LEARNING STYLES OF LD AND NLD ADHD CHILDREN

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Attention Deficit Hyperactive Disorder (ADHD) children (N = 26) with a learning disability (LD) and without (NLD) were compared on measures of information processing using the Learning Efficiency Test (LET). Method of presentation (visual vs. auditory), order of recall (ordered vs. non-ordered), and memory processes (immediate, short-term, and long-term) were assessed. While both groups showed more difficulty with short-term and long-term memory processes than with immediate memory processes, the ADHD-LD subjects demonstrated more difficulty processing information effectively. Ordered recall was significantly more difficult for both short-term and long-term memory processes than was unordered recall. While both groups demonstrated difficulty with auditory ordered recall under short-term and long-term conditions, the ADHD-LD subjects lost the most information under auditory conditions.

Attention Deficit Hyperactive Disorder (ADHD) children (American Psychiatric Association, 1987) tend to show difficulty with sustained attention (Schwartz & Johnson, 1985). Differences in the ability to sustain attention also have been found among normal, ADHD, ADHD with LD, and LD children (Tarnowski, Prinz, & Nay, 1986). The normal and LD children did not demonstrate an attention deficit, but both the ADHD groups with and without LD demonstrated significant difficulties. This inattention may be reflected in the way ADHD children learn and remember information. Currently, there has been minimal research in the learning style or patterns of ADHD children.

The research to date on memory processes of ADHD children has been mixed. Variations in type of memory process (immediate, short-term, or long-term), variations on modality presentation (visual vs. auditory), and type of task involved have made generalizations difficult. Benezra and Douglas (1988) compared normal, ADHD, and non-ADHD reading disabled boys' performance on three measures of serial, immediate recall. Their results indicated that the reading-disabled group had significantly more problems with the tasks than either the ADHD or normal subjects. Other research that assessed short-term visual memory (Lufi & Cohen, 1985) found significant differences between ADHD and emotionally disturbed (ED) children. The ADHD children demonstrated more difficulty on the short-term visual memory tasks in comparison to the ED children.

While research on memory strategies in ADHD children has been limited and inconsistent, research with LD children consistently has cited problems that involve memory strategies (Benezra & Douglas, 1988; Dawson, Hallahan, Reeve, & Ball, 1980; Maisto & Sipe, 1980). However, as Henker and Whalen (1989) suggest, a learning disability frequently occurs with ADHD. They state that learning disabilities may "concur with ADHD, as do, much less frequently, internalizing disorders such as dysthymia, depression, or anxiety" (p. 216). The combination of an ADHD with a learning disability could cause severe problems with learning strategies as well as anxiety and stress.

Many times children respond to stress by displaying inappropriate behaviors. It has been posited that environmental stress may play a role in the display of hyperactive

behavior patterns (Henker & Whalen, 1989; Rapoport, Donnelly, Zametkin, & Carrougher, 1986). Unlike adults, children have very few options in modifying environmental circumstances to reduce this stress (Youngs, 1985). Cognitive processes (i.e., memory) also have been shown to deteriorate under conditions that cause stress or anxiety (Gross & Mastenbrook, 1980). The inappropriate behavioral patterns and learning processes of an ADHD child could well be exacerbated by environmental stressors.

The purpose of the present study was to assess the memory strategies of ADHD children without LD and ADHD children with LD in regard to type of memory process (immediate, short-term, or long-term), order to recall (ordered vs. unordered), and method of presentation (visual vs. auditory). The level of stress for each child was assessed through parental report using Elkind's stress scale for children (Elkind, 1981).

Method

Subjects

Twenty-six children (20 boys, 6 girls) participated in the study. There were 20 Caucasian and 6 Black subjects. All subjects were recruited from the Learning Clinic of the East Carolina School of Medicine. Participation was voluntary, and the decision to participate or not participate in no way affected services through the clinic. The age range of the subjects was 7 years, 6 months to 14 years, 4 months with a mean age of 8 years, 4 months. All subjects had been diagnosed as having ADHD by the Learning Clinic based on diagnostic assessment that included parent and teacher ratings, diagnostic interviews of both the parent and child, and observation data. Staff members of the clinic included a pediatrician, psychologist, and education specialist who specialized in ADHD. Thirteen of the subjects were identified as LD, and 13 were NLD. Subjects identified as LD (based on North Carolina guidelines for special education) were receiving special education services through their schools. None of the subjects in the ADHD without LD group was receiving, or had received, special education services through their respective schools. The 26 subjects who participated in the study were functioning within the average range in terms of intellectual ability. All subjects were tested under off-medication conditions.

Instruments

Webster's Learning Efficiency Test (LET; Webster, 1981) was administered to each subject. The LET is a norm-referenced diagnostic test that examines how efficiently and effectively information is processed and retained through either the visual or auditory modalities. This information helps define a learner's cognitive, perceptual, and expressive abilities as they relate to modality-specific learning strengths (Webster, 1981). It consists of two tests that involve visual memory and auditory memory. Each test measures three aspects of information and recall: immediate memory (IMM), short-term memory (STM), and long-term memory (LTM). Norms are available for children aged 6 years through adulthood.

The visual portion of the LET requires the child to observe nonrhyming letters presented one at a time from a booklet for each trial. The subject is told to remember the order in which the letters are presented. If unable to do so, the student is told to recall them in the order that he or she can best remember. The items recalled immediately after presentation represent the score for the immediate recall (IMM). After the IMM task, the student is asked to count 10 consecutive numbers slowly. This is the initial interference. The student then is asked again to recall the letters just presented. This second recall represents the short-term memory recall (STM). The last interference task is performed by asking the child to repeat a simple sentence. The items recalled after this task are the long-term memory recall (LTM).

The auditory portion of the LET is similar to the visual except that the nonrhyming series of letters are presented orally by the examiner. The ceiling for either the visual or auditory portion is failure on two consecutive immediate recalls. The LET takes approximately 15 minutes to administer.

Four recall conditions can be examined in addition to IMM, STM, and LTM. They are as follows: (1) visual memory ordered recall; (2) visual memory unordered recall; (3) auditory memory ordered recall; and (4) auditory memory unordered recall. Ordered recall is the number of items the child correctly recalls in the actual order of letters presented. Unordered recall is the number of items the child recalls correctly regardless of sequence.

Test-retest reliability coefficients for the LET are well established. Reliability coefficients ranged from .81 to .97 with a median of .94 for both the Visual and Auditory subtests. Correlation matrices for the LET were calculated for average, emotionally disturbed, learning-disabled, and educable mentally retarded students. Higher correlations of consistency in information processing were obtained with the average students than with the learning handicapped, especially learning-disabled students. The average and EMH students showed the greatest consistency in information processing (Webster, 1981).

Predictive validity was determined for the LET by using stepwise regression analysis for the average students and for each of the three groups of handicapped students. The criterion variable for the first regression analysis was the actual reading level of the subjects. The second analysis was the actual grade level of performance in mathematics. The predictor variable for each analysis was the raw scores obtained on the LET. Results indicated substantial predictive validity for both actual reading and mathematics. Webster (1981) reported correlations that ranged from .49 (LET with math for average group) to .93 (LET with math for EMH group).

Elkind's (1981) stress scale for children also was administered. Elkind's scale covers a wide variety of positive and negative situations that a child might experience. Stress is not always negative, but even positive changes in our lives can result in stress overloads. The scale charts "a child's stress level by assessing the stressors he or she has undergone recently" (Elkin, 1981, p. 161). The impact of various changes over a year's time is estimated. The parent checks the items that his/her child has experienced; each item has a preassigned stress value. The total points then are obtained for all the items the child experienced in the last year. Elkind (1981) reported that scores below 150 show an average level of stress load; scores between 150 and 300 indicate a better than average chance of demonstrating some symptoms of stress; and scores above 300 point to a strong likelihood that the child will experience a serious change in health and/or behavior.

Procedure

Each subject was administered the LET individually. Directions were read aloud to the subjects. The subjects were evaluated during regularly scheduled appointments at the clinic.

The parent(s) were asked to complete Elkind's (1981) stress scale for their child and to mark those incidents that had occurred in the child's life over the past year. The examiners then computed the overall stress score for each child.

Results

A repeated measures, mixed design analysis was performed in which category (ADHD with and without LD) served as the between-subjects variable. Method of presentation (visual vs. auditory), order of recall (ordered vs. unordered), and memory process (immediate, short-term, and long-term) served as the within-subject variables. Standard scores based on the number of correct responses were the dependent variables.

Results indicated significant main effects for category and type of memory process, $F(1,24) = 5.57, p = .027$ and $F(2,48) = 6.40, p = .003$, respectively. The ADHD LD subjects demonstrated more difficulty with recall tasks than ADHD NLD subjects ($M = 6.833$, $SD = 2.433$ and $M = 7.970$, $SD = 2.400$, respectively). Analysis of type of memory process indicated a significant main effect, but when the Scheffé test was applied to determine the critical value for significance among the three means, no significant difference emerged (immediate memory $M = 8.0155$, short-term $M = 6.975$, and long-term $M = 7.211$ with CV = 2.63). No significant main effects were noted for order of recall or method of presentation, $F(1,24) = 3.70, p = .066$ and $F(1,24) = .44$, $p = .512$, respectively.

Several significant interaction effects were noted. Type of memory process by order of recall, type by method of presentation, order by method, category by type by method, type by order by method, and category by type by order by method were all significant, $F(2,48) = 11.12, p = .000$; $F(2,48) = 48.94, p = .000$; $F(1,23) = 20.44, p = .000$;

Table 1
Means and Standard Deviations for Memory Processes, Order, and Method by Category

	M	*SD*	*N*
Visual, ordered, immediate memory			
Category 1 (ADHD without LD)	6.923	2.565	13
Category 2 (ADHD with LD)	7.077	2.290	13
Visual, ordered, short-term			
Category 1	8.077	2.465	13
Category 2	5.462	3.357	13
Visual, ordered, long-term			
Category 1	8.308	2.463	13
Category 2	5.231	3.395	13
Visual, unordered, immediate			
Category 1	7.462	2.106	13
Category 2	6.923	2.178	13
Visual, unordered, short-term			
Category 1	8.846	1.951	13
Category 2	6.923	2.842	13
Visual, unordered, long-term			
Category 1	9.000	2.121	13
Category 2	6.385	3.203	13
Auditory, ordered, immediate			
Category 1	8.385	1.850	13
Category 2	9.077	1.754	13
Auditory, ordered, short-term			
Category 1	5.385	2.987	13
Category 2	3.538	1.941	13
Auditory, ordered, long-term			
Category 1	5.923	2.842	13
Category 2	4.154	2.115	13
Auditory, unordered, immediate			
Category 1	8.769	1.922	13
Category 2	9.308	1.653	13
Auditory, unordered, short-term			
Category 1	9.077	2.929	13
Category 2	8.769	2.242	13
Auditory, unordered, long-term			
Category 1	9.462	2.602	13
Category 2	10.000	2.449	13

$F(2,48) = 5.81, p = .005$; $F(2,48) = 5.88, p = .005$; and $F(2,48) = 3.76, p = .030$, respectively.

Follow-up simple effects indicated that ordered recall was more difficult for both short-term and long-term memory processes than was unordered recall, but this was not seen for immediate recall. The auditory method of presentation was more difficult for short-term and long-term memory processes, but again not for immediate recall. In addition, ADHD with or without LD and the required order of recall interacted with method of presentation and type of memory process.

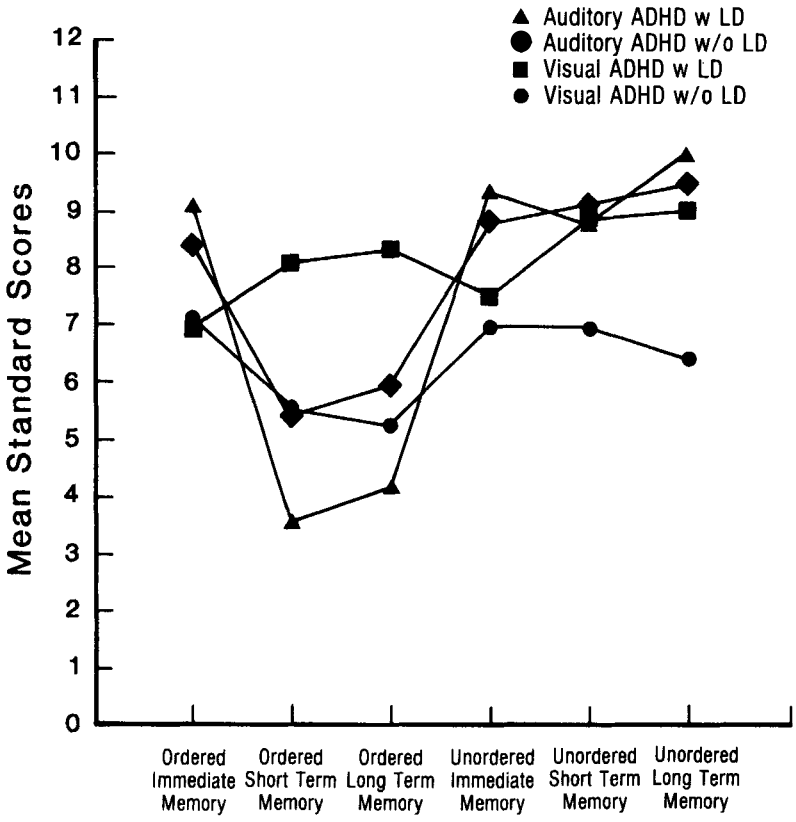

FIG. 1. Mean standard scores for correct recall of ADHD with and without LD as a function of memory process, method of presentation, and order of recall.

Figure 1 reflects the performance of ADHD subjects with and without LD for type of memory process (IMM, STM, and LTM), ordered vs. unordered recall (O vs. U), and visual vs. auditory method of presentation.

Based on Webster's (1981) procedure, the percent of information lost from immediate recall was computed for the visual and auditory means of both groups of subjects. While both groups of subjects demonstrated difficulty with auditory ordered recall under short-term and long-term conditions, the ADHD subjects with LD tended to lose the most information under auditory conditions. There were gains for the visual mode in both the ordered and unordered recall for the ADHD without LD. The subjects were able to maintain and even gain to some extent from the immediate recall to short-term and long-term recall. The ADHD with LD lost information under visual ordered

Table 2
Percent of Information Lost/Gained from Immediate Recall to Short-term and Long-term Recall by Category

	ADHD without LD		ADHD with LD	
	Short term	Long term	Short term	Long term
Visual ordered	+16.67%	+16.98%	−32.82%	−24.44%
Visual unordered	+18.55%	+20.06%	.00%	−7.77%
Auditory ordered	−35.78%	−29.36%	−61.02%	−54.24%
Auditory unordered	+3.51%	+7.90%	−5.79%	+7.43%

conditions for both short- and long-term memory processes. Only minor variations were noted for visual unordered processes for the ADHD with LD group. On the auditory unordered recall, minor fluctuations were noted from the immediate recall to short-term and long-term for both groups.

For the auditory ordered recall, the subjects in both groups were within the average range on immediate recall, but the scores declined to the below-average range on both the short- and long-term memory tasks when compared to the standardization group. Visual ordered and unordered recall for the ADHD group with LD were consistently below average. While the immediate recall scores under auditory ordered conditions suggest better recall than for the visual conditions (both ordered and unordered), the subjects were not able to maintain this advantage when transferring the information to the short-term and long-term memory storage.

On the stress scale for children (Elkind, 1981), 7 (27%) of the subjects obtained scores of less than 150, an indication of low levels of stress. Thirteen (50%) of the subjects in the sample had scores within the 150 to 300 range, which indicates moderate levels of stress. Six (25%) obtained scores above 300, which indicates high levels of stress.

A review of the questions revealed certain common patterns. Seventy-three percent (19 children) had experienced some problems with school within the last year. Of these, 46% (12 children) had experienced a school readjustment (i.e., new teacher, new class); 38% (10) indicated changes in responsibilities at home; 46% (12) had been on vacations with their family; 50% (13) had a birthday party; and 53% (14) had been punished for not "telling the truth."

Descriptive analysis of the 6 subjects above 300 on the stress scale revealed that 4 of the 6 had been diagnosed as having ADHD with LD (67%). Of the 7 subjects who scored below 150, only 2 were had a diagnosis of ADHD with LD (29%). The combination of an attention deficit hyperactive disorder with a learning disability may be resulting in a high level of stress for these children, especially with respect to school.

Discussion

The current study demonstrated that there appear to be significant differences between children diagnosed as having ADHD with and without LD in their information processing characteristics and that the ADHD with LD children demonstrate significantly more difficulties. A primary weakness of both groups was noted in recall of information in an ordered sequence, whereby both groups demonstrated significant weakness in sequential memory when compared to the test norms. Further, the ADHD with LD subjects demonstrated consistently below-average scores for visual immediate, short-, and long-term memory recall. On the auditory tasks, however, these subjects scored within the average range on the immediate memory processing, but the short-

term and long-term memory processing fell significantly below average. The results of the current study were consistent with the research of Tarnowski et al. (1986), which indicated that ADHD with LD and LD only subjects had central recall difficulties compared to control and ADHD without LD groups.

When the percent of information lost from immediate recall to short-term and long-term recall was assessed, striking patterns emerged for both groups. The ADHD without LD subjects lost significant amounts of information when transferring from immediate to short-term or long-term memory stores under auditory ordered conditions. This pattern was not seen with this group under the auditory unordered or the visual ordered or nonordered tasks. Under the auditory unordered condition, they were able to maintain average performance on all three memory tasks. However, while their performance was consistent on the visual ordered and unordered tasks, their scores were within the low average range.

The ADHD with LD subjects demonstrated a very unique pattern of scores when percent of information lost was assessed. This group functioned within the low-average to below-average range on visual ordered and unordered tasks. They did lose significant amounts of information on the visual ordered as compared to visual unordered tasks. The biggest difference occurred on the auditory ordered tasks, however. While immediate memory was within the average range, there was a substantial loss of information when transferring auditory ordered information to short-term or long-term (going from average to well below average).

This pattern of performance may help to explain some of the inconsistent results of previous studies. Immediate memory did not prove to be a significant problem for ADHD children in the Benezra and Douglas (1988) study, but the short-term visual memory tasks of the Lufi and Cohen (1985) study did indicate significant differences between ADHD and regular students. The current study indicates that the transfer of information rather than just the type of memory process is a critical area to assess. The results support previous research that has indicated that these children have cognitive deficits that do lead to problems with learning (Kirby & Grimley, 1986; Lufi & Cohen, 1985). The results also suggest that there is an "application" deficit rather than an "ability" deficit as proposed by Draeger, Prior, and Sanson (1986). This has significant implications with regard to the types of remediation strategies used with these students.

Due to the sequential processing deficit characteristic of these ADHD children, teaching strategies should be geared to showing them how to organize information effectively and efficiently and maintain information in the correct sequence (i.e., dividing information into smaller chunks, one main idea at a time). The use of rehearsal, mnemonic, or organizational strategies can be taught. However, as Mayer (1987) states, these strategies follow definite developmental stages. The level of the child's needs also should be taken into consideration when one is developing a strategy as well as whether the problem is an "availability" deficiency or a "production" deficiency. When a child has an availability deficiency, he/she is unaware of an appropriate learning strategy to use. When a production deficiency exists, the child knows the strategy, but does not always understand when to apply it (Flavell, 1970; Flavell & Wellman, 1977).

The use of rehearsal, mnemonics, or organizational strategies would allow more information to be remembered and retrieved more effectively. For example, mnemonics might involve having the child create sentences or phrases that organize the information in a way that is meaningful for the child (i.e., the colors of a spectrum of light could be remembered in their sequence by "ROY G. BIV" - red, orange, yellow, green, blue, indigo, and violet). Imagery is another technique that might be useful. This involves having the child create a scene or picture of what he/she needs to remember. Research has indicated that younger children may need to have an adult create the image, but that older students remember more efficiently if they create their own image (Mayer, 1987).

Another problem that appeared to be prominent in these ADHD children was the significant loss of information over time. If these children were unable to remember what was learned after a short period of time, what would they remember after a longer period of time? To ensure that these children retain the information, practice and repetition should be emphasized. After a concept has been introduced, there should be immediate use and practice before it has been forgotten. Information in immediate memory storage does not assure that this information will be transferred to short-term or long-term memory stores without additional practice. Considering the complaint of many teachers that the child was "able to do this yesterday, why can't he do it today?," we as educators need to understand that this is indeed a problem and not just the child's unwillingness to perform the task.

Descriptive analysis of the subjects in terms of stress indicated that there might well be a higher likelihood of experiencing stress when the child is diagnosed both ADHD and LD. Given that stress and/or anxiety may influence cognitive processes negatively (Gross & Mastenbrook, 1980), the stress experienced by these children may exacerbate their difficulties with learning. However, much more research needs to be done with larger subject samples and inferential analyses. The current study was limited in the number of subjects who scored in either the high-stress or low-stress range, and this limited the type of data analysis that could be performed.

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