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ABSTRACT

Normal children (N=8) and two groups of 8 learning disabled (LD) elementary grade children, one with and one without a short-term memory deficit, were administered a battery of questions concerning knowledge of how their memories function (metamemory). Metamemory was found to be deficient only in the subgroup of LD children with a short-term memory deficit (as indexed by poor performance on the Wechsler Intelligence Scale for Children-Revised digit span subtest). LD children without this memory deficit did not differ from normal children in metamemory. Relationships among memory, metamemory, and reading and math achievement were also explored. It was concluded that metamemory deficits, previously thought to characterize LD children in general, are found only in a relatively small subgroup of LD children. Nevertheless, for this subgroup the hypothesis of a metamemorial deficit appears to have some support. (Author/CL)

Metamemory ability in learning disabled children with and without a memory deficit

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Running head: Metamemory

Abstract

Normal children and two groups of learning disabled (LD) children - one with and one without a short-term memory deficit - were administered a battery of questions concerning knowledge of how their memories function (metamemory). Metamemory was found to be deficient only in the subgroup of LD children with a short-term memory deficit (as indexed by poor performance on the WISC-R digit span subtest). LD children without this memory deficit did not differ from normal children. Relationships among memory, metamemory, and reading and math achievement were also explored. It was concluded that metamemory deficits, previously thought to characterize LD children in general, are found only in a relatively small subgroup of LD children. Nevertheless, for this subgroup the hypothesis of a metamemorial deficit appears to have some support.

Metamemory ability in learning disabled children with and without a memory deficit

One frequently reported cognitive deficit in learning disabled (LD) children is in the area of memory skills (e.g., Smith, 1983). LD children have particular difficulty with memory tasks that require the expenditure of mental effort (Goldstein, Hasher, & Stein, 1983), such as the recall of word lists (Bauer, 1977). The relatively successful performance of non-disabled (NLD) children on effortful memory tasks is based in part upon the use of memory strategies, such as rehearsal, category clustering, and mnemonics (e.g., Kail, 1984). The failure of LD children to use memory strategies has been suggested as an important source of their learning problems (e.g., Torgesen, 1980; Wren, 1983).

An important question, then, is why should LD children be deficient in the use of memory strategies? At least two possibilites exist. First, LD children may be aware of the need for strategies but are unable or unwilling to use them (e.g., Torgesen, 1980). Second, LD children may be capable of using strategies but are unaware of the need for their use (e.g., Goldstein, Hasher, & Kosteski, 1980). Knowledge of how to use one's memory capabilites is an aspect of metamemory (Brown, 1975; Flavell & Wellman, 1977) and recently it has been suggested that the memory deficits of LD children may be due, at least in part, to metamemorial deficits (e.g., Borkowski & Kurtz, 1984; Hagen, Barclay, & Newman, 1982; Smith, 1983; Torgesen & Kail, 1980).

Despite the frequent speculation on the possibility of metamemory deficits in LD children, only two empirical investigations of this possibility have to date appeared in print. In a pioneering but rarely cited study, Torgesen (1979) compared a group of good readers and a group of poor readers with memory difficulties on a series of questions designed to assess knowledge of memory and memory strategies. The poor readers with memory difficulties demonstrated inferior knowledge in a variety of areas, such as use of rehearsal, and the ability to generate possible retrieval strategies. Torgesen concluded that poor readers with memory deficits may not have limited learning capabilites but rather fail to manage or utilize their capabilities in an efficient and planful manner.

Trepanier & Casale (1983) compared a group of children selected from LD classrooms and a group of NLD children on a similar set of metamemory questions. They reported that the LD children lagged behind the NLD children in the development of metamemorial awareness, with the older LD children and the younger NLD children giving equivalent responses. While these two studies provide support for the hypthesis that LD children have inferior metamemorial knowledge, several issues remain to be resolved.

The purpose of the present investigation was to add to our understanding of metamemory in LD children. We have attempted to replicate the basic findings of Torgesen (1979) and Trepanier & Casale (1983) and to extend these findings in the following ways:

1. Torgesen's (1979) study was limited to a group of good readers and a group of poor readers with memory deficits. We are concerned with whether a metamemory deficit is found only in LD children with poor memories or in LD children in general. Since Torgesen did not include a group of poor readers without memory

deficits, we have added such a group. Following Torgesen (Torgesen & Houck, 1980; Torgesen & Licht, 1983), our operational definition of a short-term memory deficit is a score in the retarded or borderline range on the WISC-R digit span test.

2. What is the relationship of memory to metamemory? At present, there are no data with samples of LD children that can provide an answer. While Torgesen (1979) did assess the memory abilities of his poor readers with memory deficits, the limitations of his design did not allow for an examination of the relationship between memory and metamemory skills. Nor was this relationship explored in the Trepanier & Casale (1983) study; they compared their samples only on a battery of metamemory questions. However, Cavanaugh and Perlmutter (1982) have criticized much of the metamemory literature on the grounds that metamemory is only weakly related to memory. If metamemory and actual memory performance are indeed not strongly related for nondisabled children, differences between LD and NLD children in metamemory may be of questionable utility in understanding observed memory deficits. The present study addressed this issue by comparing the metamemory and memory skills of LD children.

3. What is the relationship between metamemory and actual classroom performance? This relationship has also been ignored in previous studies. As with the relationship between memory and metamemory, the issue of the relationship between reading and math performance and metamemory bears directly upon the external validity of the metamemory construct. If metamemory deficiencies are indeed responsible for some of the LD child's academic problems, one should expect to see some relationship between

metamemorial knowledge and skill in reading and math. The nature of this relationship was explored in the present study.

In order to assess metamemorial knowledge, we selected a subset of 12 questions from a larger set used by Kreutzer, Leonard, & Flavell (1975) that were aimed at assessing a child's belief about the quality of his or her memory, a child's knowledge about the circumstances under which forgetting occurs, as well as a child's knowledge about strategies for efficient learning and for reducing the impact of forgetting. Many of these questions were the same as those incorporated into the investigation of Torgesen (1979) and Trepanier & Casale (1983).

Method

Subjects. A total of 24 subjects was examined. These subjects comprised 3 groups of 8 children each: a group of LD children with memory deficits (LD/M), a group of LD children with normal memory ability (LD), and a group of normal children (NLD). The children ranged in age from 6 yr. 2 mo. to 10 yr. 2 mo. The mean age for each of the 3 samples was 8 yr. 6 mo.

Both groups of LD children were enrolled in a year-round educational program serving approximately 250 children with learning and behavioral problems from a predominantly Black, low-income, urban population. All of the children selected for inclusion in this study were diagnosed as having a learning disability by an experienced multidisciplinary diagnostic team. In addition to the absence of motor and sensory impairments, the diagnostic criteria included: (1) a WISC-R Full-scale IQ of at least 85; (2) no evidence of socio-emotional impairment; (3)performance of at least 80% below age/IQ expectancy in both reading and math achievement as measured by the Woodcock Reading Test and the Key Math Diagnostic Test; and (4) not taking Ritalin medication at the time of the study. A more complete description of this sample, including selection criteria, characteristics of subgroups, academic and behavioral characteristics, and nature of educational and therapeutic serives, can be found in Goldstein & Dundon (in press) and Goldstein, Dundon, & Wasik (1984).

The LD and the LD/M groups were selected from a larger group of 40 LD children enrolled in the educational program. A child was considered to have a short-term memory deficit if the WISC-R digit span subtest performance was in the mentally retarded or borderline range (scaled scores 3-5). Normal memory ability was defined as digit span performance in the average or high average range (scaled scores 8-13). Eight LD children with a memory deficit were matched for WISC-R full scale IQ and age (see Table 3 for means) with eight LD children without a memory deficit to form the LD/M and LD groups respectively. The relatively small sample sizes, found also in Torgesen & Houck's (1980) work on children with memory deficits, was due to the fact that the original sample of 40 LD children contained only 8 with a short-term memory deficit.

The NLD group attended an urban parochial school and comprised the same racial and social class composition as did the LD children. Individual IQ scores were not available for most of these children, but previous research conducted with a sample of 22 children from this school (Goldstein, Hasher, & Stein, 1983) indicated a mean IQ of 99.32 (SD = 13.52). In addition, all of the children were at or above grade level in reading and math.

Materials and procedure. Children were tested in a quiet school room. The experimenter and the child sat side by side at a small table with a cassette recorder placed in front of the child and the test materials next to the experimenter.

Once rapport with the child had been established the experimenter explained that the purpose of the session was to find out what young children know about their memories. The child was told that since different children have different ways of remembering things there was no "right" answer to any of the questions. After a brief warm up task (comparable to the digit span subtest of the WISC-R) the experimental tasks were given. The experimental session generally lasted 30 minutes and was conducted in a relaxed and friendly manner. All of the children were cooperative and appeared to enjoy participating in the study.

The first task assessed metamemory and consisted of a series of 12 questions derived from a larger series developed by Kreutzer, et al. (1975). The present set of questions was chosen after pilot testing indicated that they could be comprehended by these age groups and populations. The 12 questions and scoring criteria may be found in Table 1. Since our interest was both in understanding metamemory as a general skill and in discovering differences among LD, LD/M, and NLD children on individual metamemory questions, the 12 questions were combined into a single battery for use in several of the analyses. The grand mean (based upon 1 point for each "adequate" answer; see Table 1) of 8.40

suggests that these 12 questions were of suitable difficulty for our samples.

Insert Table 1 about here

The second task (hereafter referred to as the recall task) assessed actual memory performance and consisted of lists of words, each comprised of 3 to 10 familiar nouns, which were read aloud by the experimenter. The child was presented with successively longer lists, beginning with 3 words, and was asked to recall the words. If the child failed to recall a list, a second list of equal length was presented. The child's score on this task corresponded to the longest list of words correctly recalled.

Reading and math scores from the Woodcock Reading Mastery Tests (Woodcock, 1973) and the KeyMath Diagnostic Arithmetic Test (Connolly, Nachtman, & Pritchett, 1976), respectively, were obtained from each child's school records. Both of these tests are individually administered, standardized tests in wide use in LD programs.

Results

The mean and standard deviation of scores on the metamemory battery for the LD, LD/M, and NLD groups may be seen in Table 3. An analysis of variance revealed a significant difference among the groups, $F(2,21) = 5.09$, $p<.05$. A Newman-Keuls test demonstrated that the source of the significant effect was due to the poorer performance of the LD/M group relative to the other two groups, $p<.05$. The LD and NLD groups, in turn, did not differ from each other, $p>.05$. Thus, only the group of learning disabled children with a short-term memory deficit showed a deficiency in metamemorial knowledge relative to controls. Learning disabled children with normal memory performed as well as non-disabled children.

Insert Table 2 about here

An analysis of the individual questions from the metamemory battery revealed reliable group differences ($p < .05$) for one question out of 12 (see Table 2). This question (number 4 in Tables 1 and 2) pertains to the nature of short-term memory; the LD/M children were significantly more unaware of the fact that short-term memory is fragile than either the LD or NLD children. For two additional questions (numbers 1 and 12 in Tables 1 and 2) there were marginal group differences ($p < .10$). For question 1 both LD and LD/M children were more likely to deny that they forget than NLD children. For question 12 the LD/M children were less likely to describe an adequate plan or strategy for the retrieval of a specific event than either LD or NLD children.

Insert Table 3 about here

The pattern of results found for the metamemory battery is also found when recall task scores are examined. The means and standard deviations for these scores may also be found in Table 3.

An analysis of variance again revealed a significant difference among the groups, $F\ (2,21) = 9.72$, $p<.01$. A Newman-Keuls test demonstrated that the source of the significant effect was the poorer performance of the LD/M group relative to the other two groups, $p<.05$. The LD and NLD groups, in turn, did not differ from each other, $p>.05$. Thus, only the group of learning disabled children with a short-term memory deficit showed a deficiency in recall relative to controls. Learning disabled children with normal memory performed as well as non-disabled children.

The question of the relationship between metamemorial knowledge and recall was addressed by determining correlations between these two measures (see Table 3). None of these correlations reached statistical significance, nor were they significantly different from each other (Z scores of .43 and 1.32 for the NLD - LD and LD - LD/M comparisons, respectively).

The final two sets of analyses addressed the issues of: (1) the relationship between digit span performance and achievement in reading and math and (2) the relationship between metamemory performance and achievement in reading and math. For the first of these analyses, LD and LD/M groups were compared on reading and math achievement (see Table 4 for means). Although the LD group had higher mean scores in both subjects, neither difference was statistically reliable (both ts < 1). For the second analysis the 16 LD children were divided (on the basis of a median split) into 2 groups of 8 children each, representing high and low levels of metamemorial knowle e. These two groups of children were virtually the same as the LD and LD/M groups; the high metamemory group consisted of 6 children from the LD group and 2 from the LD/M group, while the low metamemory group consisted of 6 children from the LD/M group and 2 from the LD group. Mean scores in reading and math achievement for the high and low metamemory groups may also be seen in Table 4. The high metamemory group attained slightly higher scores in both reading and math, although in neither case was the difference statistically significant ($t<1$ for both analyses).

Insert Table 4 about here

Discussion

The results of the present investigation add to the growing literature that suggests a metamemorial deficit in children with learning disabilities. However, unlike previous investigations that have suggested that LD children as a group are deficient in metamemorial knowledge relative to non-disabled children (e.g., Trepanier & Casale, 1983), the present results suggest that a metamemorial deficit actually characterizes only a relatively small subgroup of LD children, namely, those with a short-term memory deficit, as indexed by borderline or retarded performance on the WISC-R digit span subtest. LD children with normal digit span performance did not differ from non-disabled children in their level of metamemorial knowledge. This pattern of results was also obtained on the recall task - the performance of the LD/M children was significantly poorer than that of the LD and NLD children, while the latter two groups did not differ.

These findings underscore an important feature of research in the field of learning disabilities. Because so many studies of LD children use heterogeneous, undifferentiated samples (Torgesen & Dice, 1980), differences between LD and NLD children are often interpreted as characteristic of LD children in general. However, our data suggest that the metamemorial and recall deficits that have been attributed to all or most LD children may be due to the deficits shown by only a subgroup of LD children. Further, these subgroups may be rather small; in this study, the LD/M subgroup represented only 20% (8 of 40) of the children originally tested. It is possible that many other deficits reported in the LD literature are characteristic of a few, rather than all or most, LD children.

While the LD/M subgroup is clearly inferior to the LD and NLD subgroups in metamemory and recall performance, the results of the remaining analyses concerning the relationship between metamemory and recall and the relationship between metamemory and classroom performance were more equivocal. These two issues will be discussed in turn.

First, the correlations between metamemory and recall were not significant for any of the three subgroups, suggesting no reliable relationship between these variables. This finding is consistent with the argument of Cavanaugh & Perlmutter (1980) that there is at best a weak relationship between metamemory and memory. However, while the correlations for the NLD and LD subgroups were in the .20 to .40 range that Cavanaugh & Perlmutter cite as evidence for a dubious metamemory-memory relationship, the correlation for the LD/M sugroup was .50, a moderately strong relationship that would have been significant with a slightly larger sample size. It would appear, then, that the relationship between metamemory and memory that has not been shown to characterize normal children or most LD children may indeed characterize those LD children who demonstrate a short-term memory deficit, at least as far as recall task performance is concerned. Nevertheless, at the present time the skepticism of Cavanaugh & Perlmutter (1980) remains warranted.

Second, data on the relationship between metamemory and reading and math achievement provide only limited support for the utility of the LD/M subgroup. While the LD vs. LD/M differences in reading and math scores were not statistically reliable, three points can be offered in support of the hypothesis that at least differences in reading ability may yet be found:

1. The effect size of .64 for the reading analysis was in the medium to large range (Keppel, 1982). Because of the small sample size the power of the statistical analysis was low, indicating a high probability of a Type II error.

2. The small sample size in this study was dictated in part by the fact that only 20% of the LD children assessed met our criterion for short-term memory deficit. This difficulty, also encountered by Torgesen & Houck (1980) in their study of memory impaired LD children, may be overcome by either obtaining very large samples of LD children (often a practical impossibility in small to medium sized school districts) or by several replications with small samples of the finding reported here (Ke el, 1982).

3. The difference in reading achievement betwee the LD and LD/M samples was .63 years. This difference represents an entire

year's gain in reading scores for this sample of children (Goldstein, et al., 1984). Thus, the LD/M children were a year behind their LD peers in reading achievement, a substantial deficit.

Finally, it may be the case that the digit span subtest of the WISC-R is not a good measure of memory ability (particularly with regard to the use of mnemonic strategies) but rather measures the child's ability to use phonetic codes to store highly familiar verbal material (e.g., Siegel & Linder, 1984), a skill that bares no obvious or interesting relationship to metamemory. While support for the claim that the digit span subtest requires mnemonic strategies in children of the ages examined in this study is equivocal (Dempster, 1981), it should be noted that the correlation between performance on the digit span task and performance on the recall task (which does not merely measure the ability to use phonetic codes), is highly significant ($r = .69$, $p < .01$) for the subjects in the LD and LD/M subgroups.

In conclusion, the present experiment should serve as a caution to researchers and practitioners interested in the role of metamemory deficits in learning disabilities. The number of children for whom metamemory is a problem appears to be rather small and the role of metamemory in classroom performance is unclear. Further studies using a wide range of memory measures and a broader range of metamemory and metacognitive measures will shed more light on this issue.

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Author Notes

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Table 1

Metamemory battery questions and scoring criteria for determining adequacy of answers (after Kreutzer, et. al, 1975)

1. Do you forget?

    Adequate answer: yes; sometimes

    Inadequate answer: no

2. Do you remember some kinds of things better than others?

    Adequate: yes; categories (e.g., cars, letters and numbers, all of the players on the 76ers); instances (e.g., a broken airplane, a lost basketball)

    Inadequate: no

3. Are some kinds of things very hard to remember?

    Adequate: yes; categories; instances

    Inadequate: no

4. Should you dial a phone number immediately after you learn it, or is it okay to get a drink first?

    Adequate: phone first

    Inadequate: drink first, doesn't matter, don't know

5. Why?

    Adequate: you will forget

    Inadequate: any other answer

6. What do you do to try to remember a phone number?

    Adequate: write it down; rehearse; ask for help

    Inadequate: any other answer

7. (child given set of drawings and told that two children would be asked to learn them)

Who would remember more, a child who had studied for 1 minute or one who had studied for 5 minutes?

Adequate: 5 minutes

Inadequate: 1 minute

8. Why?

Adequate: child who studied longer would remember more

Inadequate: other answer, no answer

9. Which would you choose for yourself?

Adequate: 5 minutes

Inadequate: 1 minute

10. Why?

Adequate: would remember more

Inadequate: other answer, no answer

11. (child shown set of pictures from three familiar categories) Suppose I wanted you to learn these pictures. How would you learn them?

Adequate: categorization (child uses one or more of categories), association (any systematic linkage of items proposed), rehearsal (repetition strategy suggested), look (would visually inspect items)

Inadequate: any other response

12. Suppose your friend has a dog and you ask him how old his dog is. He tells you he got his dog as a puppy one Christmas but can't remember which Christmas. What things could he do to help him remember which Christmas he got his dog?

Adequate: plan or strategy (e.g., could rely on others or self)

Inadequate: no plan or strategy

Table 2

Number correct (out of 8) on individual metamemory questions for NLD, LD, and LD/M subgroups

Question (see Table 1)	NLD	LD	LD/M	X2
1	8	5	4	5.25 *
2	5	7	4	2.62
3	8	7	5	4.21
4	7	6	2	5.99 **
5	3	3	1	1.61
6	7	5	4	2.62
7	6	6	6	0.00
8	6	7	5	1.33
9	6	5	3	2.40
10	5	4	3	1.00
11	6	8	7	2.29
12	7	6	3	4.87 *

** $p < .05$

* $p < .10$

Table 3

Performance of NLD, LD, and LD/M children on digit-span, metamemory and recall tasks

	NLD	LD	LD/M
IQ	99 (approx.)	94.38 (5.21)	91.50 (6.70)
Digit Span		9.00 (1.69)	4.25 (.89)
Meta-memory	9.25 (2.05)	8.63 (2.07)	5.88 (2.85)
Recall	4.38 (.52)	4.63 (.52)	3.38 (.74)
Correlation between meta-memory and recall scores	.30	-.28	.50

Table 4

Mean grade level of subgroups (LD vs LD/M and higher vs lower metamemory score) on Woodcock Reading and KeyMath achievement tests

	Reading	Math
LD	2.69 (.84)	3.33 (.47)
LD/M	2.06 (.81)	3.08 (.67)
higher metamemory	2.45 (.64)	3.21 (.36)
lower metamemory	2.30 (1.07)	3.19 (.76)