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ABSTRACT

A group of 73 normal children (ages 8 to 10) was compared to 49 age-matched developmentally dyslexic children of average intelligence on the California Verbal Learning Test for Children (CVLT-C), to determine if reading disability was associated with impaired verbal memory. Dyslexics differed significantly from controls on 9 of the 12 CVLT-C memory measures, with a 78 percent rate of overall correct classification. The total number of words recalled across learning trials appeared to be the most sensitive index. Results indicated, however, that learning-disabled readers and normal children had the same rates of verbal learning, forgetting, and memory development, and were equally able to utilize semantic categorization. Reduced memory efficiency in dyslexia appears to result from verbal encoding difficulties rather than memory deficit per se. (Contains 22 references.) (Author/DB)

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MEMORY OF SPECIFIC LEARNING DISABLED READERS USING THE CALIFORNIA VERBAL LEARNING TEST FOR CHILDREN

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ABSTRACT

A group of 73 normal 8 to 10 year olds were compared to 49 age-matched developmentally dyslexic children of average intelligence on the California Verbal Learning Test for Children (CVLT-C) to determine if reading disability was associated with impaired verbal memory. Dyslexics differed significantly from controls on 9 of the 12 CVLT-C memory measures, with a 78% rate of overall correct classification. Results indicated that learning disabled readers and normal children have the same rates of verbal learning, forgetting, and memory development, and are equally able to utilize semantic categorization. Reduced memory efficiency in dyslexia appears to result from verbal encoding difficulties rather than memory deficit per se.

It has been well documented that reading disabled (RD) children have problems with verbal memory (e.g. Cermak, 1983; Kagan, 1983; Swanson, 1987; Torgesen, 1985). These difficulties appear to be exclusive to the verbal domain, as they do not interfere with nonverbal memory for faces, nonsense designs, or spatial patterns (Fletcher, 1985; Liberman, Mann, Shankweiler, & Werfelman, 1982). Two theories have been proposed to account for ineffective verbal memory in dyslexia. RD readers memory problems have been attributed to an encoding deficit that results from lack of familiarity with phonetic stimuli (Jorm, 1983; Mann, 1984; Mann, Liberman, & Shankweiler, 1980; Shankweiler, Liberman, Mark, Fowler, & Fisher, 1979; Snowling, Goulandris, Bowlby, & Howell, 1986; Swanson, 1983). A second theory attributes difficulties to a memory strategy deficit in rehearsal or semantic category clustering (Bauer, 1982; Cermak, 1983; Dallago & Moley, 1980; Swanson, 1986). Combined encoding and strategy deficits have also been proposed (Swanson, 1986; Torgersen & Houck, 1980).

An adequate characterization of memory impairment depends upon an examination of the stage of memory process at which difficulty occurs. For example, linguistic encoding problems secondary to dyslexia may result in reduced short-term memory span for words, letters, or numbers (Liberman et al., 1982; Olson, Davidson, Kliegal, & Davies, 1984; Mann, 1984; Shankweiler et al., 1979). RD may also be associated with impaired memory retrieval rather than storage difficulties (Fletcher, 1985; Swanson, 1987). Dyslexics do not appear to experience accelerated rates of forgetting (Bauer, 1979; Cermak, Goldberg, Cermak, & Drake, 1980). This latter finding suggests that RD may not be associated with memory difficulties per se. It is well established that memory impairment produces more rapid forgetting and reduced rate of learning, but does not limit short-term memory span (Squire, 1987). Normal short-term spans are characteristic of organic amnestic states such as those secondary to bitemporal lobectomy, herpes simplex encephalitis, bilateral hippocampal lesions, Korsakoff's syndrome. or thiamine deficiency (Strub & Black, 1977).

The California Verbal Learning Test for Children (Delis, Kramer, Kaplan, & Ober, 1989) is a measure of word list learning that allows the simultaneous measurement of short-term span, rate of learning, rate of forgetting, and extent of semantic clustering. Memory storage and retrieval efficiency can also be compared. These elements suggest that the CVLT-C may be useful in identifying and characterizing memory problems in dyslexia. The purpose of this study was therefore to assess the utility of the CVLT-C as a measure of verbal memory in dyslexia, and to determine if RD readers showed evidence of encoding, semantic clustering, or retrieval difficulties.

METHOD

Reading disabled subjects (N = 49) were between 8 and 10 years of age (M = 9.22, SC = .78) and satisfied DSM III-R criteria for developmental dyslexia. Children whose Wechsler Intelligence Scale for Children-Revised (WISC-R) Full Scale IQs fell below 85 were excluded. The mean WISC-R scores for the group were in the Average range on the Verbal (M = 96.9, SC = 12.6), Performance (M = 99.5, SC = 12.5), and Full Scale IQ (M = 97.9, SD = 10.4). Each child obtained standardized reading scores that were at least 1 standard deviation below their Full Scale IQ. All RD subjects showed normal acuity on audiological examination.

Control subjects (N = 73) were matched to the RD group on age (M = 9.38, SD = .83) and selected to represent a range of functioning in the regular classrooms. Emotionally disturbed, mentally retarded, gifted, and learning disabled children were excluded. All controls showed normal acuity on audiological examination.

Measures and Procedures: The CVLT-C was administered by standardized procedure (Delis et al., 1989). This test measures memory for a 15 word list and yields scores on several dependent variables. These include the number of words recalled on trial 1, number recalled on trial 5, total number of words recalled across the 5 repetition trials, the number of words recalled following an interference word list, the number of words recalled and number of words recognized following a 20 minute delay, and the number of words clustered by semantic category (fruit, clothing, or toys) during learning trials. Additional dependent measures include the number of perseverations during learning trials, the number of intrusions during recall, the number of false positives during recognition, and the amount of recall improvement with category cuing.

Three sets of analyses were conducted. The first set was intended to determine if the CVLT-C could differential RD readers from controls. Such a discrimination would support the validity of the CVLT-C as a memory measure by replicating the finding that memory difficulties are associated with dyslexia. The second group of analyses were designed to determine which specific memory processes (short-term span, rate of learning, rate of forgetting, semantic categorizing, storage, or retrieval) were problematic for RD readers. Finally, comparisons were made between the rates of memory development in normal and RD readers.

RESULTS

Discrimination Between RD and Normal Readers. MANOVA showed significant overall between-group differences across the 12 standard CVLT-C memory measures (F; 12,109 = 4.49, p < .0001). Subsequent univariate ANOVA's indicated that dyslexics performed more poorly (p's < .001) on 9 of the 12 measures. These included the total number of words learned across 5 repetition trials (IRT), the number of original words recalled following performance on an interference word list (SDT) and after category cuing (SDCR and LDCR), the number of words recalled after a 20 minute delay (LDT), the number of false positives during the delayed recognition trial (FP), and the extent to which they clustered words by semantic category (SCL) during learning trials. Groups did not differ on the percent of information loss following interference (SDPCT) or delay (LDPCT). Means and standard deviations for the 2 groups appear in Table 1. Discriminant function analysis showed that the group of memory variables correctly classified 77.9% of the disabled and normal readers (p < .001). These results indicated that the CVLT-C was generally sensitive to memory difficulties in RD readers.

Comparison of Memory Processes: Groups differed significantly on the number of words recalled after the first presentation of the list (t; 120 = 6.85, p < .05). The RD group showed a reduced short-term memory span (M = 5.6, SD = 1.73) compared to controls (M = 6.9, SD = 1.90).

A 2 x 2 mixed effects ANOVA (group x Trial 1 vs. Trial 5) was performed to determine if RD and control subjects differed in their rate of learning across the 5 repetition trials. RD readers recalled fewer words overall (F; 1,120 = 25.78, p < .001), and an overall improvement was noted with practice across groups (F; 1,120 = 342.96, p < .001). However, the absence of an interaction (F; 1,120 = 1.16, p = .29) indicated that the relative learning rates of both groups did not differ significantly. RD and control subjects learned on average of about 4 words with practice.

A 2 x 2 mixed effects ANOVA (group x Trial 5 vs. Long Delay Recall) was performed to determine if RD and normal readers differed in their rate of forgetting over a 20 minute delay. Significant main effects were obtained for group (F; 1,120 = 17.93, p < .001) and trial (F; 1,120 = 69.14, p < .001), but the interaction was not significant (F; 1,120 = .43, p = .51). Results indicated that both groups forgot words at rates that did not differ. The average child forgot 1 or 2 words over the 20 minute interval.

A 2 x 2 mixed effects ANOVA (group x Long Delay Recall vs. Long Delay Recognition) was performed to determine if the RD and control groups differed in the extent to which recognition memory was superior to free recall.. Exaggerated improvement in recognition over recall would suggest a retrieval difficulty because a recognition format provided cues (the correct responses) which reduce retrieval demands. The analysis revealed improvements with a recognition format (F; 1,120 = 383.57, p < .001), and better overall performance for controls (F; 1,120 = 21.81, p < .001), but the extent of gain produced by recognition cues was not significantly different between groups (F; 1,120 = .26, p = .61). The typical child recognized 4 or 5 more words than they were able to recall.

Initial analysis revealed less semantic clustering in the performance of the RD group (Table 1). The semantic cluster score represented the consecutive number of words recalled in a given category (fruit, clothing, or toys). When fewer words are recalled, there is less opportunity to demonstrate clustering. The Semantic Cluster Score was therefore corrected for number of words recalled (Delis et al., 1987). The corrected scores were a ratio of the observed number of clustered words to the number expected to cluster by chance for a given word recall total. Comparison between the two groups revealed no significant difference on this parameter (t; 120 = .44, $p < .05$). Results therefore suggest that RD readers utilize semantic clustering in a normal manner.

Rates of Memory Development: Multiple regression analyses were conducted to determine if RD and normal readers differed in the rates at which learning efficiency, long-term recall, and semantic clustering improved between age 8 and age 10. Age was associated with increases in the total number of words recalled over the 5 repetitions of the word list (F; 1,120 = 12.54, $p = .001$), but the lack of an interaction between age and reading status (F; 1,118 = .16, $p = .688$) indicated that disabled and normal readers showed rates of development that did not differ significantly. Age produced improvements in disabled and normal readers showed rates of development that did not differ significantly. Age produced improvements in the number of words recalled after a 20 minute delay (F; 1,120 = 5.76, $p = .018$) that were similar for both groups (F; 1,118 = 1.65, $p = .20$). The number of words that were clustered by semantic category during learning trials increased with age (F; 1,120 = 4.43, $p = .037$), but there was no interaction between age and reading status (F; 118 = .016, $p = .90$), again suggesting that developmental memory improvements in dyslexic children occur at a normal rate.

DISCUSSION

Present results support the validity of the CVLT-C in several ways. The measure appears to be sensitive to the verbal memory difficulties encountered by reading disabled children. Dyslexics differed significantly from controls on 9 of the 12 standard CVLT-C memory indices, with a 78% rate of correct classification overall. From a diagnostic standpoint, the total number of words recalled across learning trials appears to be the most sensitive index. The RD group scored about 1 standard deviation below controls on this measure. Results also indicate that the CVLT-C is sensitive to improvements in memory functions for both RD and normal readers. Both groups demonstrated developmental gains in learning efficiency, long-term recall, and semantic clustering.

Present findings suggest that the primary difficulty encountered by dyslexics during the learning of semantically related material is at the initial stage of verbal encoding. Learning disabled readers were able to recall significantly fewer words after the first presentation of a list of categorically similar words than normal age peers. This initial encoding difficulty resulted in reduced recall following practice, verbal interference, and time delay. However, both reading disabled and normal readers learned and forgot words at the same relative rate. Both groups improved upon their free recall performance during a recognition memory trial to the same degree, and were equally able to utilize semantic categorization during the free recall trials. Accordingly, the present study yielded no evidence to suggest that dyslexics suffer from memory strategy or retrieval deficiencies. The memory development of reading disabled children occurred at a normal rate. Given their normal rates of verbal learning and long-term retention, LD readers appear to have difficulty with words rather than with memory per se.

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Table 1

<u>Means and Standard Deviations for the CVLT-C</u>

	RD Readers (n = 49)		Control Subjects (n = 73)	
	Mean	SD	Mean	SD
IRT	40.76*	8.52	48.26	8.06
SCL	11.37*	4.34	14.59	3.16
P	4.10	3.73	5.67	5.50
I	3.16*	2.86	1.34	2.41
SDT	7.86*	2.74	9.48	2.13
SDPCT	17.51	21.92	15.95	15.00
SDCR	8.37*	2.41	9.90	1.93
LDT	8.29*	2.63	9.81	2.20
LDPCT	8.02	28.91	5.43	20.75
LDCR	8.47	2.64	10.14	2.04
LDR	12.78*	2.09	14.07	1.17
FP	2.98*	3.34	.71	1.16

* $p < .001$ compared to controls

IRT = Immediate Recall Total, SCL = Semantic Cluster Score, P = Perseverations, I = Intrusions, SDT = Short Delay Total Recall, SDPCT = Short Delay Percent Decrement, SDCR = Short Delay Cued Recall, LDT = Long Delay Total Recall, LDPCT = Long Delay Percent Decrement, LDCR = Long Delay Cued Recall, LDR = Long Delay Recognition, FP = False Positives.