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ABSTRACT

Thirty learning disabled and thirty nondisabled children (mean age 10 years) were compared on a paired associate learning task that simulated the process of sight word learning. Two instructional variables (response competition and stimulus complexity) that have been hypothesized as contributing to overloading in learning disabled children, were manipulated during the teaching of 16 symbol(s)-word associations. Results indicated that: overall, the learning disabled group had lower accuracy and retention scores than the nondisabled group; and the reduction of either response competition of stimulus complexity during instruction significantly improved the accuracy and retention of the disabled children, but did not significantly influence the performance of the nondisabled group. The study demonstrated that the difference in learning and retention of learning disabled and nondisabled children can be virtually eliminated by using instructional modifications that reduce overloading. (Author)

RESEARCH INSTITUTE FOR THE STUDY OF LEARNING DISABILITIES
Teachers College, Columbia University

ELIMINATING DIFFERENCES BETWEEN LEARNING DISABLED AND NONDISABLED CHILDREN ON A PAIRED-ASSOCIATE LEARNING TASK

N. Dale Bryant and Maribeth Gettinger

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Abstract

Thirty learning disabled children and thirty non-disabled children were compared on a paired-associate learning task that simulated the process of sight word learning. Two instructional variables (response competition and stimulus complexity), that have been hypothesized as contributing to overloading in learning disabled children, were manipulated during the teaching of 16 symbol(s)-word associations. Results indicated that: (1) Overall, the learning disabled group had lower accuracy and retention scores than the non-disabled group; and, (2) The reduction of either response competition or stimulus complexity during instruction significantly improved the accuracy and retention of the disabled children, but did not significantly influence the performance of the non-disabled group. The study demonstrated that the difference in learning and retention of learning disabled and non-disabled children can be virtually eliminated by using instructional modifications that reduce overloading.

Eliminating Differences Between Learning Disabled and Non-Disabled Children on a Paired-Associate Learning Task

The processing dysfunctions underlying learning disabilities are likely to be multidimensional, but the effect of the dysfunction can be usefully conceptualized as overloading. Overloading occurs when the amount of information to be processed within a given time span exceeds the individual's capacity. Clinical reports and theoretical frameworks often use the concept of overloading to express the processing difficulties of learning disabled (LD) children (Bryant, 1965; Haring & Bateman, 1977; Johnson & Myklebust, 1967; Otto, McMenemy, & Smith, 1973). The literature on the subject of overloading suggests that the extent to which it occurs depends on both processing difficulties of the child as well as processing demands of the learning task.

Processing difficulties of the LD child that may contribute to overloading in usual instructional procedures include slow speed of processing (Spring, 1971; Spring & Capps, 1974), failure to automatize and tendency to fatigue early (Eakin & Douglas, 1971), and, distractability that leads to unnecessary processing of irrelevant information (Hallahan, 1975). Some of these within-the-child factors can be circumvented by instructional procedures, such as provision of adequate processing time, teaching for automatization, and avoidance of fatigue and distractability. Other, more obvious factors contributing to overloading are due to processing demands of the task and are readily under the control of a teacher. There are many ways in which the processing load of a task can be minimized to reduce overloading. These include reducing the amount of information presented at one time, limiting the complexity of material to be learned at one time, increasing the amount of repetition, reducing interference from other learned material, and extending the amount of time allotted for learning. For purposes of this study, two modifications that reduce overloading in instruction will be considered - reducing response competition and reducing stimulus complexity.

Learning disabled youngsters appear to be more vulnerable to the normal effects of interference among learned responses than their non-handicapped peers. Interference effects from new material have been attributed to both forgetting of earlier responses as well as competition among available responses (Postman, 1961). Studies on the effects of response competition in short- and long-term memory found that if subjects were forced to make selections from a number of responses available at the time of recall, the likelihood of error was greater (Barnes & Underwood, 1959; Keppel & Underwood, 1962; Underwood, 1948). Results from a later investigation (Wickens, Born, & Allen, 1963) supported the notion of response competition. These results showed that initial, perfect performance on a learning task declined across trials as the number of response alternatives increased.

It is possible that if previously mastered responses have not been excluded from learning trials, interference may occur when attempting to learn a new response. Since LD children are characterized by their difficulty in achieving mastery in school subjects, they may be particularly susceptible to these interference effects that contribute to overloading. Presumably, reducing response competition in learning new associations, such as sight words, would reduce the processing load and would facilitate learning for disabled children, and possibly even for non-handicapped children.

The second example of how overloading can be minimized through instructional modifications is limiting the complexity of material to be learned at any one time. Requiring LD children to process, sequence, and discriminate among more than one stimulus element (even when the individual elements are familiar) may result in as much overloading as having to choose from among competing responses. Studies have shown that as the number of objects in a visual display increased, the time required to discriminate and locate a specific object within the display also increased (Eriksen, 1955; Rabbitt, 1964). Although this research was conducted with non-handicapped individuals, it is also applicable to disabled children. Strauss and Lehtinen (1967) suggest that handicapped children are particularly bound to stimuli, and, therefore, require limited visual stimuli in order to learn. Experts recommend that, whenever possible, the complexity of stimuli to be learned should be minimized (Johnson & Myklebust, 1967; Otto, McMenemy, & Smith, 1973).

To examine the relative effects of processing load due to response competition and stimulus complexity on LD and non-LD children, it is necessary to utilize a task similar to those in which LD children show school failure. The use of actual reading of words cannot be used because of the disparity between LD and non-LD children. However, paired-associate learning of familiar symbols with meaningful words is similar to what is involved in learning to read sight words. Studies have shown that the associative learning ability tapped in paired-associate learning tasks and reading ability are directly related (Gascon & Goodglass, 1970; Otto, 1961; Stevensen, Friedrichs, & Simpson, 1970; Walters & Kosowski, 1963).

The present investigation, therefore, used a paired-associate learning task to examine the differential overloading effects of response competition and stimulus complexity on learning and retention by LD and non-LD children. It sought to answer the following questions: (1) How does the performance of LD children compare to that of non-LD children in terms of the average number of trials to criterion per symbol(s)-word association and in terms of the number of associations retained? (2) What is the effect of response competition and stimulus complexity on the total amount of instructional time, the number of trials to criterion, and the retention of symbol(s)-word associations by LD and non-LD children?

Method

Subjects

Thirty children (19 boys and 11 girls), who were clinically diagnosed and classified as learning disabled, participated in the study. They were enrolled in three, middle class, private schools for LD children in rural communities of New Jersey and New York. These children had a mean age of 10-6, a mean IQ of 105.3 (SD = 10.3; range = 84 to 121), and an average reading level, after substantial remedial training, of 2.3 (grade equivalent on the Wide Range Achievement Test).

Thirty non-LD children (19 boys and 11 girls), with a mean age of 10-4, were also chosen from three elementary schools in middle class, rural communities in Maine. They were selected from a population of 4th, 5th, and 6th graders who had been designated by their teachers as average with respect to IQ and school achievement. The non-LD and LD samples were matched for age and sex distribution.

Procedure

Experimental task. The experimental, paired-associate learning task was designed to simulate the process of sight word learning. Each associative pair consisted of a single geometric figure (e.g., star) or a combination of two or three geometric figures (e.g., diamond and square) as the stimulus item. The associated response was always an auditorily-presented, single-syllable, concrete noun (e.g., dog, hat).

Two instructional variables were manipulated using repeated measures of the learning task for all children. The first was stimulus complexity. The stimulus materials were two decks of eight cards. One deck, labeled reduced stimulus complexity (RSC), contained eight cards of single figures; the other deck, labeled stimulus complexity (SC), contained eight cards with either two or three figures.

The second variable was response competition. Half of each deck of eight cards was taught with reduced response competition (RRC) by temporarily removing cards from the half-deck as the associated words were learned. The criterion level for learning was two correct consecutive responses. The other half of each deck was taught with usual response competition (RC) by keeping all cards in the set of four until all responses were learned to criterion. In effect, the manipulation of the two variables resulted in each child receiving four learning conditions: RSC + RRC, RSC + RC, SC + RRC, and SC + RC.

Instruction. The individual, 30-minute procedure was the same for all children. After a demonstration on two practice items, the first four stimulus-response pairings were presented to the child. The experimenter (E) laid down four cards from one deck and gave the words associated with each card. The child repeated words as they were presented. The four cards were then presented at random, one at a time, and the child was asked to say the associated words. If the child gave a correct response to a stimulus card within five seconds, the E said, "That's right. This is ____." and put a checkmark under the Trial 1 column on a recording sheet. If an incorrect or no response was given, the E said, "This is ____." and marked an X. The response, the corrective feedback, and the recording constituted a single trial for each paired-associate. The E went through all four cards in this manner. The cards were then shuffled and the procedure repeated.

For the conditions involving reduced response competition, the above procedure was repeated until each card had been named correctly (i.e., the correct associated word was given) on two consecutive trials, or until a maximum of ten trials per card had been reached. Once a card had been named correctly two consecutive times, it was dropped from the set. For the conditions involving usual response competition, however, a card was not dropped from the set when the criterion level was reached. The child continued to go through the entire set of cards until all four were named correctly on two consecutive trials.

Each child learned two eight-item decks (RSC and SC deck); the order of presentation was balanced across children and a 10-minute break was given between decks. Each deck was taught four words at a time (four with RRC and four with RC); again, the order of type of instruction was balanced across children. After completing one training round to criterion on a set of four cards, a 30-second break was given and all four cards were put back in the set so that the procedure could be repeated a second time. After these two training rounds to criterion on each half-deck, there was a five-minute period of interspersed activity followed by a retention trial for the combined deck of eight cards. Each card was presented one time and the child was asked to give the associated words.

<u>Measures.</u> Three measures of performance were taken for each child. The first was a measure of total instructional time needed to complete one training round to criterion (as measured by the total number of card presentations). The second score was a measure of accuracy. This was measured in terms of the average number of trials needed, in one round, to reach the criterion level of two consecutive correct responses per card, regardless of whether the card was dropped from the deck or not. The third score was a retention score. This was the number of correct responses (words learned and retained) on the reten-

tion trial after a five-minute break.

Results

Instructional Time

For the LD group, the total instructional time (mean number of card presentations) with RRC was 52.7 (SD = 19.9). The total instructional time under the RC condition was 92.9 (SD = 29.7). Thus, for LD children, instruction with usual response competition took significantly longer (75% more time) than instruction with reduced competition, t (29) = 6.18, p <.001.

For the non-LD group, the total instructional time was cut by 50% by reducing response competition. The average number of card presentations was reduced from 62.4 (SD = 18.4) under the RC condition to 41.4 (SD = 9.2) with RRC, t (29) = 6.70, p <.001. In summary, for both LD and non-LD children, training which used reduced response competition necessitated significantly fewer total card presentations.

Accuracy

Mean accuracy scores (as well as retention scores) are presented in Table 1 for the LD and non-LD groups.

Table 1

Mean Accuracy and Retention Scores for LD and Non-LD Groups Under Two Conditions of Response Competition and Stimulus Complexity

	Accuracy [a]		Retention [b]	
	LD	Non-LD	LD	Non-LD
Total	4.1	2.6	5.2	6.5
	(1.6)	(0.8)	(1.8)	(1.6)
Response Competition				
RRC	3.3	2.6	6.1	6.5
	(1.8)	(1.1)	(1.6)	(1.8)
RC	4.9	2.6	4.3	6.5
	(1.7)	(1.2)	(2.2)	(1.1)
Stimulus Complexity				
RSC	3.4	2.5	5.9	6.6
	(1.9)	(1.3)	(1.7)	(1.2)
SC	4.8	2.7	4.5	6.5
	(1.4)	(1.7)	(2.0)	(1.8)

[a] Average number of trials per item to reach criterion in a training round. Possible range = 2 to 10.

[b] Average number of items learned and retained after five minutes. Possible range = 0 to 8.

Overall, the LD children needed significantly more trials to achieve mastery on each item than the non-LD children, t (58) = 4.38, $p < .001$.

Each variable significantly influenced the performance of LD children, but did not influence the performance of the non-LD children. For the LD youngsters, the number of trials needed to reach criterion on each paired-associate was significantly reduced (i.e., accuracy increased) under both RRC, t (29) = 3.70, $p < .001$, and RSC conditions, t (29) = 3.63, $p < .01$. Neither of these variables, however, had a significant effect on the performance of the non-LD group.

The differential effect of reduced response competition and reduced stimulus complexity on the accuracy of the groups was dramatic. The use of either variable to reduce overloading eliminated significant differences between LD and non-LD children.

Retention

Overall, non-LD children retained more items than LD children. On the average, the non-LD group retained between six and seven of the eight items taught five minutes after training, while the LD group retained only about five items. This difference in retention scores is significant at the .01 level, t (58) = 3.19. (See Table 1.)

For the LD children, although the conditions with usual response competition included 75% more exposure time as well as equivalent criterion levels, retention scores were significantly lower than for conditions with reduced response competition, t (29) = 4.67, $p < .001$. Similarly, significantly fewer SC items were retained by the LD group than RSC items, t (29) = 5.41, $p < .001$. The effect of each instructional variable on retention scores for the non-LD children, on the other hand, was negligible.

The differential effect of reduced response competition and reduced stimulus complexity on the retention of the two groups was also dramatic. The use of either variable eliminated significant differences in retention between LD and non-LD children.

Discussion

The results of this investigation demonstrate that the differences in learning and retention of LD and non-LD children can be virtually eliminated by using procedures that reduce overloading. The hypothesis that certain instructional modifications (i.e., reducing response competition and reducing stimulus complexity) have more positive effects on the associative learning of LD children than non-LD children was clearly supported. It appears that LD children are more influenced by instructional variables than their non-disabled peers, and, that their disability is, in part, a function of the teaching procedures used. Overall, the performance of LD children was substantially inferior to that of non-LD children on measures of accuracy and retention. However, providing LD children with more optimal instruction enabled them to perform at a level comparable to that of non-handicapped children.

The experimental procedures, although carried out in an individual, laboratory setting, suggest remedial techniques for LD children that are appropriate for either individual or group instruction. For example, keeping the number of available responses at a minimum (and, thereby reducing competition among responses) may be accomplished by temporarily dropping material as it is mastered. Examples of associative learning for which this modification is appropriate include sight word learning, whole word learning of spelling lists, or learning of factual information in science or social studies. Minimizing complexity of stimulus material is another instructional modification of importance for LD children. This might be accomplished by prior practice with the stimuli to be learned, including discrimination practice.

The experimental procedures used in this study are suggested as an approach toward obtaining knowledge about how to teach learning disabled children. Similar studies are needed to elaborate, extend, and differentiate additional effective instructional techniques. These modifications can be used as guidelines for learning disability teachers. The present research suggests that instructional procedures that reduce overloading, such as reducing response competition and reducing stimulus complexity, can substantially circumvent the effect of learning disabilities.

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