Journal of Psychiatry, 47*(12), 1116-1118. http://doi.org/10.1177/0004867413509694

British Psychological Society (2011). *Good Practice Guidelines on the use of psychological formulation.* Retrieved from http://www.sisdca.it/public/pdf/DCP-Guidelines-for-Formulation-2011.pdf

Cavanagh, S. (2017). Early childhood matters most. *InPsych: The Bulletin of the Australian Psychological Society Ltd, 39*(6), 8.

Creswell, C., Waite, P., & Cooper, P. J. (2014). Assessment and management of anxiety disorders in children and adolescents. *Archives of disease in childhood, 99*(7), 674-678. http://doi.org/10.1136/archdischild-2013-303768

Cross, A. J., Goharpey, N., Laycock, R., & Crewther, S. G. (2019). Anxiety as a Common Biomarker for School Children with Additional Health and Developmental Needs Irrespective of Diagnosis. *Front Psychol, 10*, 1420. http://doi.org/10.3389/fpsyg.2019.01420

Cuthbert, B. N. (2014). The RDoC framework: facilitating transition from ICD/DSM to dimensional approaches that integrate neuroscience and psychopathology. *World Psychiatry, 13*(1), 28-35. http://doi.org/10.1002/wps.20087

Dempsey, I., & Davies, M. (2013). National test performance of young Australian children with additional educational needs. *Australian Journal of Education, 57*(1), 5-18. http://doi.org/10.1177/0004944112468700

Elkins, J., Van Kraayenoord, C. E., & Jobling, A. (2003). Parents' attitudes to inclusion of their children with special needs. *Journal of Research in Special Educational Needs, 3*(2), 122-129. http://doi.org/10.1111/1471-3802.00005

Engel, G. L. (1977). The need for a new medical model: a challenge for biomedicine. *Science, 196*(4286), 129-136. http://doi.org/10.1037/h0089260

Forrest, C. B., Bevans, K. B., Riley, A. W., Crespo, R., & Louis, T. A. (2011). School outcomes of children with special health care needs. *Pediatrics, 128*(2), 303. http://doi.org/10.1542/peds.2010-3347

Goessl, V. C., Curtiss, J. E., & Hofmann, S. G. (2017). The effect of heart rate variability biofeedback training on stress and anxiety: a meta-analysis. *Psychological medicine, 47*(15), 2578-2586. http://doi.org/10.1017/S0033291717001003

Goldfeld, S., O'Connor, M., Sayers, M., Moore, T., & Oberklaid, F. (2012). Prevalence and correlates of special health care needs in a population cohort of Australian children at school entry. *Journal of Developmental & Behavioral Pediatrics, 33*(4), 319-327. http://doi.org/10.1097/DBP.0b013e31824a7b8e

Goldfeld, S., O'Connor, M., Quach, J., Tarasuik, J., & Kvalsvig, A. (2015). Learning trajectories of children with special health care needs across the severity spectrum. *Academic pediatrics, 15*(2), 177-184. http://doi.org/10.1016/j.acap.2014.09.001

Insel, T., Cuthbert, B., Garvey, M., Heinssen, R., Pine, D. S., & Quinn, K. (2010). Research domain criteria (RDoC): toward a new classification framework for research on mental disorders. *Am J Psychiatry, 167*. http://doi.org/10.1176/appi.ajp.2010.09091379

Insel, T. R. (2014). The NIMH research domain criteria (RDoC) project: precision medicine for psychiatry. *American Journal of Psychiatry, 171*(4), 395-397. http://doi.org/10.1176/appi.ajp.2014.14020138

Johnstone, L. (2018). Psychological formulation as an alternative to psychiatric diagnosis. *Journal of Humanistic Psychology, 58*(1), 30-46. http://doi.org/10.1177/0022167817722230

Klein, B., & Kraus de Camargo, O. (2018). *A Proposed Functional Abilities Classification Tool for Developmental Disorders Affecting Learning and Behaviour.* Paper presented at the Frontiers in Education.

Lawrence, D., Johnson, S., Hafekost, J., Boterhoven de Haan, K., Sawyer, M., Ainley, J., & Zubrick, S. R. (2015). The mental health of children and adolescents: report on the second Australian child and adolescent survey of mental health and wellbeing. Retrieved from: https://www1.health.gov.au/internet/main/publishing.nsf/Content/9DA8CA21306FE6EDCA257E2700016945/%24File/child2.pdf

Looman, W. S., O'Conner-Von, S. K., Ferski, G. J., & Hildenbrand, D. A. (2009). Financial and employment problems in families of children with special health care needs:

implications for research and practice. *Journal of Pediatric Health Care, 23*(2), 117-125. http://doi.org/10.1016/j.pedhc.2008.03.001

Lundahl, A., & Nelson, T. D. (2015). Sleep and food intake: A multisystem review of mechanisms in children and adults. *Journal of health psychology, 20*(6), 794-805. http://doi.org/10.1177/1359105315573427

Mavromaras, K. G., Moskos, M., & Mahuteau, S. (2016). *Evaluation of the NDIS: Intermediate report*: Department of Social Services.

McDowell, M., & O'Keeffe, M. (2012). Public services for children with special needs: discrimination by diagnosis? *Journal of paediatrics and child health, 48*(1), 2-5. http://doi.org/10.1111/j.1440-1754.2011.02394.x

McPherson, M., Arango, P., Fox, H., Lauver, C., McManus, M., Newacheck, P. W., . . . Strickland, B. (1998). A new definition of children with special health care needs. *Pediatrics, 102*(1), 137-139. http://doi.org/10.1542/peds.102.1.137

Miller, A., Shen, J., & Mâsse, L. C. (2016). Child functional characteristics explain child and family outcomes better than diagnosis: population-based study of children with autism or other neurodevelopmental disorders/disabilities. *Health reports, 27*(6), 9.

Newacheck, P. W., Strickland, B., Shonkoff, J. P., Perrin, J. M., McPherson, M., McManus, M., . . . Arango, P. (1998). An epidemiologic profile of children with special health care needs. *Pediatrics, 102*(1), 117-123. http://doi.org/10.1542/peds.102.1.117

Noam, G. G., & Hermann, C. A. (2002). Where education and mental health meet: Developmental prevention and early intervention in schools. *Dev Psychopathol, 14*(4), 861-875. http://doi.org/10.1017/S0954579402004108

O'Connor, M., O'Connor, E., Quach, J., Vashishtha, R., & Goldfeld, S. (2019). Trends in the prevalence and distribution of teacher-identified special health-care needs across three

successive population cohorts. *Journal of paediatrics and child health, 55*(3), 312-319. 319. http://doi.org/10.1111/jpc.14192

O'Connor, M., Quach, J., Goldfeld, S., Gold, L., Aston, R., Beatson, R., & Hopkins, D. (2015). *Approaches to the provision of educational support for children and young people with additional health and developmental needs: Autism Spectrum Disorder*s. Centre for Community Child Health, Melbourne, Victoria.

O'Grady, L., Quayle, A., Martin, L. Cavangh, S. (2017). Tackling Mental Heatlh in Primary Schools. *InPsych, 33*(3).

Ridley, C. R., Jeffrey, C. E., & Roberson III, R. B. (2017). Case mis-conceptualization in psychological treatment: An enduring clinical problem. *Journal of clinical psychology, 73*(4), 359-375. http://doi.org/10.1002/jclp.22354

Rydz, D., Shevell, M. I., Majnemer, A., & Oskoui, M. (2005). Topical review: developmental screening. *Journal of child neurology, 20*(1), 4-21. http://doi.org/10.1177/08830738050200010201

Rzepecka, H., McKenzie, K., McClure, I., & Murphy, S. (2011). Sleep, anxiety and challenging behaviour in children with intellectual disability and/or autism spectrum disorder. *Res Dev Disabil, 32*. http://doi.org/10.1016/j.ridd.2011.05.034

Selzer, R., & Ellen, S. (2014). Formulation for beginners. *Australasian Psychiatry, 22*(4), 397-401. http://doi.org/10.1177/1039856214536240

Skellern, C., Schluter, P., & McDowell, M. (2005). From complexity to category: responding to diagnostic uncertainties of autistic spectrum disorders. *Journal of paediatrics and child health, 41*(8), 407-412. http://doi.org/10.1111/j.1440-1754.2005.00634.x

State Government of Vicotria- Department of Education and Training (2016). Inclusive Education for All Students with Disabilities and Additional Needs. Retrieved from:

https://www.education.vic.gov.au/Documents/about/department/PSD-Review-Response.pdf

Taylor, S. P., & Epstein, S. (1967). The measurement of autonomic arousal: Some basic issues illustrated by the covariation of heart rate and skin conductance. *Psychosomatic Medicine, 29*(5), 514-525. http://doi.org/10.1097/00006842-196709000-00010

Van Dyck, P. C., Kogan, M. D., McPherson, M. G., Weissman, G. R., & Newacheck, P. W. (2004). Prevalence and characteristics of children with special health care needs. *Archives of pediatrics & adolescent medicine, 158*(9), 884-890. http://doi.org/10.1001/archpedi.158.9.884

Winters, N. C., Hanson, G., & Stoyanova, V. (2007). The case formulation in child and adolescent psychiatry. *Child and Adolescent Psychiatric Clinics, 16*(1), 111-132. http://doi.org/10.1016/j.chc.2006.07.010

World Health Organisation. (2001). *International classification of functioning, disability and health: ICF*: World Health Organization.

Appendix B

Participant Information Sheet- Department of Education

Participant Information Statement

Do You See What I See? The Role of Visual Attention in Learning

---

Research Project supervised by Professor Sheila G. Crewther from the School of Psychology and Public Health at La Trobe University

What is the purpose of the study? The project aims to examine how individual differences in personality affect visual and auditory attention, working memory, and information processing during development.

What will participants be asked to do? Participants will be asked to perform a number of paper-and-pen tasks and short computer-based tasks. Recording techniques such as eye tracking and electroencephalography (EEG) will also be conducted as part of this study. All tasks and techniques are detailed on page 3.

How will the study be conducted? Testing will take place in schools. The two testing sessions will take no longer than 1 hour. A number of short visual tasks will be completed, including a screening task to detect any visual anomalies (e.g., colour blindness) and a hearing test to ascertain adequate hearing. The parent/guardian of participants 17 and under will be asked to fill in a questionnaire.

Statement to be read to participants: "Would you like to help us by playing some computer games? If you get tired, you can rest, or stop playing." "Can I put this electrode on your head? It won't hurt you."

What are the risks of this study? There are no anticipated risks associated with participation in the study. There are no disadvantages, penalties or adverse consequences for not participating or for withdrawing from the research, at any time.

Exclusions Criteria of the study: Due to the flickering nature of some the stimuli used in this study any individual with a known history of epilepsy will be unable to participate in this study.

What are the benefits of this study? The major benefits to participants are a vision and auditory screening. The research will provide improved understanding of the factors underlying individual differences, and hence how better to educate individual participants.

How will the information collected be used? Where permission is granted by the participant or their parent/guardian, identifying information to allow the matching of a participant's data between current and future research projects may be securely held in the trust of the Chief Investigator. Results suggesting a need for more formal assessment by an appropriate professional will be reviewed by the Chief Investigator and communicated to the parents/guardians. Except where necessary for the circumstances outlined above, all participant names will be removed from the data, and group data will be analysed. Data will be securely stored at the university, and disposed of by shredding when no

longer in use. Data stripped of identifying personal information will be stored in electronic form for statistical analysis, and will be used in summary form in research papers. Individual data will never be identified except for vision and hearing screening results, which will be given to participants or to their parent, if the participant is a child.

Steps to take if you would like to cancel your consent: Please contact chief investigator, Professor Sheila Crewther, of La Trobe University within four weeks of the completion of your participant's participation in the project by e-mail (s.crewther@latrobe.edu.au) or telephone (9479-2290) if you wish to withdraw your consent for your participant's data to be used in this research project. Any questions regarding this project can also be directed to the investigator. If you have any complaints or queries that the investigator has not been able to answer to your satisfaction, you may contact the Secretary, Human Ethics Committee, Research Services, La Trobe University, Victoria, 3086, ph: 03 9479 1443, e-mail: humanethics@latrobe.edu.au. If any visual anomalies are detected, the participant or parent/guardian of the participant will be notified by the Chief Investigator and referred to an appropriate specialist. It is important to note, this study is not designed to assess ocular health or intelligence. Rather we are interested in what participants preferentially look at and how that can be used to help them educationally.

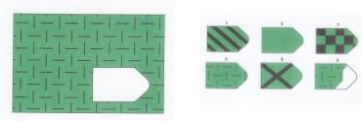
Who will be conducting the research?

Prof. Sheila G. Crewther (Professor in the School of Psychological Science at La Trobe University – Bundoora Campus), Dr Philippe Chouinard (Lecturer in the School of Psychological Science at La Trobe University – Bendigo Campus), Dr Nahal Goharpey (Postdoctoral fellow in the School of Psychological Science at La Trobe University) and Prof. David Crewther (Professor in the Brain Science Institute, Swinburne University of Technology) will be responsible for overseeing all testing. Other people who are involved in this project and help out in data collection include:

- Alyse Brown, PhD Candidate from La Trobe University, Melbourne
- Jessica Peters, PhD Candidate from La Trobe University, Melbourne
- Deena Ebaid, PhD Candidate from La Trobe University, Melbourne
- Talitha Ford, PhD Candidate from La Trobe University, Melbourne
- Daniel Crewther, Masters Candidate from La Trobe University, Melbourne
- Dr. Robin Laycock, Postdoctoral Fellow from La Trobe University, Melbourne
- Alan Jade Cross, Doctorate Candidate from La Trobe University, Melbourne.
- Chantanee Mungkhetklang, PhD Candidate from La Trobe University, Melbourne.
- Dr. Oriane Landry, Visiting Scholar from McMaster University, Canada.

If you have any complaints or concerns about your participation in the study that the researcher has not been able to answer to your satisfaction, you may contact the Senior Human Ethics Officer, Ethics and Integrity, Research Office, La Trobe University, Victoria, 308 (P: 039479 1443, E: humanethicsLatrobe.edu.au). Please quote the application reference number_FHEC-14071.

What type of tasks will my participant be asked to complete? Example provided below.

COMPUTER TASKS	
Visual and auditory based tasks 	Computer tasks will measure participant's reaction time and accuracy in detecting visual and/or auditory targets and ignoring distractions.
Eye Tracking 	An eye tracker (such as the one shown here: http://gazept.com/products/) will be used to assess gaze location, duration and tracking by monitoring eye movements using a sensor located at the bottom of a computer screen. This will enable us to determine where your participant is looking when they are reading and while they perform visual tasks.
PAPER AND PEN TASKS	
Visual Problem Solving 	Participants will be shown figures that have a piece missing, such as that shown on the left. They will be asked to select the missing piece of the puzzle from 6 possible choices. This task assesses ability to use vision to problem solve.
ELECTROPHYSIOLOGY TASKS	
Electroencephalography (EEG) 	Electroencephalography (EEG) measures brain waves by placing electrodes along the scalp. The technique measures tiny electrical fluctuations in the brain. These brain waves change as the brain performs different tasks. This measure is a routine clinical task and is totally safe.
Heart rate and blood pressure measure 	Heart rate and blood pressure measures will be taken by placing a devise around the wrist. This will provide us with a measure of level of arousal before and after task completion.
QUESTIONNAIRES	
Questionnaires 	Parents will be asked to complete questionnaires about their child's abilities in attention switching, attention to details, communication, imagination, social skills and sleep patterns. Adults will be asked to complete a questionnaire that measures individual personality traits.

Note:

- *Tasks designed to increase in difficulty will stop at a comfortable level for the participant.*
- *If a task seems inappropriate for a participant they will not be asked to do it.*

Appendix C

Participant Information Sheet- Catholic Education Victoria

Exploring Attention and Cognitive Development as Potential Predictors of Literacy

Research Project supervised by Professor Sheila G. Crewther from the School of Psychology & Public Health at La Trobe University and funded by La Trobe University.

What is the purpose of the study?

Children develop rapidly in their first years of life as brain maturation occurs. Thus, research is needed to investigate the development of cognition and changes in attention and their relationship with early literacy development in children aged 4-7 years. This knowledge will potentially enable earlier identification of children likely to develop learning problems.

What will children be asked to do and how will the study be conducted?

All <u>children</u> will be asked to:

- Complete a number of short paper and computer tasks that measure attention, intelligence, motor coordination, language, and memory skills known to be important in literacy development (tasks are outlined in more detail on pages 3-4).
- Have their eye movement's video recorded during some of the tasks noted above as eye movements are a measure of attention shifting.
- Complete a brief screen of visual acuity and colour vision. Where potential difficulties in these areas are detected, a follow-up screen is available.
- Complete the testing sessions individually at school during school hours, in the presence of another child and researcher. Testing will take place over a number of sessions and only when the child is willing and interested (a total of up to 1 hour 30 minutes).
- Children are invited to participate in future studies (see Consent Form), which will focus on re-testing their child on the same tasks, in order to investigate the nature of cognitive development. Children are under no obligation to take part in future studies.

All <u>parents</u> will be asked to:

- Complete and sign and attached consent form if you are willing for your child to participate in the research.
- Complete the attached questionnaires about your children. This provides us with valuable information about your child's development, language skills, anxiety levels, behaviours, and personality traits. All of these factors have the ability to affect cognitive development and learning.
- **If you consent for your child to participate, please return the completed consent form and the attached questionnaires (completed) to your child's classroom teacher/school office, no later than <u>four weeks</u> after receiving them.**

The following statement to be read to all participants:
"Would you like to play some activities and computer games with us? If you get tired to you can rest, or stop playing whenever you like."

What are the risks of this study?
There are no anticipated risks associated with participation in the study. There are no disadvantages, penalties, or adverse consequences for not participating or for withdrawing from the research.

What are the benefits of this study?
- Visual screening assessment results will be the immediate benefit to participants and their families. Where potential difficulties in this area are identified, a follow-up screen is available. These families will also receive a letter detailing the potential issues, and provided recommendations for follow-up (and for classroom learning).
- If parental consent is provided, a summary of your child's performance on standardised assessment tasks will be provided to classroom teachers, to aid their understand of your child's learning
- Overall knowledge obtained from this research will benefit schools and the wider educational community as it will potentially be used to develop educational tools and practices that will facilitate understanding of the attention mechanism that are fundamental to cognitive development.

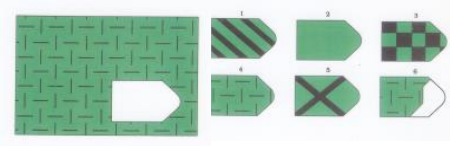
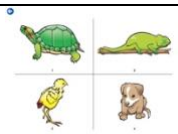
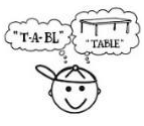
How will the information collected be used?
- All identifiable personal information (e.g. participant names) will be removed from the data, and group data will be analysed. Data will be securely stored at the University, and disposed of by shredding when no longer in use. Data stripped of identifying personal information will be stored in electronic form for statistical analysis, and may be used in summary form, in research theses, books, journals, and presented and recorded at conferences. Individual data will never be identifiable except for abnormal vision screening results, in which case a written referral will be given to the child to take home to their parent/guardian.
- Video recordings of eye position recorded by the eye tracker are only used immediately following the task to confirm the accuracy of the data and are not stored. The recordings only show each eye and not the participant's face, so as to ensure the anonymity of the participant is protected.
- If any visual anomalies are detected, the participant or parent/guardian of the participant will be notified by letter from the Chief Investigator (an Optometrist) and a referral to an appropriate specialist provided.
- A summary of the group research outcomes will also be provided to your child's principal/director to disseminate. In past research this summary has been included in school newsletters for parents/guardians to read and/or communicated to teachers. Where permission is granted by the parent/guardian, an individual child's outcomes may be communicated to their classroom teacher(s), literacy support teachers and/or principals.

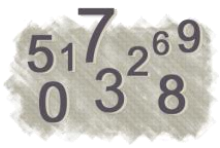
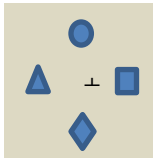
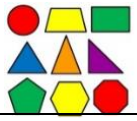
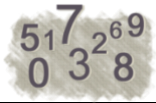
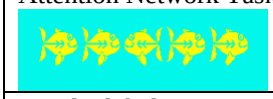
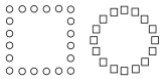
Steps to take if you would like to cancel your consent:
- Please contact Chief Investigator, Professor Sheila Crewther, of La Trobe University within four weeks of the completion of your child's participation in the project by e-mail (s.crewther@latrobe.edu.au) or telephone (03 9479 1035) if you wish to withdraw your consent for your child's data to be used in this research project. Any questions regarding this project can also be directed to the investigator.
- If you have any complaints or queries that the investigator has not been able to answer to your satisfaction, you may contact the Secretary, Human Ethics Committee, Research Services, La Trobe University, Victoria, 3086, ph: 03 9479 1443, e-mail: humanethics@latrobe.edu.au.

Who will be conducting the research?

- *Professor Sheila G. Crewther*, Professor of Neuroscience, is the Chief Research Investigator
- *Rana Alghamdi*, PhD candidate from La Trobe University
- *Hayley Pickering*, PhD candidate from La Trobe University
- *Areej Abdulrahman*, PhD candidate from La Trobe University
- *Jessica Peters*, PhD Candidate from La Trobe University
- *Laila Hugrass*, Research Associate (PhD) at La Trobe University
- *Dr Melanie Murphy*, Associate Lecturer (PhD) at La Trobe University
- *Rowena Bicknell*, Masters candidate from La Trobe University
- *Kate Mellody*, Honours candidate from La Trobe University
- *Larissa Roman*, from La Trobe University
- *Rebecca Ravenhill*, from La Trobe University
- *Alana Cross*, from La Trobe University
- *Dr Robin Laycock*, from La Trobe University and RMIT University

What tasks will my child be asked to complete?

Tasks	Procedure
PROBLEM SOLVING TASK	
Visual Problem Solving 	Children will be shown figures that have a piece missing, such as that shown on the left. They will be asked to select the missing piece of the puzzle from 6 possible choices. Children's eye movements will be recorded during this task. This task assesses visual problem solving ability. It will take around 5 minutes to complete.
VISUAL SCREENING TASKS	
Visual Screening: Snellen Chart and Ishihara pseudochromatic plate 	Children will be asked to look at and label shapes from a distance of two metres, using each eye individually. They will also be asked to look at colours numbers (pictured) and identify the numbers. This will indicate whether children have any basic visual abnormalities. This will take up to 5 minutes.
LANGUAGE TASKS	
Vocabulary 	Children will be asked to select one of four pictures that matches a spoken word (receptive vocabulary) or to provide a name or synonym for a picture (expressive vocabulary). There tasks assess vocabulary knowedlge and will take 10-20 minutes in total.
Reading Screen: Letter-Sound Knowledge 	Children will be asked to read 26 letters and 6 dithongs ("ch") and provide the appropriate sound. This will take less than 5-minutes.
Phonological Awareness 	Children will be asked remove an individual sound from a word (e.g. remove 'steam' from 'steamboat'?), and repeat made-up words. These tasks assess the child's phonological awareness, and take up to 10 minutes in total.
MOTOR TASKS	
Pegboard and balance board 	Children will be asked to place pegs in a pegboard as fast as possible, with only their left hand, followed by their right hand, then both hands. The task assesses hand motor dexterity and will take 2 minutes.

Slurp 	Slurp is an iPad app that asks children to trace shapes with their fingers rapidly and accurately. The activity assesses hand-eye coordination and will take around 2 minutes to complete.
MEMORY TASKS	
Memory 	Children will view or hear information (e.g., shapes, stories, numbers), and then will be asked to recall this information. These tasks provide a measure of children's ability to hold information in memory and recall it. Some tasks are re-administered up to 20 minutes later to assess long-term memory.
COMPUTER TASKS	
Visual Change Detection 	Children will view two images containing a number of objects displayed very quickly one after the other. In the second image, one aspect of the figure will have changed. The child is task to identify which part of the image has changed. This assesses the child's ability to detect change in visual stimuli. It will take around 3 minutes.
Visual Inspection Time 	Children will view a picture of a fish, truck, or butterfly, and asked to indicate which picture they have seen. This assesses the child's ability to rapidly identify visual stimuli. It takes around 3 minutes.
Track It 	Children will view a grid, and be asked to track shapes moving around that grid. After a time, the shape disappears, and the child is asked to recall where it has last been. This measures visual attention and will take around 5 minutes.
Visual Digit Span 	Children will view a series of numbers on a computer screen, and are asked to recall what they saw either in the same order, or in backward order.
Audio-Visual Task 	Children view a box to see if a light is flickering, and will also be listening for a sound. When either is presented (or both at once), the child is asked to press the space-bar as quickly as they can. This measure efficiency of children's auditory, visual, and audio-visual processing, and will take up to 5 minutes to complete.
Attention Network Task 	Children view a line of fish on the screen and have to identify which way the middle fish is facing.
Local/Global Processing Task 	Children view a large shape (square) made up of smaller shapes (circles), and are asked to respond to either the large shape or the small shape.
EYE MOVEMENTS	
Eye Tracker 	Children's eye movements will be video recorded during some of the tasks by an eye tracking bar at the bottom of the computer screen. Children will be able to use a chin rest to help keep still for the task.

Notes:

- Tasks designed to increase in difficulty will stop at a comfortable level for the child.
- If a task seems inappropriate for a child, they will not be asked to do it.
- Pictures are a guide only and the final task stimuli may look different.

Appendix D

Participant Consent Form

Consent Form - Guardian

Do You See What I See? The Role of Visual Attention in Learning

---

Research Project supervised by Professor Sheila G. Crewther from the School of Psychology and Public Health at La Trobe University

I _____ (the legal guardian of the participant) have read and understood the **Participant Information Statement and Consent Form**. I agree that _____ who was born on ____/___/____ for whom I am legal guardian may participate in the project, realising that I may withdraw my consent at any time, up to four weeks following the completion of participation in the research project. I agree that research data provided by me or with my permission during the project may be included in a thesis, presented at conferences, and published in journals on the condition that neither the participant's name nor any other identifying information is used.

Individuals with known epilepsy are not eligible for this study:
There is **no** history of epilepsy True/False

Name of Participant (block letters): ……..……

Name of Parent/ Guardian (block letters): ……..……

Signature: ……..……. **Date:** …….

.

Name of Investigator (block letters): Professor Sheila Crewther

Signature: ……..…. Date: ……

Appendix E

Spence Children's Anxiety Scale (Parent Report)

Your Name:
Your Child's Name:
Date:
Below is a list of items that describe children, for each item please circle the response that best describes your child. Please answer all the items.

1. My child worries about things	Never	Sometimes	Often	Always
2. My child is scared of the dark	Never	Sometimes	Often	Always
3. When my child has a problem, s(he) complains of having a funny feeling in his/ her stomach	Never	Sometimes	Often	Always
4. My child complains of being afraid	Never	Sometimes	Often	Always
5. My child would feel afraid of being on his/her own at home	Never	Sometimes	Often	Always
6. My child is scared when s(he) has to take a test	Never	Sometimes	Often	Always
7. My child is afraid that (she)he will make a fool of him/herself in front of people	Never	Sometimes	Often	Always
8. My child worries about being away from us/me	Never	Sometimes	Often	Always
9. My child feels afraid that (s)he will make a fool of him/herself in front of people	Never	Sometimes	Often	Always
10. My childhood worries that (s)he will do badly at school	Never	Sometimes	Often	Always
11. My child worries that something awful will happen to someone in our family	Never	Sometimes	Often	Always
12. My child complains of suddenly as if (s)he can't breathe when there is no reason for this	Never	Sometimes	Often	Always
13. My child has to keep checking that (s)he has done things right (like the switch off, or the door is locked)	Never	Sometimes	Often	Always

14. My child is scared if (s)he has to sleep on his/her own	Never	Sometimes	Often	Always
15. My child has trouble going to school in the mornings because (s)he feels nervous or afraid	Never	Sometimes	Often	Always
17. My child can't seem to get bad or silly thoughts out of his/ her head	Never	Sometimes	Often	Always
18. When my child has a problem, s(he) complains of his/her heart beating really fast	Never	Sometimes	Often	Always
19. My child suddenly starts to tremble or shake when there is no reason for this	Never	Sometimes	Often	Always
20. My child worries that something will happen to him/her	Never	Sometimes	Often	Always
21. My child is scared of going to the doctor or dentist	Never	Sometimes	Often	Always
22. When my child has a problem, (s)he feels shaky	Never	Sometimes	Often	Always
23. My child is scared of heights (e.g. being at the top of a cliff)	Never	Sometimes	Often	Always
24. My child has to think special thoughts (like numbers or words) to stop bad things from happening	Never	Sometimes	Often	Always
25. My child feels scared if (s)he has to travel in the car, or on a bus or train	Never	Sometimes	Often	Always
26. My child worries what other people think of him/ her	Never	Sometimes	Often	Always
27. My child is afraid of being in crowded places (like shopping centres, the movies, buses, busy playgrounds)	Never	Sometimes	Often	Always
28. All of a sudden my child feels really scared for no reason at all	Never	Sometimes	Often	Always
29. My child is scared of inspects or spiders	Never	Sometimes	Often	Always
30. My child complains of suddenly becoming dizzy or faint when there is no reason for this	Never	Sometimes	Often	Always
31. My child feels afraid when (s)he has to talk in front of the class	Never	Sometimes	Often	Always

32. My child complains of his/her heart suddenly starting to beat too quickly for no reason	Never	Sometimes	Often	Always
33. My child worries that (s)he will suddenly get a scared feeling when there is nothing to be afraid of	Never	Sometimes	Often	Always
34. My child is afraid of being in small closed places, like tunnels or small rooms	Never	Sometimes	Often	Always
35. My child has to do some thigs over and over again (like washing his/her hands, cleaning or putting things in a certain order)	Never	Sometimes	Often	Always
36. My child gets bothered by bd or silly thoughts or pictures in his/her head	Never	Sometimes	Often	Always
37. My child has to do certain things in just the right way to stop bad things from happening	Never	Sometimes	Often	Always
38. My child would feel scared if (s)he had to stay away from home overnight	Never	Sometimes	Often	Always
39. Is there anything else that your child is really afraid off?	YES		NO	
Please write down what it is, and fill out how often (s)he is afraid of this thing:	Never	Sometimes	Often	Always

Appendix F

The Autism Spectrum Quotient: Children's Version (AQ – Child)

NOTE: This questionnaire is to be completed by the parent/guardian of each child aged 4 and above. Please complete all three pages.

Name ……
Date of Birth (Month in words) ……... Today's date (Month in words)……
Address……

Please answer each of the following questions about your child or the person who is under your care by ticking a box that reflects your answer to the question most appropriately. If there is any question that you feel not able to comment, please ask your son, daughter, partner or the person to answer.

	Definitely Agree	Slightly Agree	Slightly Disagree	Definitely Disagree
40. S/he prefers to do things with others rather than on her/his own.				
41. S/he prefers to do things the same way over and over again.				
42. If s/he tries to imagine something, s/he finds it very easy to create a picture in her/his mind.				
43. S/he frequently gets so strongly absorbed in one thing that s/he loses sight of other things.				
44. S/he often notices small sounds when others do not.				
45. S/he usually notices house numbers or similar strings of information.				
46. S/he has difficulty understanding rules for polite behaviour.				
8. When s/he is read a story, s/he can easily imagine what the characters might look like.				
9. S/he is fascinated by dates.				
10. In a social group, s/he can easily keep track of several different people's conversations.				
11. S/he finds social situations easy.				
12. S/he tends to notice details that others do not.				

13. S/he would rather go to a library than a birthday party.				
14. S/he finds making up stories easy.				
15. S/he is drawn more strongly to people than to things.				
16. S/he tends to have very strong interests, which s/he gets upset about if s/he can't pursue.				
17. S/he enjoys social chit-chat.				
18. When s/he talks, it isn't always easy for others to get a word in edgeways.				
19. S/he is fascinated by numbers.				
20. When s/he is read a story, s/he finds it difficult to work out the characters' intentions or feelings.				
21. S/he doesn't particularly enjoy fictional stories.				
22. S/he finds it hard to make new friends.				
23. S/he notices patterns in things all the time.				
24. S/he would rather go to the cinema than a museum.				
25. It does not upset him/her if his/her daily routine is disturbed.				
26. S/he doesn't know how to keep a conversation going with her/his peers.				
27. S/he finds it easy to "read between the lines" when someone is talking to her/him.				
28. S/he usually concentrates more on the whole picture, rather than the small details.				
29. S/he is not very good at remembering phone numbers.				
30. S/he doesn't usually notice small changes in a situation, or a person's appearance.				
31. S/he knows how to tell if someone listening to him/her is getting bored.				

32. S/he finds it easy to go back and forth between different activities.				
33. When s/he talk on the phone, s/he is not sure when it's her/his turn to speak.				
34. S/he enjoys doing things spontaneously.				
35. S/he is often the last to understand the point of a joke.				
36. S/he finds it easy to work out what someone is thinking or feeling just by looking at their face.				
37. If there is an interruption, s/he can switch back to what s/he was doing very quickly.				
38. S/he is good at social chit-chat.				
39. People often tell her/him that s/he keeps going on and on about the same thing.				
40. When s/he was in preschool, s/he used to enjoy playing games involving pretending with other children.				
41. S/he likes to collect information about categories of things (e.g. types of car, types of bird, types of train, types of plant, etc.).				
42. S/he finds it difficult to imagine what it would be like to be someone else.				
43. S/he likes to plan any activities s/he participates in carefully.				
44. S/he enjoys social occasions.				
45. S/he finds it difficult to work out people's intentions.				
46. New situations make him/her anxious.				
47. S/he enjoys meeting new people.				
48. S/he is good at taking care not to hurt other people's feelings.				
49. S/he is not very good at remembering people's date of birth.				
50. S/he finds it very to easy to play games with children that involve pretending.				

Appendix G

Sleep Disturbance Scale for Children

Appendix A. SLEEP DISTURBANCES SCALE FOR CHILDREN

***INSTRUCTIONS**: This questionnaire will allow to your doctor to have a better understanding of the sleep-wake rhythm of your child and of any problems in his/her sleep behaviour. Try to answer every question; in answering, consider each question as pertaining to the **past 6 months** of the child's life. Please answer the questions by circling or striking the number ① to ⑤.* Thank you very much for your help.

Name:_____ Age:_____ Date:_____

1. How many hours of sleep does your child get on most nights.	① *9-11 hours*	② *8-9 hours*	③ *7-8 hours*	④ *5-7 hours*	⑤ *less than 5 hours*
2. How long after going to bed does your child usually fall asleep	① *less than 15'*	② *15-30'*	③ *30-45'*	④ *45-60'*	⑤ *more than 60'*

					⑤ **Always (daily)**
				④ **Often (3 or 5 times per week)**	
			③ **Sometimes (once or twice per week)**		
		② **Occasionally (once or twice per month or less)**			
	① **Never**				
3. The child goes to bed reluctantly	①	②	③	④	⑤
4. The child has difficulty getting to sleep at night	①	②	③	④	⑤
5. The child feels anxious or afraid when falling asleep	①	②	③	④	⑤
6. The child startles or jerks parts of the body while falling asleep	①	②	③	④	⑤
7. The child shows repetitive actions such as rocking or head banging while falling asleep	①	②	③	④	⑤
8. The child experiences vivid dream-like scenes while falling asleep	①	②	③	④	⑤
9. The child sweats excessively while falling asleep	①	②	③	④	⑤
10. The child wakes up more than twice per night	①	②	③	④	⑤
11. After waking up in the night, the child has difficulty to fall asleep again	①	②	③	④	⑤
12. The child has frequent twitching or jerking of legs while asleep or often changes position during the night or kicks the covers off the bed.	①	②	③	④	⑤
13. The child has difficulty in breathing during the night	①	②	③	④	⑤
14. The child gasps for breath or is unable to breathe during sleep	①	②	③	④	⑤
15. The child snores	①	②	③	④	⑤
16. The child sweats excessively during the night	①	②	③	④	⑤
17. You have observed the child sleepwalking	①	②	③	④	⑤
18. You have observed the child talking in his/her sleep	①	②	③	④	⑤
19. The child grinds teeth during sleep	①	②	③	④	⑤
20. The child wakes from sleep screaming or confused so that you cannot seem to get through to him/her, but has no memory of these events the next morning	①	②	③	④	⑤
21. The child has nightmares which he/she doesn't remember the next day	①	②	③	④	⑤
22. The child is unusually difficult to wake up in the morning	①	②	③	④	⑤
23. The child awakes in the morning feeling tired	①	②	③	④	⑤
24. The child feels unable to move when waking up in the morning	①	②	③	④	⑤
25. The child experiences daytime somnolence	①	②	③	④	⑤
26. The child falls asleep suddenly in inappropriate situations	①	②	③	④	⑤

Disorders of initiating and maintaining sleep (sum the score of the items 1,2,3,4,5,10,11)	
Sleep Breathing Disorders (sum the score of the items 13,14,15)	
Disorders of arousal (sum the score of the items 17,20,21)	
Sleep-Wake Transition Disorders (sum the score of the items 6,7,8,12,18,19)	
Disorders of excessive somnolence (sum the score of the items 22,23,24,25,26)	
Sleep Hyperhydrosis (sum the score of the items 9,16)	
Total score (sum 6 factors' scores)	