

Corpus callosum morphology and function in attention deficit hyperactivity
disorder and the relationship between the corpus callosum and cognitive
functioning in healthy adults

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Table of Contents

Abstract	7
Declaration	11
Acknowledgements	13
Statements of the contributions on jointly authored papers	15
Permission for the use of published papers and manuscripts submitted for peer review and publication	18
Chapter 1: Introduction	21
1.1 The Corpus Callosum	21
1.1.1 Measurement of the corpus callosum.	23
1.1.2 Gender differences.	29
1.1.3 Role of the corpus callosum in attention.	29
1.2 Attention Deficit Hyperactivity Disorder	34
1.2.1 Diagnosis of childhood ADHD.	34
1.2.2 Diagnosis of adult ADHD.	35
1.2.3 Prevalence of ADHD.	37
1.2.4 Comorbidities.	39
1.2.5 Treatment.	40
1.2.6 Causal models of ADHD.	44
1.2.7 Methodological issues.	52
1.3 ADHD and the Corpus Callosum	55
1.4 The Corpus Callosum and Cognitive Performance	59
1.5 General Summary	64
1.5.1 Gaps in the Current Literature.	65
1.5.2 Aims.	66

Chapter 2: Corpus Callosum Morphology in Children and Adolescents with Attention Deficit Hyperactivity Disorder: a Meta-analytic Review	69
Chapter 3: Corpus Callosum Size and Integrity in Adults with Attention Deficit Hyperactivity Disorder	111
Chapter 4: Relationship Between Intelligence and the Size and Composition of the Corpus Callosum	163
Chapter 5: Discussion	201
5.1 Corpus Callosum Morphology in ADHD	202
5.1.1 The splenium.	202
5.1.2 The rostral body.	204
5.1.3 The midbody.	204
5.2 The Relationship Between Corpus Callosum Morphology and IQ	205
5.2.1 IQ and CC area.	205
5.2.2 IQ and FA of the CC.	207
5.3 Limitations	208
5.4 Recommendations for future research	211
5.5 Conclusions	213
References	214
Appendix A: Corpus Callosum Morphology in Children and Adolescents with Attention Deficit Hyperactivity Disorder: a Meta-analytic Review	249
Appendix B: Supplementary Material - Corpus Callosum Morphology in Children and Adolescents with Attention Deficit	259

Hyperactivity Disorder: a Meta-analytic Review	
Appendix C: Supplementary Material - Corpus Callosum Size and Integrity in Adults with Attention Deficit Hyperactivity Disorder	267
Appendix D: Relationship Between Intelligence and the Size and Composition of the Corpus Callosum	269
Appendix E: Supplementary Material - Relationship Between Intelligence and the Size and Composition of the Corpus Callosum	279

Abstract

The corpus callosum (CC) is the largest fiber¹ tract in the brain and connects homological regions of the two cerebral hemispheres. Research with split-brain patients, whose CC has been surgically severed, and neurologically intact groups has shown that the CC is important for sustained and divided attention. Due to its role in attention, the CC is of interest to clinical conditions in which attention is affected, such as attention deficit hyperactivity disorder (ADHD).

Although the size of the CC has been examined in children and adolescents with ADHD, the results have been inconsistent. Therefore, the first of three studies in this thesis synthesized the current research in a meta-analysis, which analyzed the data from 13 studies that examined CC area in children and adolescents with ADHD, when compared to healthy controls. This study found that the splenium, the most posterior region of the CC, was smaller in ADHD and the rostral body, an anterior region, was smaller in boys with ADHD compared with controls. Thus, there is evidence for differences in area in both the anterior and posterior regions of the CC in ADHD.

It was not known whether these differences persist into adulthood, however, because CC size had not been examined in adults with ADHD. Therefore, the second study examined CC area and structural integrity in young adults with ADHD compared with healthy controls using magnetic resonance imaging (MRI) and diffusion tensor imaging (DTI), respectively. The difference in the size of the splenium was not present in this adult sample,

¹ American spelling is used throughout the thesis in order to be consistent with the published papers which have been published or prepared using American spelling.

although the genu (an anterior region of the CC) was smaller and two mid-posterior regions were larger in adults with ADHD when compared with controls. In addition, a reduction in the integrity of the genu and greater integrity in the splenium was found in ADHD.

The relationship between CC morphology and measures of attention and IQ was also examined in young adults with ADHD and controls in order to assess the functional significance of differences in the CC. The integrity of the splenium was correlated with performance on the Stroop task, which requires attentional control. Hence, this study indicated that the morphology of the CC is atypical in young adults with ADHD and that these differences in the CC may impact on cognitive functioning. Interestingly, an estimate of performance IQ was negatively correlated with CC area in controls. This result conflicts with previous research on the relationship between IQ and the CC in healthy adults although the literature has yielded inconsistent findings.

The third study, therefore, examined the relationship between IQ and both CC area and integrity in more detail in a larger sample of young adults. A negative correlation was found between the area of posterior regions of the CC and an estimate of performance IQ, while an estimate of verbal IQ was associated with decreased structural integrity in the genu. This study supports the hypothesis that differences in CC size and or integrity may have cognitive consequences.

In summary, this thesis confirms the view that the development of the CC is atypical in children and young adults with ADHD. In addition, differences in CC integrity were associated with cognitive functioning in

young adults with ADHD. Finally, the morphology of the CC is related to cognitive performance in healthy adults.

Declaration

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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Date

* Published Works

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“Every new beginning comes from some other beginning's end”

Closing Time, Semisonic

Statements of the contributions on jointly authored papers

Chapter 2

Title: Corpus callosum morphology in children and adolescents with attention deficit hyperactivity disorder: a meta-analytic review.

Co-authors: J.L. Mathias, M.T. Banich

Contributions: Both co-authors acted in a supervisory capacity during all stages of this research and manuscript preparation. I was responsible for this study's inception and design, data-collection, statistical analyses, data interpretation, and manuscript preparation, under the supervision of J.L. Mathias and M.T. Banich.

Chapter 3

Title: Corpus callosum size and integrity in adults with attention deficit hyperactivity disorder

Co-authors: J.L. Mathias, B.L. Jacobson, L. Ruzic, A.N. Bond, E. Willcutt, L.C. Bidwell, Y.P. Du and M.T. Banich

Contributions: B.L. Jacobson developed the semi-automated algorithm that was used to trace the corpus callosum from the MRIs performed on study participants. L.T. Ruzic processed the imaging data using FSL and ascertained measures of FA from the DTI data. A.N. Bond conducted traces of the corpus callosum in order to allow the inter-rater reliability of the tracing technique to be evaluated. E. Willcutt and L.C. Bidwell were involved in participant recruitment, screening and neuropsychological data collection. Y.P. Du helped with Magnetic Resonance acquisition, writing the pulse

sequence for data acquisition, and initial analyses. J.L. Mathias and M.T. Banich acted in a supervisory capacity and guided all stages of this work, including manuscript preparation. I was responsible for this study's inception and design, completed all traces of the corpus callosum (excluding those completed by A.N. Bond for the analysis of inter-rater reliability), conducted all statistical analyses and data interpretation, and was the primary author on this paper.

Chapter 4

Title: Relationship between intelligence and the size and composition of the corpus callosum.

Co-authors: J.L. Mathias, B.L. Jacobson, L. Ruzic, A.N. Bond and M.T.

Banich

Contributions: B.L. Jacobson developed the semi-automated algorithm used to trace the corpus callosum. L.T. Ruzic processed the imaging data using FSL and ascertained measures of FA from the DTI data. A.N. Bond conducted traces of the corpus callosum in order to allow the inter-rater reliability of the tracing procedure to be evaluated. J.L. Mathias and M.T. Banich acted in a supervisory capacity and guided all stages of this work, including manuscript preparation. I was responsible for this study's inception and design, completed all traces of the corpus callosum (excluding those completed by A.N. Bond for the analysis of inter-rater reliability), undertook all statistical analyses and data interpretation, and was the primary author on this paper.

The undersigned agree that the statements made regarding author contributions are accurate and true.

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Disorder: a meta-analytic review. *Neuropsychology*, 22(3), 341-349.

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Chapter 4

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