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ABSTRACT

This study investigated the role of executive function in children with attention deficit disorders (ADD) by comparing differences resulting when diagnostic measures of reading comprehension consisting of either short or long passages were used. Subjects (all in grades 1-12) were grouped as having an attention deficit disorder (ADD) and not taking medication (N=37), as non-ADD learning disabled (N=36), as ADD on medication (N=19), and as non-handicapped (N=58). Findings indicated that the ADD subjects tended to: (1) do more poorly in comprehending extended reading passages than shorter ones; (2) do more poorly than other children on extended reading passages; and (3) manifest a greater difference between their abilities to comprehend shorter versus longer passages than other groups at three of the five age levels considered. Results also supported the existence of two types of learning disability: attention-based LD and language-based LD. (Author/DB)

Reading Comprehension, Extended Processing and Attention Dysfunction

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ABSTRACT

INFORMATION PROCESSING DEMANDS, READING COMPREHENSION, AND ATTENTION DYSFUNCTION

Because of the complex and systemic nature of processing difficulties associated with attention deficit disorder (ADD), special measurement techniques are likely to be needed to identify learning disability (LD) in this population and to diagnose academic areas requiring remediation. This study compared a measure of reading comprehension which uses short passages (Woodcock-Johnson - R) with one which uses longer ones (Gray Oral Reading Test - R). Longer passages were included in order to challenge attention capacity and to tax the executive function component of the attention complex. Subjects in this study were ADDs not taking medications (N=37); LDs (N=36); ADDs taking optimal dosages of medication (N=19); and nonhandicapped children (N=58). Subjects were divided into 5 levels: Level 1 - early elementary grades (1 and 2); Level 2 - late elementary (3 and 4); Level 3 - middle school (5 and 6); Level 4 - traditional junior high school (7,8,9); and Level 5 - secondary (10,11,12). Findings indicate that ADDs tend to: 1)do more poorly comprehending extended reading passages than shorter ones; 2)do more poorly than other groups of children on extended (longer) reading passages; 3)manifest a greater difference between their abilities to comprehend shorter vs longer passages than other groups at Levels 1,2 and 5. Implications are drawn for including a measure of extended reading in batteries used to identify learning disability, at least in the ADD population.

This study confirms our previous work which seems to indicate a basis for conceptualizing two types of learning disability: attention based LD and language based LD.

ATTENTION - BASED LEARNING DISABILITY

Because of the nature of attention dysfunction and its interaction with existing psychometric instrumentation, the identification of Learning Disability (LD) and the documentation of significant discrepancy often requires specialized procedures within the population of children with attention deficit disorder (ADD). The complex and multifaceted nature of the attentional system necessitates a well-regulated and finely tuned balance among related processes and thus makes it highly vulnerable to dysfunction.

THE ROLE OF EXECUTIVE FUNCTION IN THE ATTENTIONAL AND LEARNING NETWORK

Recent findings have recognized the neurobiological basis of the problems among attentional subcomponents (Tucker and Williamson, 1984; Ryan, 1990; Zametkin and Rapoport, 1989), have highlighted the critical role of the frontal lobes and therefore executive function in the control of attentional processing (Denckla, 1991; Benson, 1991; Zametkin, et al, 1990). Executive function allows for the control and management of information. It becomes a particularly vital function whenever information load and goal management are at issue (Carpenter, Just and Shell, 1990).

Executive function is clearly documented neurophysiologically (Colby, 1991; Zametkin, et al, 1990) and cognitively (Hockey, 1984; Stolzenberg and Cherkes-Julkowski, 1991) as part of the attentional network as well. The link among these systems is described briefly here. We pursue the nature of the attention-working memory-executive function network more fully elsewhere (Cherkes-Julkowski and Stolzenberg, in press; Stolzenberg and Cherkes-Julkowski, 1991).

Executive function is a particularly likely candidate for processing breakdown in the ADD population. It is the "site" where the finely tuned juggle takes place between attend- process-attend again-compile, ad infinitum.

EXECUTIVE FUNCTION AS A SOURCE OF LEARNING DISABILITY

Executive function accounts for most of the variance among a number of academic tasks which require extended processing in a group of children with ADD, who are not medicated (Stolzenberg and Cherkes-Julkowski, 1991). Disorders of executive function interfere with the ability to manage complex or extended information efficiently, may cause disorganization of the cognitive system at large and make it difficult to measure the ability to think abstractly in any valid way according to traditional testing procedures.

HYPOTHESIS

1) If executive function is part of the processing dysfunction in ADDs and in some LDs, the procedure for testing reading will need to be able to observe reading when extended passages are presented and ideally will be able to compare reading comprehension under extended processing conditions to reading when only limited amounts of information need be managed.

2) Executive function is a late developing ability. The frontal lobes which are the basis in the brain for executive abilities myelinate late. The process continues through adolescence (Denckla, 1991; Breslin and Weinberger, 1991). We would expect, therefore, that problems in reading would increase for children with ADD as they progress through the grades and simultaneously their abilities to manage information become comparatively weaker as task demands become more extended and complex.

3) Further, our recently reported work (Stolzenberg and Cherkes-Julkowski, 1991) has found that attention based LDs differ significantly from language based LDs in the underlying processes which lead to their problems in extended processing in reading and math problem solving. We expect the current study to confirm these findings.

FINDING I.

The trend is for ADD's, with or without medications, to do more poorly whenever they must read longer passages.

Ia) They do more poorly when compared to their own performance on shorter passages and when compared to other groups.

Ib) The difference is greatest at levels 1 + 2.
There is a leveling effect during the middle school years but the difference begins to re-emerge in the later years of high school.

FINDING II.

In the early grades, level 1, 2 and 3, ADDs, meds and no meds, seem to perform more poorly when compound verbs or compound sentences are at issue. Over time the manifestation of processing difficulty shifts first to the number of morphemes and then embedded phrases.

IIa) Passages which were relatively easy for children with ADD, no meds were 3, 5 and 6. Each of these passages was conceptually tight. The main idea was set forth at the beginning of the passage and by the time half of each passage had been read, the remaining portion could be predicted easily.

FINDINGS III.

For ADDs, no meds, at all levels, an attention/working memory measure is the strongest and always a significant correlate of extended processing as measured by the number of morphemes and embedded phrases per passage. For all other groups, at all ages, language measures dominate as correlates

Sample and Instumentation

	NH	ADD,NM	LD	ADD,M	TOTAL-N
LEVEL 1 (grades 1, 2)					
n	12	2	NONE	3	17
prompted Raven	95.58	56.40		75.71	
LEVEL 2 (grades 3,4)					
n	14	7	4	3	28
prompted Raven	96.07	71.06	79.00	68.50	
LEVEL 3 (grades 5,6)					
n	15	9	5	3	32
prompted Raven	94.33	76.57	67.66	67.40	
LEVEL 4 (grades 7,8,9)					
n	8	11	13	6	38
prompted Raven	84.37	85.20	72.80	72.81	
LEVEL 5 (grades 10,11,12)					
n	9	8	14	4	35
prompted Raven	85.44	77.00	68.40	82.40	
TOTAL	57	37	36	19	150

Subjects were children referred to the authors' private practices.

Diagnosis of ADD was made in accordance with DSM - III and III - R criteria and medical/psychoeducational evaluation. Diagnosis of Learning Disability was made by the first author.

Subjects on medications described in this study were on a variety of pharmacologic agents which included stimulants (methylphenidate, dextroamphetamine, pemoline), and tricyclics (imipramine, desipramine) alone or in combination. Dosages were titrated based on emotional, behavioral, and, as much as possible in each case, cognitive responses.

1. GRAYZ, the number of standard deviations from the mean score of 10 on the gray oral reading test - R.
2. WJPCZ, the number of standard deviations from the mean score 100 on the Woodcock-Johnson-R, passage comprehension test.
3. RCDIFF=WJPCZ-GRAYZ
4. Word Opposites (WO), Sentence Imitations (SI), Word Sequences (WS), Object Sequences (OS)

GRAY PASSAGE SCORING FOR EACH PASSAGE:
1. number of compound sentences: 2. number of compound verbs; 3. number of morphemes; 4. number of embedded phrases

Table 1

Means, (standard deviations) and significance of T-tests for reading comprehension and reading comprehension difference Z scores

	NH no meds	ADD meds	LD	ADD
Level 1 (Grades 1,2)	N=12	N=2		N=3
GRAYZ	1.11 a	-1.33 a		- .66
	(.95)	(.47)		(1.58)
WJPCZ	1.63 b	- .68 b		.45
	(.60)	(1.25)		(1.33)
RCZDIFF	.52	.71		1.11
	(1.05)	(1.04)		(.44)
Level 2 (Grades 3,4)	N=14	N=7	N=4	N=3
GRAYZ	.28 a, b	- .92 b	.20	- .91 a
	(.84)	(.83)	(1.28)	(.31)
WJPCZ	1.12 c	.40 c	.45	.38
	(.71)	(.82)	(.94)	(1.09)
RCZDIFF	.83	1.20 b	.25 b	1.30
	(1.03)	(.91)	(.39)	(.46)
Level 3 (Grades 5,6)	N=15	N=9	N=5	N=3
GRAYZ	- .11	.00	- .61	.00
	(.80)	(.76)	(1.18)	(.98)
WJPCZ	.71 c	.51	- .80 c,c	1.04 c
	(.72)	(.58)	(1.57)	(.88)
RCZDIFF	.82	.51	.45	.82
	(.55)	(1.03)	(.50)	(.23)
Level 4 (Grades 7,8,9)	N= 8	N=11	N=13	N=6
GRAYZ	.25 b	.23 a	.38 b	1.44 bab
	(.80)	(.76)	(1.18)	(.98)
WJPCZ	.65	.47	.83	1.41
	(.67)	(.57)	(.93)	(1.34)
RCZDIFF	.40	.25	.53	- .03
	(1.02)	(.72)	(86)	(1.10)
Level 5 (Grades 10,11,12)	N= 9	N=8	N=14	N=4
GRAYZ	.63 b	.00	- .40 b	-.16
	(1.04)	(.66)	(.85)	(1.50)
WJPCZ	.70	.21	.40	.35
	(.97)	(1.78)	(1.62)	(1.59)
RCZDIFF	.07	.71	.80	- .51
	(.83)	(.89)	(1.16)	(.88)

a, p=.001 b, p<.02 c, p<.05

Table 2

Means and (standard deviations) for measures of processing demands

PROCESSING DEMANDS

	Compound Verbs	Compound Sentences	Morphemes	Embeddedness
LEVEL 1				
NH	12.00(3.86)a			
ADD,nm	.00(.00)a			
ADD,m	4.66(8.08)			
LEVEL 2				
NH		2.64(1.73)bc	540.92(185.81) bc	
DD,nm		1.37(1.18)c	329.62(207.02) c	
LD		5.00(3.08)	635.00(358.29)	
ADD,m		.66(1.03)b	254.33(171.84) b	
LEVEL 3				
NH	13.26(.79)			
ADD,nm	11.71(5.18)			
LD	11.00(5.51)			
ADD,m	13.00(1.41)			
LEVEL 4				
NH			891.37(331.47)b	3.12(3.18)
ADD,nm			939.00(236.68)b	2.57(1.91) c
LD			874.84(294.39)b	2.15(2.11) c
ADD,m			1394.66(313.91)bbb	7.66(4.76)cc
LEVEL 5				
NH				5.60(4.78)
ADD,nm				3.12(2.16)
LD				2.26(2.25)
ADD,m				4.50(7.68)

a, p=.001 b, p<.02 c, p<.05

Table 3

Attentional and Language Correlates of the Effects of Information Load on passage reading as measured by number of morphemes and embedded phrases

	Level 2	Level 4	Level 5
MORPHEMES			
NH	WO .21 p=.23	SI .83 p=.007	WO .58 p=.03
ADD, nm	WS .42 p=.05	OS .53 p=.008	OS .64 p=.008
LD	WO .98 p=.000	WO .46 p=.01	WO .69 p=.000
ADD, m	WO .86 p=.000	WO .64 p=.01	SI .56 p=.15
EEMBEDDEDNESS			
NH	WO .29 p=.15	SI .73 p=.01	WO .65 p=.02
ADD, nm	WS .41 p=.05	SI .63 p=.001	OS .46 p=.05
LD	SI .90 p=.003	WO .35 p=.06	WO .58 p=.003
ADD, m	no variance	WO .70 p=.008	SI .47 p=.20

IMPLICATIONS

1. IN ADDS, NO MEDS, THE UNDERLYING EXTENDED PROCESSING DIFFICULTY PERSISTS ALTHOUGH IT FINDS A DIFFERENT MANIFESTATION DEPENDING UPON THE DEVELOPMENTAL STATUS OF THE CHILD AS WELL AS THE DEMANDS SHE OR HE IS LIKELY TO MEET IN SCHOOL OR ELSEWHERE. THE PROBLEM AT ITS ESSENTIAL LEVEL WAS NEVER ONE OF (FOR EXAMPLE) DEALING WITH COMPOUND CONSTRUCTIONS. IT WAS ALWAYS ONE OF, IN THIS POPULATION, ATTENTIONAL LIMITATIONS.

2. IT IS CRITICAL TO HELP WITH THE CURRENT MANIFESTATION OF THE PROBLEM BUT DECISIONS ABOUT THE NATURE OF THE PROBLEM AND ITS NEED FOR SUPPORT CANNOT BE DEPENDENT ON THE TRANSITORY NATURE OF HOW IT MANIFESTS. THIS SEEMS TO BE EQUALLY TRUE FOR A LEARNING DISABILITY OF ANY KIND WHETHER BASED NEUROPHYSIOLOGICALLY IN ATTENTION DYSFUNCTION OR NOT.

3. THE PERSISTENT AND TRANSITORY NATURE OF THE MANIFESTATIONS OF A PROCESSING DISORDER MAKE IT DIFFICULT TO SET USEFUL EXIT CRITERIA FROM SPECIAL EDUCATION PROGRAMS.

4A. THE CURRENT, MOST FREQUENTLY USED INSTRUMENTATION IN THE IDENTIFICATION OF READING DISABILITY IS LIKELY TO BE INSUFFICIENT TO IDENTIFY READING/LEARNING DISABILITY IN THE POPULATION OF CHILDREN WITH DIVERSE SOURCES FOR THEIR LEARNING DISORDERS.

4B. THE USE OF ENCAPSULATED TASKS WHICH DO NOT PLACE STRESS ON EXECUTIVE FUNCITON FAILS TO IDENTIFY THE DIFFICULTIES OF MANY CHILDREN WITH ATTENTION DEFICIT DISORDER.

4C. THESE DATA MAKE A STRONG CASE FOR THE INCLUSION OF BOTH KINDS OF READING ANALYSES IN BATTERIES USED TO DIAGNOSE AND TREAT LEARNING DISABILITIES: SHORTER PASSAGES AS WELL AS LONGER ONES. THIS IS PARTICULARLY IMPORTANT WHEN CHILDREN WITH ADD ARE REFERRED FOR EDUCATIONAL EVALUATION.

5. LANGUAGE BASED LDS ARE LESS EFFECTED BY PASSAGE LENGTH. ADDS MANIFEST PROBLEMS TO THE DEGREE THAT THE CONCEPT OF ATTENTION BASED LD SHOULD BE CONSIDERED.