Cognitive Functioning and Academic Performance in Elementary School Children with Anxious/Depressed and Withdrawn Symptoms

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Abstract: *Rationale*: Few studies have evaluated the relationship between depressive symptomatology and neuropsychological performance in children without symptomatic depression.

Objectives: This study determined the relationship between anxious/depressed and withdrawn symptoms and performance on cognitive and academic achievement measures.

Methods: 335 Caucasian and Hispanic children aged 6 to 11 years who participated in the Tucson Children's Assessment of Sleep Apnea (TuCASA) study were administered a comprehensive neuropsychological battery measuring cognitive functioning and academic achievement. Their parents completed the Child Behavior Checklist (CBCL). Correlations between performance on the cognitive and academic achievement measures and two Internalizing scales from the CBCL were calculated. Comparisons were made between a "Clinical" referral group (using a *T*-score of $\geq$ 60 from the CBCL scales) and a "Normal" group, as well as between Caucasians and Hispanics.

Results: No differences were found between those participants with increased anxious/depressed or withdrawn symptoms on the CBCL and those without increased symptoms with respect to age, gender, ethnicity, or parental education level. However, significant negative correlations were found between these symptoms and general intellectual function, language, visual construction skills, attention, processing speed, executive functioning abilities, aspects of learning and memory, psychomotor speed and coordination, and basic academic skills.

Conclusions: These findings support the hypothesis that depressive symptomatology negatively impacts performance on cognitive and academic achievement measures in school-aged children and these findings are not affected by ethnicity. The findings also reinforce the concept that the presence of anxious/depressed or withdrawn symptoms needs to be considered when evaluating poor neuropsychological performance in children.

Keywords: Cognitive, anxious, depressed.

INTRODUCTION

Educators, researchers, and health care providers working with children have long been interested in understanding what causes children with average intelligence to suffer from academic underachievement, particularly when these academic difficulties are not the result of physical, environmental, or behavioral problems. Childhood depression may provide a causal link. Emotional distress, disrupted cognitive functioning, and deterioration in academic performance have all been theorized to be possible results of depression. Specific clinical features of depression such as reduced attention span, lethargy, poor concentration and memory, as well as abridged task perseverance are all factors that have emerged as obstacles to effective learning. Furthermore, poor academic performance has been associated with an increase in social and behavioral problems [1].

Despite initial test results finding normal intelligence and satisfactory early academic achievement, children with depressive symptomatology can manifest poor academic performance over time. Poor classroom performance is consistently demonstrated in children with depressive symptoms when no other intervening learning disability is present [2]. Negative correlations between severity of depressive symptoms and intelligence scores, particularly by adolescence, have also been reported [3, 4]. Similarly, a weaker performance on a variety of measures assessing cognitive functioning has been observed in cohorts of children with symptoms of depression including visual spatial perception [4] and problem-solving tasks [5] as well as various aspects of memory such as verbal memory [6] and

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list learning tasks [7, 8], working memory [9], short-term memory processing and immediate recall [6, 10], and metamemory [8]. Likewise, slowed cognitive response time [11], decreased motor speed [2, 9, 12], and poor coordination [4, 13] have been reported. These children have also exhibited a weaker performance on academic achievement measures including mathematics and knowledge clusters [14] and reading abilities [15]. In addition, behavioral manifestations of depression including attention difficulties [4, 16-19], poor concentration and motivation [12, 19, 20], and behavior problems [4] have been observed.

Although previous studies have linked depressive symptomatology to subsequent poor academic achievement, there is also some evidence to suggest that academic problems result in the development of depression caused by negative reinforcement from parents, peers, and teachers. Whether depressive symptoms are primary or secondary, children with depression manifest poor self-esteem, and consequently, have lower expectations of themselves, further contributing to weaker academic performance.

Overall, the literature suggests that depressive symptoms appear to have considerable predictive power with respect to cognitive functioning, academic performance, and overall emotional adjustment. However, most studies have used clinically derived cohorts with greater severity of depressive symptomatology including in-patients [6-8, 10, 14] and/or children being treated for depression [1-5, 15]. Thus, there have been relatively few studies that have been performed in a general population of children who have not been selected for depressive symptoms alone.

The TuCASA study is a prospective observational cohort study of Caucasian and Hispanic elementary school aged children designed to determine the incidence and prevalence of sleep disordered breathing (SDB) and to assess its impact on a variety of cognitive and physiologic outcomes. Inasmuch as the participants were not selected on the basis of the presence or absence of psychopathology, it potentially provides a means of determining the association between depression, and cognitive functioning and academic achievement, in a general population of children as well as to assess whether there are differences between Caucasians and Hispanics. We hypothesized that children with depressive symptoms as defined by elevated scores on the Anxious/Depressed and Withdrawn Internalizing scales from the CBCL would have weaker performances on a variety of neuropsychological measures than children without these symptoms, and that the impact of depressive symptomatology would differ between Caucasians and Hispanics.

MATERIALS AND METHODOLOGY

Participants

Participants were 335 children who took part in the initial examination of the TuCASA study. Participants underwent an unattended home polysomnogram (PSG) and completed a cognitive evaluation and behavioral assessment. A detailed description of the recruitment and enrollment of the TuCASA cohort has been previously published [21]. Briefly, Hispanic and Caucasian children ages 6 to 11 were recruited from a large public school district (Tucson Unified School District, TUSD) between 1999-2003. TUSD has a population representative of children living in Southern Arizona. The University of Arizona Human Subjects Committee and the TUSD Research Committee approved the TuCASA study. At the time of initial contact, parents of children in participating schools were asked to complete a short screening questionnaire inquiring about sleep habits related to bedtime behaviors that could be attributable to breathing problems during sleep. Additionally, parents were asked to provide contact information if they would allow study personnel to call them for further participation. Approximately 33% (n = 2327/7055) of the families who were sent questionnaires returned them, and of those families, 52% (n = 1210) provided their contact information [21]. During a phone screening, parents were asked about their child's medical history to see if the child qualified for the study. Children with a parent-reported history of asthma or respiratory disorders, head injury with loss of consciousness, formally diagnosed attention deficit hyperactivity disorder (ADHD), learning disabilities or developmental disorders (including mental retardation), and other major medical conditions were excluded from the study. Children with known sleep problems, previous tonsillectomies, or who regularly took stimulant medication for ADHD were also excluded. All parents provided IRB-approved parental consent and the children completed assent forms before participating in the study.

Neuropsychological evaluations were conducted approximately one month after the PSG and evaluators were blinded to PSG findings. Parents finished a behavioral assessment by completing the CBCL for Ages 6-18 [22] at the time of their child's neuropsychological evaluation. Children who did not speak English were excluded from this portion of the TuCASA study since evaluation measures were only appropriate for English speakers. Approximately 95% (n = 343) of children who completed PSG studies also participated in the neuropsychological and behavioral assessment portion of the study. Evaluations were conducted in the Pediatric Neuropsychology Clinic at the University of Arizona. Families were compensated $25.00 for participation and parking fees were paid.

Neuropsychological Test Battery

The measures administered to the children were completed in a fixed order. The Wechsler Abbreviated Scale of Intelligence (WASI) [23], a brief and reliable measure of global intellectual function, was used to facilitate characterization of the study participants by obtaining measures of Full Scale IQ (Full Four IQ), Verbal IQ, and Performance IQ. The WASI uses age-based standard scores for composites, with a mean of 100 and standard deviation of 15; higher scores indicate better performance.

Language was assessed with the Vocabulary subtest from the WASI, a task requiring the subject to provide verbal definitions of words. Visual construction skills using colored blocks were evaluated with the Block Design subtest from the WASI.

Executive function abilities were evaluated using measures that require attention and higher order problem solving. More specifically, Similarities and Matrix Reasoning subtests from the WASI were administered as

they require superordinate concept formation and the completion of abstract visual spatial patterns, respectively. Individual WASI subtests use age-based *T*-scores, with a mean of 50 and a standard deviation of 10; higher scores indicate better performance. In addition, Trail Making Part A and Trail Making Part B [24] were used to assess executive function skills as they require conceptual tracking and rapid set-shifting ability by connecting consecutive numbers and numbers and letters in an alternating sequence, respectively. The Trail Making tests use age-corrected *z* scores, which have a mean of 0 and standard deviation of 1; lower scores indicate faster completion time. Animal Fluency from the Controlled Oral Word Association Task [25], a semantic fluency task in which children were asked to name as many animals as possible in a minute, was also administered to assess executive function abilities. Animal Fluency uses an age-corrected *z* score with a mean of 0 and standard deviation of 1; on this measure a higher score indicates better fluency (i.e., more animals named).

The Children's Auditory Verbal Learning Test-2 (CAVLT-2) [26] was administered to assess verbal learning of and memory for novel information learned within the evaluation setting. This multi-trial word list learning task provides age based standard scores, with a mean of 100 and standard deviation of 15; higher scores indicate better performance for each of the following: five list learning trials, overall learning across trials (Level of Learning), recall of a second word list (Interference Trial) presented after the learning trials, immediate and delayed recall of the original list, and a recognition of the list.

Attention and processing speed were evaluated with Digit Span, Coding, and Symbol Search subtests from the Wechsler Intelligence Scale for Children-Third Edition [27]. The WISC-III subtests use age-based scaled scores, with a mean of 10 and a standard deviation of 3; higher scores indicate better performance.

Psychomotor speed and coordination were assessed with the Purdue Pegboard [28]. The Purdue Pegboard uses age-corrected *z* scores which have a mean of 0 and standard deviation of 1; lower scores indicate faster completion time.

The Woodcock-Johnson Psycho-Educational Battery-Revised Tests of Achievement (WJ-R) [29] academic achievement measures were used to assess learning of and memory for academic information learned prior to and outside of the evaluation setting. The WJ-R uses age-based standard scores with a mean of 100 and standard deviation of 15; higher scores indicate better performance. Letter-Word Identification assesses letter and single word reading. Applied Problems assesses math skills. Dictation is a measure of spelling, punctuation, grammar, and word usage.

Behavioral function was evaluated with the CBCL, a standardized parent report questionnaire. The CBCL includes 118 items that parents' rate on a three-point scale (Not True, Somewhat True, or Very/Often True). In addition to eight syndrome scales, the CBCL includes a Total problem score and higher-order Internalizing and Externalizing scales. We used two of the Internalizing scales, Anxious/Depressed and Withdrawn, each of which describes a cluster of symptoms, in this analysis. The CBCL yields age-and gender-based *T*-scores, with a mean of 50 and standard deviation of 10. For internal and external problems, *T*-scores $\geq$ 60 are considered within the borderline/clinical referral range, with higher scores representing more significant problems in those areas.

Sleep Variables

On the night of the home visit, a parent was asked to complete a detailed Sleep Habits Questionnaire (SHQ). Difficulty initiating and maintaining sleep (INSOM) was present if the parents reported that their child had trouble falling asleep, staying asleep, did not get enough sleep, or was troubled by waking up too early and not being able to get back to sleep. Snoring was present if it occurred every night or on most nights.

As we have done in previous analyses, the respiratory disturbance index (RDI) was defined as the number of respiratory events (apneas and hypopneas) per hour of the total sleep time. For this analysis, a 3% oxygen desaturation was required for an event to be counted in the total RDI. We considered a child to have SDB if their RDI was greater than or equal to 1 event per hour of total sleep time [30]. Use of this definition is supported by previous evidence that a RDI of 1, based on events with a 3% oxygen desaturation, is clinically significant.

Analyses

Chi-square tests were performed to determine group differences on categorical variables including age, gender, ethnicity, and parent education level. Pearson correlation coefficients were used to indicate the relationship between the selected CBCL clinical scales, Anxious/Depressed and Withdrawn, and the cognitive and academic achievement measures.

To further explore the relationship between children with depressive symptoms and their cognitive and academic achievement, participants were assigned to one of two groups according to their *T*-scores. Those who had scores on the Anxious/Depressed and Withdrawn clinical scales greater than or equal to 60 were placed in the borderline or clinical referral category (Clinical) whereas those with scores less than 60 were in the normal category (Normal). Mean differences in cognitive and academic achievement measures between subjects who were within the borderline/clinical referral range on the Anxious/Depressed and Withdrawn clinical scales and those who were normal were compared using t-tests. Analyses also were repeated after stratification by ethnicity, age, and gender as well as after exclusion of children with SDB or insomnia. All statistical procedures were conducted using Intercooled Stata version 9.0 for Windows or SPSS 15.0 for Windows. A significance alpha level of 0.05 was used for all statistical tests. Correction for multiple comparisons was not performed because we were making independent *apriori* hypotheses that the independent variables, Anxious/Depressed or Withdrawn symptomatology, were associated with each of the neuropsychological measures used.

RESULTS

As shown in Table **1**, there were 335 participants, with approximately equal gender distribution. However, the percent of children aged 6 to 8 years was slightly less than

those who were aged 9 to 11 years (46% *vs* 54%). Additionally, there were nearly twice as many Caucasian than Hispanic children (63% *vs* 37%). In general, the parents were well educated with 64% having more than a high school education.

Table 1. Characteristics of Sampled Subjects

Sample Characteristics	Total Sample Size (N) = 335	
	N	%
Gender		
Boys	163	49
Girls	172	51
Age Category		
6-8 years old	155	46
9-11 years old	180	54
Ethnicity		
Caucasian	210	63
Hispanic	125	37
Parent Education*		
8 years or less	7	2
9-12 years	111	34
13-24 years	212	64

Correlations between symptoms assessed by the CBCL scales and measures of cognitive and academic achievement indicators for the entire cohort are presented in Table **2**. Significant negative correlations were found between both the Anxious/Depressed and Withdrawn clinical scales of the CBCL and two components of global intellectual function as assessed by the WASI. Specifically, the WASI Performance IQ was negatively correlated with anxious/depressed symptomatology (r = -0.14, p = 0.01) and WASI Verbal IQ was negatively correlated with withdrawn symptomatology (r = -0.11, p = 0.04). Symptoms on the Anxious/Depressed and Withdrawn clinical scales were also correlated with WASI Full Scale IQ. There also was a negative correlation between symptoms on both the Anxious/Depressed and Withdrawn clinical scales and language as assessed by the Vocabulary subtest of the WASI (r = -0.13, p = 0.02; r = -0.15, p = 0.00, respectively). Moreover, as shown in Table **2**, negative correlations were found between symptoms on the Anxious/Depressed and Withdrawn clinical scales and several other domains including attention and processing speed, executive function abilities, and psychomotor speed and coordination. Strong correlations were observed in attention/processing speed as assessed by the WISC-III Symbol Search (r = -0.16, p = 0.00; r = -0.12, p = 0.02) subtest, executive function skills represented by the WASI Similarities (r = -0.11, p = 0.05; r=-0.13, p=0.01) subtest, and psychomotor speed and coordination with the dominant hand as assessed by the Purdue Pegboard (r = -0.13, p = 0.02; r = -0.14, p = 0.01). In contrast, there were weaker relationships between symptoms on the Anxious/Depressed and Withdrawn clinical scales for visual construction skills, verbal learning and memory, and most academic achievement.

Table 2. Correlations between Anxious/Depressed and Withdrawn Symptoms in the Borderline/Clinical Referral Range and Cognitive and Academic Measures

Cognitive and Academic Measures	Anxious/Depressed		Withdrawn	
	r	p-Value	r	p-Value
WASI Full Scale IQ[1]	-0.16	0.00**	-0.13	0.02*
WASI Verbal IQ[1]	-0.09	0.10	-0.11	0.04*
WASI Performance IQ[1]	-0.14	0.01**	-0.07	0.18
WASI Vocabulary[2]	-0.13	0.02*	-0.15	0.00**
WASI Similarities[2]	-0.11	0.05*	-0.13	0.01**
WASI Block Design[2]	-0.12	0.02	-0.05	0.32
WASI Matrix Reasoning[3]	-0.14	0.01**	-0.08	0.12
WISC-III Coding[3]	0.03	0.61	-0.08	0.15
WISC-III Symbol Search[3]	-0.16	0.00**	-0.12	0.02*
WISC-III Digit Span[3]	-0.12	0.02*	-0.09	0.11
Animal Fluency[4]	-0.00	0.95	-0.08	0.13
Trail Making Part A[5]	-0.06	0.01**	-0.09	0.12
Trail Making Part B[5]	-0.15	0.02*	-0.04	0.43
Purdue Pegboard Dominant[6]	-0.13	0.02*	-0.14	0.01**
Purdue Pegboard Non-dominant[6]	-0.08	0.14	-0.05	0.40
Purdue Pegboard Both[6]	-0.00	0.98	-0.03	0.65
CAVLT-2 Level of Learning[7]	-0.05	0.39	-0.10	0.06
CAVLT-2 Interference[7]	-0.04	0.50	-0.12	0.02*
CAVLT-2 Immediate Recall[7]	-0.02	0.78	-0.07	0.18
CAVLT-2 Delayed Recall[7]	-0.08	0.16	-0.11	0.05*
WJ-R Letter-Word Identification[8]	-0.10	0.08	-0.07	0.20
WJ-R Applied Problems[8]	-0.19	0.00**	-0.15	0.00**
WJ-R Dictation[8]	-0.13	0.01	-0.04	0.43

P-value * = < 0.05, ** = < 0.01.
[1]WASI Full Scale, Verbal and Performance IQ use age-based standard scores for composites, with a mean of 100 and standard deviation of 15; higher scores indicate better performance; [2]WASI subtests use age-based *T*-scores, with a mean of 50 and a standard deviation of 10; higher scores indicate better performance. [3]WISC=III subsets use age-based scaled scores, with a mean of 10 and a standard deviation of 3; higher scores indicate better performance. [4]Animal Fluency uses an age-corrected *z* score with a mean of 0 and standard deviation of 1; on this measure a higher score indicates better fluency. [5]Trail Making tests use age-corrected *z* scores which have a mean of 0 and standard deviation of 1; lower scores indicate faster completion time. [6]Purdue Pegboard uses age-corrected *z* scores which have a mean of 0 and standard deviation of 1; lower scores indicate faster completion time. [7]CAVLT uses age based standard scores, with a mean of 100 and standard deviation of 15; higher scores indicate better performance. [8]WJ-R uses age-based standard scores with a mean of 100 and standard deviation of 15; higher scores indicate better performance.

As shown in Table **3**, 58 (17%) children had a *T*-score above or equal to 60 on the Anxious/Depressed clinical scale and were placed in the Clinical group. In a comparison of

Table 3. Mean Differences for Subjects with Anxious/Depressed Symptoms in the Borderline/Clinical Referral Range as Compared to Subjects Showing No Borderline/Clinical Anxious/Depressed Symptoms on Cognitive and Academic Measures

Dependent Cognitive and academic Measures[1]	Anxious/Depressed N=58		Non-Anxious/Depressed N=277		p-Value
	Mean	SD	Mean	SD	
WASI FSIQ	102.6	13.3	108.0	12.6	0.00**
WASI Verbal IQ	105.2	17.0	109.7	19.0	0.10
WASI Performance IQ	99.9	15.7	106.2	17.7	0.01**
WASI Vocabulary	52.1	9.64	55.0	8.10	0.02*
WASI Similarities	53.2	8.90	55.8	8.90	0.05*
WASI Block Design	49.8	8.80	52.9	9.61	0.02*
WASI Matrix Reasoning	49.9	10.0	53.5	9.90	0.01**
WISC-III Coding	11.2	2.80	11.0	2.90	0.60
WISC-III Symbol Search	11.4	3.17	12.7	3.00	0.00**
WISC-III Digit Span	9.30	2.97	10.2	2.86	0.02*
Animal Fluency	0.86	1.30	0.87	1.32	0.95
Trail Making Part A	0.34	0.87	0.50	1.00	0.27
Trail Making Part B	0.11	0.89	0.48	0.91	0.00**
Purdue Pegboard Dominant	-1.00	1.20	-0.63	1.10	0.02*
Purdue Pegboard Non-dominant	-0.80	1.10	-0.56	1.10	0.14
Purdue Pegboard Both	-0.60	1.00	-0.60	1.10	0.98
CAVLT-2 Level of Learning	103.9	13.9	105.7	14.6	0.39
CAVLT-2 Interference	98.3	18.4	99.9	15.9	0.50
CAVLT-2 Immediate Recall	104.1	13.4	104.8	16.6	0.78
CAVLT-2 Delayed Recall	101.0	15.7	104.1	15.3	0.16
WJ-R Letter-Word Identification	104.5	15.5	108.5	15.7	0.08
WJ-R Applied Problems	104.7	14.1	112.1	14.4	0.00*
WJ-R Dictation	94.2	10.5	98.3	11.9	0.01*

P-value * = < 0.05, ** = < 0.01.

[1]Description of scoring for each cognitive and academic measure is given in the legend for Table **2** and in the text of the Methods.

this group with the Normal group who had scores below 60, the Clinical group had lower scores on several measures, which assessed components of intellectual function, language, visual construction skills, attention and processing speed, executive function skills, psychomotor speed and coordination, and basic math and spelling skills. There were few differences found between anxious/depressed symptomatology and verbal learning and memory or academic achievement as related to basic reading. These findings are consistent with the correlation analysis performed on the entire cohort.

A total of 46 (13%) participants were in the Clinical group on the Withdrawn clinical scale of the CBCL. As documented in Table **4**, similar to the findings observed for the Anxious/Depressed clinical scale, those in the Clinical group on the Withdrawn clinical scale had weaker performance on components of intellectual function, language, attention and processing speed, executive function abilities, psychomotor speed and coordination, and basic math skills. However, when compared to those in the Clinical group on the Anxious/Depressed clinical scale, a poorer performance was observed on certain trials of the CAVLT-2 suggesting that there was some impairment in aspects of verbal learning and memory for those who exhibited withdrawn symptomatology.

As shown in Table **5**, 26 (8%) participants were in the Clinical group on both the Anxious/Depressed and Withdrawn clinical scales of the CBCL. The results from the analysis found that those participants in the Clinical group on both these clinical scales had a significantly weaker performance on all components of global intellectual function as assessed by the WASI, which included the WASI FSIQ, Verbal IQ, and Performance IQ. Likewise, differences were observed in language skills (WASI Vocabulary), visual construction skills (WASI Block Design), and most tests of executive function (Similarities and Matrix Reasoning subtests from the WASI and Trail Making Part A and B). Furthermore, the attention and processing speed measures (Symbol Search and Digit Span subtests from the WISC-III) and psychomotor speed and coordination with the dominant

Table 4. Mean Differences for Subjects with Withdrawn Symptoms in the Borderline/Clinical Referral Range as Compared to Subjects Showing No Borderline/Clinical Withdrawn Symptoms on Cognitive and Academic Measures

Dependent Cognitive and Academic Measures[1]	Withdrawn N = 46		Non-Withdrawn N = 289		P-Value
	Mean	SD	Mean	SD	
WASI FSIQ	102.8	13.4	107.7	12.6	0.01*
WASI Verbal IQ	103.7	16.7	109.7	18.9	0.04*
WASI Performance IQ	101.9	17.9	105.6	17.4	0.18
WASI Vocabulary	51.3	9.05	55.0	8.23	0.01**
WASI Similarities	52.3	9.62	55.8	8.71	0.01**
WASI Block Design	51.1	9.24	52.6	9.58	0.33
WASI Matrix Reasoning	50.8	11.4	53.2	9.70	0.12
WISC-III Coding	10.5	2.84	11.1	2.87	0.14
WISC-III Symbol Search	11.5	3.03	12.6	3.10	0.02*
WISC-III Digit Span	9.41	2.85	10.2	2.90	0.11
Animal Fluency	0.59	1.01	0.91	1.40	0.95
Trail Making Part A	0.26	0.83	0.50	1.00	0.12
Trail Making Part B	0.32	1.16	0.44	0.87	0.43
Purdue Pegboard Dominant	-1.10	1.40	-0.63	1.03	0.01**
Purdue Pegboard Non-dominant	-0.73	1.30	-0.58	1.07	0.40
Purdue Pegboard Both	-0.67	1.03	-0.59	1.06	0.65
CAVLT-2 Level of Learning	101.6	16.1	106.0	14.1	0.06
CAVLT-2 Interference	94.6	16.1	100.4	16.3	0.02*
CAVLT-2 Immediate Recall	101.7	15.1	105.1	16.2	0.18
CAVLT-2 Delayed Recall	99.4	15.4	104.2	15.3	0.05*
WJ-R Letter-Word Identification	105.1	14.4	108.2	15.4	0.20
WJ-R Applied Problems	105.2	15.4	111.7	14.3	0.00**
WJ-R Dictation	96.4	11.1	97.8	11.9	0.43

P-value*= < 0.05,** = < 0.01.
[1]Description of scoring for each cognitive and academic measure is given in the legend for Table **2** and in the text of the Methods.

hand (Purdue Pegboard) were significantly better in the Normal group. Similar to the pattern observed when the Anxious/Depressed and Withdrawn clinical scales were examined separately, differences in measures of verbal learning and memory as well as academic achievement were less striking with only delayed recall on the CAVLT-2 and the Applied Problems and the Letter-Word Identification subtests on the WJ-R reaching significance.

Intellectual functioning (IQ) and academic achievement were average for both Caucasian and Hispanic children. Additionally, ethnicity did not affect differences between those participants in the Clinical group and those in the normal group on the Anxious/Depressed, Withdrawn, or both the Anxious/Depressed and Withdrawn clinical scales. Also, age, gender, and parental education had no impact on our findings. Furthermore, in order to evaluate the possible influence of SDB, snoring, and INSOM, we performed separate analyses comparing those with and without these parameters (data not shown). We found little difference in our results after these analyses.

DISCUSSION

In this study we found that an increase in anxious/ depressed or withdrawn symptomatology was negatively correlated with performance on neuropsychological measures. More specifically, there was a decrease in general intellectual function for both verbal and nonverbal abilities. Likewise a weaker performance was observed for language, visual construction skills, attention and processing speed, executive functioning abilities, some aspects of verbal learning and memory, and psychomotor speed and coordination with the dominant hand. Academically, basic math, spelling/early writing and reading skills were weaker. There were no significant differences found between those participants who had borderline/clinical referral range depressive symptoms as assessed by the Anxious/Depressed and Withdrawn clinical scale of the CBCL and those participants who did not with regard to ethnicity.

Table 5. Mean Differences for Subjects with both Anxious/Depressed and Withdrawn Symptoms in the Borderline/Clinical Referral Range as Compared to Subjects Showing No Borderline/Clinical Anxious/Depressed or Withdrawn Symptoms on Cognitive and Academic Measures

Dependent Cognitive and Academic Measures[1]	Anxious/Depressed and Withdrawn N=26		Non-Anxious/Depressed and Withdrawn N=257[+]		p-Value
	Mean	SD	Mean	SD	
WASI FSIQ	99.0	12.7	108.0	12.6	0.00**
WASI Verbal IQ	100.0	18.8	109.8	19.4	0.01**
WASI Performance IQ	97.0	14.3	106.0	17.5	0.01**
WASI Vocabulary	50.3	10.7	55.1	8.20	0.00**
WASI Similarities	49.6	10.1	55.7	8.90	0.00**
WASI Block Design	48.0	8.80	52.9	9.61	0.02*
WASI Matrix Reasoning	49.0	11.0	53.6	9.71	0.03*
WISC-III Coding	10.5	2.70	11.1	2.90	0.32
WISC-III Symbol Search	10.6	2.63	12.7	3.04	0.00**
WISC-III Digit Span	8.62	2.93	10.2	2.89	0.01**
Animal Fluency	0.56	1.02	0.89	1.34	0.24
Trail Making Part A	0.07	0.75	0.50	1.02	0.04*
Trail Making Part B	0.11	0.89	0.48	0.91	0.00**
Purdue Pegboard Dominant	-1.22	1.17	-0.61	1.02	0.00**
Purdue Pegboard Non-dominant	-0.94	1.03	-0.57	1.07	0.09
Purdue Pegboard Both	-0.76	1.05	-0.60	1.07	0.48
CAVLT-2 Level of Learning	100.8	14.6	106.0	14.3	0.08
CAVLT-2 Interference	94.8	16.8	100.3	15.9	0.09
CAVLT-2 Immediate Recall	101.2	13.1	104.9	16.5	0.26
CAVLT-2 Delayed Recall	97.7	15.0	104.3	15.3	0.04*
WJ-R Letter-Word Identification	101.4	14.7	108.4	15.9	0.03*
WJ-R Applied Problems	101.4	14.8	112.3	14.4	0.00**
WJ-R Dictation	93.6	12.7	98.2	12.2	0.07

P-value* = < 0.05,** = < 0.01.

[+]Total N < 335 because participants with T Scores ≥ 60 on only Anxious/Depressed or Withdrawn CBCL scales were excluded.

[1]Description of scoring for each cognitive and academic measure is given in the legend for Table **2** and in the text of the Methods.

The results found here are consistent with previous research that has documented negative correlations between severity of depressive symptoms and general intellectual function [3], as well as a weaker performance with regard to visual spatial perception [4], problem solving [5], and working memory tasks [9]. These children with anxious/depressed or withdrawn symptoms also exhibit decreased motor speed [4, 9, 12] and poor coordination [4, 13] as well as weaker mathematic skills [14] and reading skills [15]. In contrast to some of the literature reviewed here, our results only found weaknesses with regard to certain aspects of learning and memory, mainly interference and delayed recall.

Our results are consistent with observations commonly noted in adults with depression who have problems with attention and processing speed, various aspects of executive function such as basic visual motor tracking and scanning, visual spatial tasks, and variable weaknesses with verbal learning and memory [31, 32]. Although we did not find any problems with verbal fluency, a common executive function weakness found in adults with depression [32], an explanation for the differences between our findings and previous adult studies may be attributable to our study population of children. Unlike many other studies that have clinically derived cohorts with greater severity of depressive symptomatology, our findings were obtained from a general population cohort that was not selected because of symptoms of depression. Thus, the cohort is likely more reflective of elementary school aged children in the general community.

This study lends support to previous research that has sought to identify a relationship between depressive symptomatology in children and their performance on neuropsychological measures. Our findings highlight the importance of identifying depressive symptoms during an evaluation with a child when poor cognitive functioning and academic achievement is a primary concern, even in those

who are not overtly depressed. Treatment of such symptoms, if present, would be an important remedial factor in improving performance.

Clinical manifestations of sleep disorders, in particular SDB (including snoring) and insomnia frequently include symptoms of depression. We do not think that this is a likely explanation to our findings because in focused sensitivity analyses comparing those with and without these conditions, we did not find significant differences in our results.

One of our initial hypotheses was that the impact of anxious/depressed or withdrawn symptomatology would be greater in those children with Hispanic ethnicity. Recent studies suggest that Hispanic youth, especially adolescent Hispanic girls exhibit higher levels of depression than Caucasians [33, 34]. However, whether depression differentially impacts neuropsychological performance in Hispanic children has not been well studied. Our results suggest there are no performance differences between Hispanic children in comparison to Caucasians.

There were some clear limitations to this study. The relatively small sample sizes of participants who scored at the borderline/clinical referral range on the CBCL Anxious/Depressed and Withdrawn clinical scales points to the need for conducting a similar study with a larger sample size to compare clinically significant scores on these same clinical scales in order to confirm the findings that were reported in this study. This small sample size could to some degree have been the result of self-selection although the subjects' parents did not know they were being analyzed for depressive symptoms *per se*.

Another limitation to the study is that by using the CBCL Anxious/Depressed and Withdrawn clinical scales it is quite possible that these results in part reflect both anxious and withdrawn symptoms as well. However, it has been well described in the literature that patterns and correlates of comorbidity for depression, whose symptoms include withdrawal and anxiety clearly exist, and in fact, reflect a larger psychiatric group of internalizing disorders [35]. Nevertheless, subsequent studies should include a specific instrument that only assesses depression such as the Children's Depression Inventory (CDI) [36] or the Children's Depression Rating Scale-Revised (CDRS-R) [37]. Furthermore, in order to maintain a reasonable duration for the neuropsychological evaluation, we were able to select only a single measure to assess depression; multiple assessment tools would have been preferable.

Future research will benefit from consistent longitudinal research to precisely identify the causal association between depressive symptomatology and various aspects of cognitive functioning and academic achievement. This can be accomplished with larger sample sizes that include meaningful numbers of children. In addition, assessing if there are differences found across more diverse ethnic populations would be useful information. Instruments to measure depression should be consistent, both methodologically and diagnostically. More precise clinical criteria for defining depressive symptomatology are necessary and the development of new tools to assess depression specifically targeting children and adolescents would be helpful. As our understanding of the relationship between depression and cognitive functioning and academic achievement increases, educators, researchers, health care providers, and others working with children and their parents will have better tools to address these issues with the potential to improve overall emotional adjustment and academic performance.

CONCLUSIONS

We found that anxious/depressed or withdrawn symptomatology is associated with poorer cognitive and academic achievement performance in a general population of school-aged children. These findings may be important considerations when children undergo neuropsychological and/or school-based evaluations for problems with certain aspects of cognitive functioning and/or academic achievement as the underlying cause of the difficulties could be treatable through psychotherapeutic and/or psychopharmacological support.

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