IMPROVING THE GENERALIZED MNEMONIC
PERFORMANCE OF A DOWN'S
SYNDROME CHILD¹

JOEL FARB AND JOHN M. THRONE

UNIVERSITY OF KANSAS AND
LAKEMARY CENTER FOR EXCEPTIONAL CHILDREN

A training program was conducted to improve the generalized mnemonic performance, or memory, of a Down's Syndrome child. Training was directed at digit-span performance with generalization from training determined by responses to untrained mnemonic performance probes. The digit-span items varied in length from three to five digits. Each length constituted an item class, with each class trained within the framework of a multiple-baseline design. Probes consisted of untrained digit-span items, grammatical sentences, nongrammatical sentences, and match-to-sample items. A training procedure, in which 15 items from each class varied continually from trial to trial and from day to day, resulted in the percentage of correct responses to both training and probe items increasing to levels substantially above baseline. The results demonstrate the effectiveness of the training procedure in improving the generalized mnemonic performance of a Down's Syndrome child.

DESCRIPTORS: generalized mnemonic performance, digit-span training, multiple probes, sentence imitation, matching to sample, memory, Down's Syndrome retardates

Until recently, research on mnemonic performance, or memory, of the mentally retarded has been primarily basic or comparative in nature—suggesting only possible implications for the development of training strategies aimed at its improvement. For example, a review of research on long-term memory of the mentally retarded by Belmont (1966) did not include a single reference concerned with training. A review of short-term memory research by Scott and Scott (1968) likewise turned up no training studies.

Since the Belmont and Scott and Scott reviews appeared, a research strategy has developed that combines training with basic and comparative research (Butterfield, Wambold, and Belmont, 1973). Summarizing 5 yr of basic, comparative, and training research aimed

ultimately at remediating short-term memory deficits in the retarded, Butterfield *et al.* concluded that the retarded lack rehearsal techniques, do not sequence rehearsal techniques, and fail to coordinate retrieval strategies and strategies of acquisition. Hence, it would seem that the improvement of mnemonic performance for the retarded must await the development of training techniques designed to overcome deficiencies in prerequisite mnemonic processes (Brown, 1974). The present study was designed to improve the generalized mnemonic performance of a single retarded child through the application of operant techniques to targeted mnemonic performances without regard to presumed prerequisite mnemonic processes.

METHOD

Subject and Setting

Molly, a Trisomy 21 Down's Syndrome child attending the Lakemary Center for Exceptional Children, was 6 yr and 7 mo of age and her IQ scores clustered around 50.

Molly was seen in sessions lasting approximately 20 min each day, three days per week.

¹Based on a thesis submitted by the first author in partial fulfillment of the requirements for the degree of Master of Arts from the University of Kansas. The authors wish to thank Donald M. Baer, James A. Sherman, Joseph E. Spradlin, and Wayne Sailor for their comments and suggestions in the preparation of the manuscript. Reprints may be obtained from Joel Farb, Lakemary Center for Exceptional Children, 100 Lakemary Drive, Paola, Kansas 66071.

The sessions were conducted in small rooms containing a table and chairs and a one-way observation glass.

General Experimental Design

The specific mnemonic performance trained was digit-span. Digit-span was selected because it is commonly accepted, highly specific index of mnemonic performance, and is a category included on many tests purporting to measure general intelligence (Terman and Merrill, 1960; Wechsler, 1949, 1973). A pool of digit-span items was developed varying in length from three to five digits. Each length constituted an item class. In the initial stages of the study, untrained digit-span items and grammatical sentences corresponding in number of syllables to the digit-span items were presented as probes (see Table 1). Grammatical sentences were selected for use as probes because, like digit-span, they constitute a mnemonic performance included on many standardized intelligence tests. The probe items never received direct training, and served to measure generalization across mnemonic performances. Each digit or syllable length constituted an item class and each class was trained within the framework of a multiple-baseline design (Baer, Wolf, and Risley, 1968).

Table 1

Some examples of grammatical- and nongrammatical-sentence probes from the three-, four-, and five-item classes.

Three-Item Class

Grammatical:	I see you.
Give me that.
Nongrammatical:	Me with come.
Go there you.

Four-Item Class

Grammatical:	Give me the ball.
I see the tree.
Nongrammatical:	Book the me show.
Me hand your give.

Five-Item Class

Grammatical:	I see the big dog.
I read from this book.
Nongrammatical:	Block this big green is.
Work I here school in.
-

Baseline

Baseline measures were recorded across all item classes. Fifteen items were presented from each item class. The 15 items consisted of 10 digit-span items and five grammatical sentences corresponding in syllable length to the digit-span items. The same 15 items from each class were presented daily.

Eye contact was established between Molly and the trainer, who then presented an item with the instruction: "Say this." In presenting the digit-span items, the trainer pronounced one digit per second in accordance with the method described by Wechsler (1949, 1973). A correct response was defined as a complete imitation of the item occurring within 10 sec after the item was presented. Any other response was recorded as incorrect, and another item, together with the instruction, was presented. In the baseline condition, no responses, whether correct or incorrect, produced any scheduled consequences. The percentage of correct responses per session was recorded for each task.

Unmodified Training Procedure

Two training procedures were investigated. Under the first, called the unmodified training procedure, items were presented to Molly in the same manner as described for the baseline condition. However, five digit-span items in each item class were selected as training items; five other digit-span items in the class served, along with the grammatical sentences, as probes. Under the unmodified training procedure, correct responses to the digit-span training items produced immediate reinforcement in the form of a combination of praise and candy or potato chips. Incorrect responses to a digit-span training item were followed by repeated presentations of the item, with procedures involving a combination of chaining and fading used to establish correct responses to these items.

Establishing a correct response to a digit-span item involved the linking of several digits in a complete digit-span response. For example, on

presentation of an item such as 3-8-4, the child might respond 8-4, leaving off the initial digit, 3. In another case, the child's response might include an incorrect digit such as 4-8-4 in response to the 3-8-4 items. Either response might be initially reinforced as partially correct. The item would then be repeatedly presented with reinforcement contingent on any complete response including the correct initial digit, 3. In response to the 3-8-4 item, the child might also respond 3-8 or 3-8-1. Again, either response might initially be reinforced as partially correct. The item would then be repeatedly presented with reinforcement contingent on any complete response including the correct final digit, 4.

When the chaining procedure described above failed to result in an improved response to an item after several repetitions, a fading procedure was included in the chaining procedure. For example, the child might respond 6-2 to the trainer's presentation of the item 8-1-6-2. The trainer would then present the item with a short pause between digit groupings in the item. That is, the item might be presented as 8-1 — 6-2 or 8 — 1-6-2, with reinforcement contingent on more increasingly correct responses. Fading out or shortening the pause in subsequent presentations of the item would then be instituted until a correct response to the item without the pause was emitted.

Under the unmodified training procedure, all items, training and probe, were the same each day. Response to the probes, whether correct or incorrect, produced no scheduled consequences, but were simply recorded as correct or incorrect. There was no repetition of probe items within a session. When Molly's responses to the digit-span training items reached 50% correct, the continuous schedule of reinforcement was gradually phased into a variable-ratio 3 (VR 3) schedule.

Modified Training Procedure

The modified training procedure involved continually varying a large number of different items, training and probe, both within and

between sessions, using the same techniques of chaining, fading, and reinforcement employed under the unmodified procedure.

Also, when the modified training procedure was instituted, two additional probe measures were included in the study. These were non-grammatical sentences corresponding in number of syllables to the digit-span items in each class, and match-to-sample items (see Table 1). The nongrammatical-sentence probes were added to control for initially high levels of correct responses to the grammatical-sentence probes, as well as to provide further evidence of generalized training effects because imitation of non-grammatical sentences is reported by some investigators to be more difficult than imitation of grammatical sentences (Berry-Luterman and Bar, 1971; Menyuk, 1963; Smith, 1970). The match-to-sample probes were introduced to determine whether improvements on training and probe items were limited only to mnemonic performances involving imitation. The question could be raised whether or not any improvement of mnemonic performance was evidence solely of improved generalized imitation as opposed to both generalized imitation and generalized mnemonic performance. This might seem a possibility because all of the other mnemonic performances involved imitation of a modelled response. The extent to which generalized mnemonic performance, as distinct from generalized imitation, has been improved, could be demonstrated only by introducing a mnemonic performance, such as a match-to-sample task, not involving imitation.

The match-to-sample task consisted of cards showing varying numbers of different letters of the alphabet (see Figure 1). The sample card (the upper card in Figure 1) was presented to Molly with the instruction: "Look at these." Molly was then allowed to look at the sample card for 10 sec. The sample card was then withdrawn and Molly was presented with a second card (the lower card in Figure 1), which contained the letters from the sample card interspersed among an equal number of letters not

Fig. 1. An example of a three-item match-to-sample probe. The upper card represents the sample that is to be matched on the lower card.

appearing on the sample card and was given the instruction: "Find them." A correct response consisted of Molly pointing to (but not necessarily vocalizing) the letters on the second card matching those on the first. It was not required that Molly match the letters on the second card in the same sequence as they appeared on the sample card. The number of letters on the sample card corresponded to the various digit-span item classes (3 to 5). Five match-to-sample items were presented for each of the item classes. The letters from the sample card were imbedded nonsequentially among the letters on the second card, thus eliminating all

possibility that correct matching could be a function of either position-in-sequence or sequence itself.

In order to keep the length of each session to approximately 20 min in length and to avoid overtaxing Molly, five grammatical sentence probes, five nongrammatical-sentence probes, or five match-to-sample probes were presented for each item class on alternating days. Only the digit-span items continued to be presented daily.

Reliability

Reliability checks were conducted once a week in all conditions by two trained, independent observers. Reliability was recorded for the occurrence or nonoccurrence of a correct response by Molly and for the occurrence or nonoccurrence of reinforcement on the part of the trainer. Each discrete trial was scored by both observers as either an occurrence or nonoccurrence of both of the above events.

The percentage of interobserver agreement was calculated for each event as follows:

$$\frac{\text{Number of Agreements}}{\text{Number of Agreements and Disagreements}} \times 100$$

Mean interobserver agreement on occurrence or nonoccurrence of a correct response was 97%. Agreement was 99% for the occurrence or nonoccurrence of reinforcement.

RESULTS

Unmodified Training Procedure

As can be seen in Figure 2, the application of the unmodified training procedure resulted in the level of correct responses to the digit-span training items increasing to 100% for each of the item classes. However, generalization, as indicated by responses to the probes, was minimal, with the exception of responses to the match-to-sample probes in the four- and five-item classes. The level of correct responses to the probes of untraining digit-span items, gram-

Fig. 2. Percentage of correct responses to training items and probes of the three-, four-, and five-item classes.

maternal sentences, and nongrammatical sentences showed little, if any, change from their baseline levels.

Modified Training Procedure

In the case of each item class, the switch from the unmodified to the modified training procedure resulted in a substantial decrease in the percentage of correct responses to the digit-span items approximating the initial baseline level. As can be seen in Figure 2, this decrease in correct responses was limited to the digit-span training items in each class. The probes of untrained digit-span items, grammatical sentences, nongrammatical sentences, and match-to-sample items did not show the transitional decrease in evidence with the digit-span training items. Continued application of the modified procedure resulted in the percentage of correct responses to all items, training and probe, in each item class increasing to levels substantially above baseline (see Figure 2).

Followup

A followup probe session was conducted approximately seven months after training on the five-item class ended. The results of the followup (included in Figure 2) show that the improvements in all generalized mnemonic performance levels in all item classes (3 to 5) were maintained over the extended period during which no training sessions were conducted.

DISCUSSION

The results of this study demonstrate the effectiveness of the modified training procedure in improving Molly's generalized mnemonic performance. While the unmodified training procedure resulted in 100% correct responses to the five digit-span training items in each item class, only the application of the modified procedure to the three-, four-, and five-item classes succeeded in producing improved performance that generalized across all probe measures. Hence, given the aim of improving Molly's gen-

eralized mnemonic performance, the modified procedure was considerably superior to the unmodified procedure. The functional superiority of the modified training procedure in producing improved generalized mnemonic performance was probably due to the fact that, under the modified procedure, a large number of continually varying digit-span items were trained. Under the unmodified training procedure, only five digit-span items in each item class were trained. The training of so few digit-span items under the unmodified procedure was apparently insufficient to produce generalization.

The increases in correct responses to probes of nongrammatical sentences and match-to-sample probes provide further evidence for the generalized effects of the modified procedure. Because there were no baseline measures of three-word nongrammatical-sentence probes or three-item match-to-sample probes, it cannot be concluded that this procedure functioned contingently to increase correct responses to these probes in the three-item class. However, extensive baselines on these probes were provided in the four- and five-item classes against which the effects of both the unmodified and modified training procedures were evaluated.

The effect of the unmodified procedure on responses to the match-to-sample probes presents an interesting result. The match-to-sample probes were the only probe measures showing substantial increases under this procedure. During the application of the unmodified procedure, there was no evidence of a similar level of generalized imitation as all of the probe measures involving imitation (*i.e.*, digit-span, grammatical sentences, and nongrammatical sentences) showed little or no change from their baseline levels. On the face of it, this result might appear to demonstrate generalized mnemonic performance in the absence of a corresponding level of generalized imitation. However, as the match-to-sample performance involved no requirement of correct sequentiality, this result might indicate generalized nonsequential mnemonic performance in the absence

of a corresponding level of generalized sequential mnemonic performance. The resolution of this issue is the purpose of further research now underway by the authors.

Molly's classroom teachers, who were unaware of the nature of the study, reported that her attention to task seemed improved and that she was using longer sentences in her speech. It was mentioned by both her parents and her teachers that Molly had improved in following simple instructions and in following two- and three-part instructions. Molly's parents also reported that she had become more verbal at home. While these results are purely anecdotal, they might suggest the generalization of some socially important behaviors into the classroom and home settings.

Midway through the present study with Molly, a second study was conducted in which the modified training procedure was applied to two other retarded children. For the first of these two children, the modified procedure was applied with item classes two through five. For the second child, item classes four through seven were trained. The results obtained in both cases replicated those obtained in the study with Molly. All items, training and probe, in all item classes increased to levels substantially above baseline (Farb, Cottrell, Montague, and Throne, 1977; Throne, Farb, Cottrell, and Montague, 1977).

In conclusion, the present findings support the effectiveness of operant techniques in improving the generalized mnemonic performance of a single retarded child in whose behalf they were applied. The modified procedure might offer a means for improving the generalized mnemonic performance of retarded children on a wide variety of tasks, irrespective of prerequisite mnemonic processes.

REFERENCES

Baer, D. M., Wolf, M. M., and Risley, T. R. Some current dimensions of applied behavior analysis.

- Journal of Applied Behavior Analysis*, 1968, 1, 91-97.
- Belmont, J. M. Long-term memory in mental retardation. In N. R. Ellis (Ed), *International review of research in mental retardation*, Volume 1. New York: Academic Press, 1966. Pp. 219-255.
- Berry-Luterman, L. and Bar, A. The diagnostic significance of sentence repetitions for language impaired children. *Journal of Speech and Hearing Disorders*, 1971, 36, 20-39.
- Brown, A. L. The role of strategic behavior in retardate memory. In N. R. Ellis (Ed), *International review of research in mental retardation*, Volume 7. New York: Academic Press, 1974. Pp. 55-111.
- Butterfield, E. C., Wambold, C., and Belmont, J. M. On the theory and practice of improving short-term memory. *American Journal of Mental Deficiency*, 1973, 77, 654-669.
- Farb, J., Cottrell, A. W., Montague, J. C., and Throne, J. M. Update on research into increasing intelligence levels of the mentally retarded. In P. Mittler (Ed), *Research to practice in mental retardation: Proceedings of the Fourth Congress of the International Association for the Scientific Study of Mental Deficiency*, Volume 2. Baltimore: University Park Press, 1977. Pp. 129-136.
- Menyuk, P. A preliminary evaluation of grammatical capacity in children. *Journal of Verbal Learning and Verbal Behavior*, 1963, 2, 429-439.
- Scott, K. G. and Scott, M. S. Research and theory in short-term memory. In N. R. Ellis (Ed), *International review of research in mental retardation*, Volume 3. New York: Academic Press, 1968. Pp. 135-162.
- Smith, C. S. An experimental approach to children's linguistic competence. In J. R. Hayes (Ed), *Cognition and the development of language*. New York: Wiley, 1970. Pp. 48-61.
- Terman, L. M. and Merrill, M. A. *Stanford-Binet intelligence scale*. Boston: Houghton-Mifflin, 1960.
- Throne, J. M., Farb, J., Cottrell, A. W., and Montague, J. C. Extended update on research into increasing intelligence levels of mentally retarded children. In J. S. Martois (Ed), *Proceedings of the Fourth Annual Conference and Exhibition on Measurement and Evaluation: Office of the Los Angeles County Superintendent of Schools and the Los Angeles County School Board*. Downey, California: OLASS-LACBE, 1977. Pp. 161-198.
- Wechsler, D. *Wechsler intelligence scale for children*. New York: The Psychological Corporation, 1949.
- Wechsler, D. *Wechsler intelligence scale for children—Revised*. New York: The Psychological Corporation, 1973.

Received 15 April 1977.

(Final Acceptance 11 April 1978.)