DOCUMENT RESUME

ED 136 234 CS 003 292

AUTHOR	Brown, Ann L.; Campione, Joseph C.
TITLE	Memory Strategies in Learning: Training Children to Study Strategically. Technical Report. No. 22.
INSTITUTION	Bolt, Beranek and Newman, Inc., Cambridge, Mass.; Illinois Univ., Urbana. Center for the Study of Reading.
SPONS AGENCY	National Inst. of Child Health and Human Development (NIH), Bethesda, Md.; National Inst. of Education (DHEW), Washington, D.C.
PUB DATE	Mar 77
GRANT	HD-00111; HD-05951; HD-06864
NOTE	54p.
EDRS PRICE	MF-$0.83 HC-$3.50 Plus Postage.
DESCRIPTORS	Children; Elementary Education; Immaturity; *Learning Processes; Literature Reviews; Memorizing; *Memory; *Psychological Studies; *Reading Research; *Training Techniques
IDENTIFIERS	*Center for the Study of Reading (Illinois)

ABSTRACT

The history of basic research in the area of memory development is briefly reviewed as part of an attempt to illustrate how basic research can inform educational practice. The historical overview is supplemented by more detailed consideration of a few prototypical research studies. This is followed by a description of the progress, problems, and practical significance of attempts to devise effective training techniques aimed at overcoming the inadequacies of the immature learner. Finally, some practical steps for training in the laboratory and in the classroom are described, based on the current state of knowledge concerning the young child as a memorizer. (Author/AA)

CENTER FOR THE STUDY OF READING*

Technical Report No. 22

MEMORY STRATEGIES IN LEARNING: TRAINING CHILDREN TO STUDY STRATEGICALLY

Ann L. Brown and Joseph C. Campione

University of Illinois at Urbana-Champaign

March 1977

University of Illinois
at Urbana-Champaign
1005 West Nevada Street
Urbana, Illinois 61801

Bolt Beranek and Newman Inc.
50 Moulton Street
Cambridge, Massachusetts 02138

The preparation of this manuscript was supported by Grants HD 06864 and HD 05951, and a Research Career Development Award HD 00111 from the National Institutes of Child Health and Human Development.

*Designation as a Center pending approval.

Table of Contents

I. Introduction

The aim in this volume is to present a series of case studies to illustrate how the accumulation of basic knowledge in psychology has led to information of applied value; the particular charge of this chapter is to consider developmental memory research in this light. Traditionally there has been a division between basic and applied developmental research, and the majority of research reviewed and described in this chapter would be regarded as basic since it is laboratory inspired and conducted. Its origins are firmly based in theoretical and empirical backgrounds rather than practical problems raised in an applied setting. As such, the problem of practical application is more difficult for the basic researcher as his studies, at their inception, are rarely intended to answer specific applied questions. Nonetheless, while the possibility of practical application is of more central interest for the applied researcher, the topic cannot and should not be avoided by those concerned with basic research.

The task is made somewhat easier in the case of the development of memory strategies as several of the leading proponents in the field have been continually motivated by the combined purposes of addressing theoretical problems and, at the same time, applying information of practical significance directly in the form of training techniques to enhance performance. Classroom applications have been discussed and attempts to design curricula which embody the successful features of basic training studies are already under way in several laboratories (e.g., Ross & Ross, 1972). Thus, the ties between the laboratory of the basic researcher and the practical needs of the classroom teacher are less nebulous than has traditionally been the link between developmental psychology as a science and education practice as a problem of cognitive engineering.

In this chapter, we will attempt to illustrate how basic research can inform educational practice and vice versa. To do this we will progress chronologically, giving first a brief encapsulation of the history of basic research in the area of memory development. As this brief overview is intended to provide a broad historical perspective, procedural details will be omitted. So that the complexities of such procedures can be appreciated, we will next examine in more detail a series of case studies that illustrate the progress and problems of a few prototypical research programs. This will be followed by a description of the progress, problems and practical significance of attempts to devise effective training techniques aimed at overcoming the inadequacies of the immature learner. Finally, we will attempt to describe what would seem to be some practical steps for training in the laboratory and in the classroom, given the current state of our basic knowledge concerning the young child as a memorizer.

Before proceeding we should point out the limited focus of this chapter. It would be impossible to cover the wide variety of research areas which could be subsumed under its heading. Because of our focus on potentially applicable knowledge we have limited our attention to a certain class of situations, those that deal with deliberate attempts to learn or remember, although we realize that much of what one knows is not the result of deliberate attempts to retain information. The child's knowledge of the world around him, of the people, places, and things that occupy his everyday world, is the more or less automatic product of this continuous interaction with a meaningful environment. This will not be a concern in this chapter. Here we will concentrate exclusively on the development of deliberate actions to facilitate the retention of information, actions or skills we must master if we are to survive in schools. The natural development, susceptibility to training, and potential application of these skills to study situations will be the central concern.

We concentrate on the development of strategies for remembering because considerable experimentation has been directed to both the development of this form of problem-solving activity and the refinement of techniques for accelerating that development by means of direct training, intervention and enrichment programs. We should stress, however, that we make no distinction between learning and memory. Obviously, we measure what is learned by how much is remembered. Additionally, we do not believe that the knowledge we have is limited to a strict domain labelled "how to remember". Deliberate remembering is just one example of intelligent planning, and many of the difficulties which underly the young child's problems with remembering are also behind his general deficiencies as an active problem solver on school-related tasks. Memory skills are specialized problem-solving activities tailored to the purpose of reconstructing past events; they are not different in kind from problem-solving skills in general.

As a final introductory comment we would like to defend our concentration on experimental work with slow-learning children. Children with marginal academic skills, which render them at risk for special education, are found to experience particular problems in two main areas: strategic planning in school problem-solving tasks (including deliberate remembering) and reading effectively. Our interest in developing training routines to overcome some of these deficiencies stems from our belief that remediation aimed at marginal children can be the most fruitful in terms of obtaining worthwhile educational improvements. It also reflects our belief that average children acquire many of the skills we will consider without explicit training; repeated contact with a variety of tasks in school, all requiring the same basic strategies, is probably sufficient to inculcate at least the very simple strategies we will describe. Slow learning children, however, need direct and explicit training before they will acquire the skills; without intervention they may never acquire them (Brown, 1977; Campione & Brown, 1977).

II. History of Basic Developmental Research in Memory

Since the inception of experimental child pschology as a scientific discipline with some degree of external recognition and internal cohesion, a great deal of research effort has been directed to the problem of learning and memory in children. Thus, any history of that research must be only a very superficial guide to progress in the field. Secondary sources are available to elaborate on this impoverished outline and the reader is referred to a series of recent chapters by Flavell (1970), Brown (1975, 1977), and Hagen, Jongeward, and Kail (1975). Here we will give only an indication of the major trends, the motivations behind each trend, and the current state of the art.

A) Capacity Differences

Although children's memory was a topic of interest even for the very early experimentalists (Binet & Henri, 1894; Binet, 1904; Galton, 1887; Hunter, 1917), concentrated attention on this topic did not become part of the mainstream of psychological research until the late 1950s and early 1960s. The majority of these early studies on the development of memory can be crudely categorized as demonstration studies of "capacity" differences, i.e., the older we get the greater memory capacity we have. It was readily shown that on a variety of tasks, older children remembered more than younger children, and slow learners had more difficulty remembering than did those of average ability, hardly a surprising result. The predominant explanation was simply that immature learners have a limited memory capacity and as they mature this capacity increases, allowing them to retain more. The underlying metaphor is clearly a container metaphor; little people have little storage boxes or jars in the head but bigger people have more room. Any demonstration of inferior performance on the part of the developmentally young, and such demonstrations were readily obtainable, "proved" this point.

Needless to say, the problem turned out to be somewhat more complex and it did not take long (even for psychology) for researchers to realize that certain reservations must be added. For example, the nature of the material that would be placed in the memory container was important. If the material was interesting to the child, or reinforced his preexisting beliefs, it was retained much better. Even very young children have excellent memories for certain categories of information, for example, real-world environments, location of objects, concentration-like games, nursery rhymes, familiar songs, Sesame Street chants, etc. (Brown, 1975). The anecdotal accounts of parents concerning the longevity of toddlers' memory for familiar people, places and things appear to be factual (Huttenlocher, 1975). In addition, memory differences across levels of maturity could not simply be accounted for by differences in the size of the memory container for if all that is required is recognition of past events, or familiar objects, young children's memory is extremely efficient, possibly not less efficient than that of adults (Brown, 1975). Even young babies show excellent recognition of pictures (Cohen & Gelber, 1975).

So much for a simple capacity notion, and therefore the utility of simple demonstration studies. We knew that children remembered less well than adults, except when they remembered as much or more. The question became, when and under what conditions do children perform poorly, rather than do they perform in general less well than adults.

B) Mnemonic Strategies

The mainstream of research during the 1960s and early 1970s was dominated by attempts to classify the common features of situations where the developmentally young routinely performed very poorly compared to adults. Situations meeting these criteria required that the child actively participate in a deliberate attempt to memorize, and usually demanded verbatim recall of impersonal material, often lists of items out of context. In order to perform efficiently on such tasks the memorizer must introduce a mnemonic strategy of some kind; for example, he might say the items over and over (rehearse them): he might elaborate the material so that it fits into a meaningful context (e.g., make up a story to embed the items): or he might look for redundancies, repeated elements or categories of information to reduce the memory load. Remembering there were four animals in a list of words will help retrieve the actual items; noting the repetition in the sequence 3 4 9 3 4 9 will reduce the load by half; noting that 1 4 9 2 1 7 7 6 1 9 4 1 is not simply a list of 12 arbitrarily chosen numbers, but rather three very well-known historical dates will make the list easily retainable. All these strategies help the deliberate memorizer make more efficient use of a limited ability for verbatim recall.

A mnemonic strategy can be broadly defined as any course of action which is deliberately instigated for the purpose of remembering. By means of various mnemonic schemes, material is organized, transformed, or maintained in such a way that a more efficient use of a limited capacity memory system is ensured. Thus, the main feature of a mnemonic strategy is that it is not essential for task performance but is a voluntary plan adopted by the memorizer for cognitive economy, a plan which is deliberately introduced for the goal of remembering.

During the late 1960s and early 1970s, developmental psychologists focused on the development of strategies of deliberate remembering to the virtual exclusion of other forms of memory. The simplest statement concerning the state of the art was one made by Flavell (1970), that if a mnemonic strategy is required for efficient performance on a task, developmental differences will be obtained. Brown (1975) added the corollary that when the need for such strategies is minimal, the task will be relatively insensitive to developmental trends. Reviews of the literature have amply documented that the deliberate control of what to remember and what to forget, together with the strategic use of various tactics to aid these processes, is inadequate in the developmentally young. There seems a general consensus that the degree to which some deliberate mnemonic strategy is required will determine the extent to which developmentally-related differences in performance will occur. As the child matures, he gradually acquires a basic repertoire of these skills, which emerge first as isolated task dependent actions but gradually evolve into flexible, generalizable skills (Brown, 1975, 1977; Meacham, 1977; Smirnov & Zinchenko, 1969). With extensive use, strategic intervention may become so dominant that it takes on many of the characteristics of automatic and unconscious processing, in that only intensive introspective questioning can reveal the operations of the strategic device even to the operator. The use of strategies becomes second nature to the efficient problem solver.

Under instructions to remember, the mature memorizer employs a variety of strategies which are not available to the developmentally less mature individual. These strategies form a hierarchy from simple processes like labelling and rote rehearsal, to elaborate attempts to extract or impose meaning and organization on the to-be-remembered material. Indeed, the outstanding feature of the mature memorizer is the amazing array of complex transformations he will bring to even the simplest laboratory task (Reitman, 1970). Thus, the extent of developmental differences seems to be determined by the degree to which increasingly complex strategic skills can be applied. While it may be possible to distinguish certain basic skills the child must acquire, once he has mastered these it is no longer possible to define an optimal strategy on a specific task. The optimal strategy for any one memorizer will depend on his success or failure with previous strategies, his estimation of his own capabilities, his creativity, certain personality variables, in fact, his personal cognitive style.

C) Training Studies

The next major interest to influence the field was a focus on training studies. This interest was generated both for basic and applied reasons but originally the impetus came from the importance of the outcome of such studies for developmental theory. In 1970, Flavell distinguished between two major deficits the young or retarded child may bring to a memory task. The first is a mediation deficiency, where the child is unable to employ a potential mediator (strategy) even when he is specifically instructed to do so. The hypothetical case in question refers to situations where the potential strategy is produced but fails to influence performance. A mediational deficiency would be said to exist if the child could be trained to overtly rehearse items, but that this activity failed to improve performance. The second type of deficiency is that of production. A production deficiency is said to be operating when potential mediators are not produced and hence do not aid performance. Thus, the child would perform poorly on a memory task requiring rehearsal because he does not spontaneously employ the rehearsal strategy, although he can be shown capable of doing so if he were instructed. The training studies were used to determine whether the child's problems were productional, and hence could be trained, or mediational and thus would resist training.

In summary of the early training studies it can be said that although immature learners display a strategic deficit in a wide variety of memorization situations, these deficiences readily respond to training. The problem appears to be one of production rather than mediation. With even quite limited training programs immature learners can be induced to attempt a variety of deliberate mnemonic activities. As it seems that most of the simple strategies are easily programmable, the possibility of applied value becomes intriguing.

To determine the degree of success of any training program, it must be evaluated against three basic criteria of effectiveness: (1) performance must improve as the result of training, both in terms of accuracy and in terms of the activities (strategies) used to effect this accuracy; (2) the effects of this training must be durable; it is obviously desirable to show that what has been trained can be detected after a reasonable time period has elapsed; (3) training must result in generalization to a class of similar situations where the trained activity would be appropriate, for without evidence of breath of transfer, the practical utility of any training program must be called into question.

Many of the early studies were successful in demonstrating that training effectively improved performance; however, considerably more difficulty was experienced when criteria 2 and 3 were used to evaluate the success of intervention. Although relatively brief instruction would lead to temporarily improved performance, the less experienced memorizer showed a marked tendency to abandon a trained strategy when not explicitly instructed to continue in its use. Several recent studies have shown that more extended training can result in durability of a trained behavior over a period of months and even years. The tendency to maintain a trained behavior also appears to be related to developmental level. Very young or retarded individuals are more likely to abandon the strategy than are slightly more sophisticated trainees (Brown, 1977).

The criterion of success that presents the most problems is generalization, or transfer to appropriate new situations. Although there is some controversy over what constitutes a suitable transfer task (Belmont & Butterfield, 1977; Brown, 1977) there is general agreement that evidence for flexible generalization to new situations is sadly lacking. This inflexibility in the use of trained skills in new situations is particularly problematic when the trainee is a retarded child. Both American and Soviet psychologists, not to mention parents and teachers, have repeatedly observed the difficulty mildly retarded children experience with generalization. Indeed it has been suggested that one of the major problems with slow-learning children is that they tend to weld new information to the specific situation in which it was acquired. Successfully training the child to use a simple skill in one specified situation seems to be well within our competence as instructors; getting the child to use the information appropriately in other settings appears to be the major hurdle.

To encapsulate the results to date of training studies aimed at inculcating rudimentary mnemonic strategies, it would seem fair to say that young, inefficient and slow-learning children do not tend to use a variety of simple memory strategies spontaneously. However, they are production deficient, as they can be instructed quite easily, and their performance improves. This improvement can be relatively durable on the specific task used for training. Flexible use of the skills in new situations is rarely found. Given these findings the next question concerned why the immature did not use the skills in the first place, or failed to use them intelligently once shown how. This led to an interest in the child's knowledge and control of himself as a memorizer, the currently popular area of metamemory research.

D) Knowledge about Memory-Strategies: Metamemory

Metamemory refers to the knowledge and beliefs one has concerning the activities of remembering and oneself as a memorizer. While the adult appears to know a considerable amount about his ability to study and acquire new information, the young child, in contrast, seems remarkably uninformed about his own strengths and weaknesses as a studier. In order to concoct a realistic plan for remembering, the memorizer must be capable of estimating his own capacity limitations and of realizing the need for some deliberate plan in those situations where his capacity limitation will be exceeded. The immature learner has difficulty with such requirements for he is generally not aware of his limitations in deliberate memorization tasks. Over and above the obvious problem of not knowing how to memorize efficiently, the young child does not seem to realize that he needs to memorize. He appears oblivious to the limitations of his memory capacity and unaware that he can make more efficient use of this limited capacity by strategic intervention (Brown, 1977; Flavell & Wellman, 1977). A simple concrete example of this state of ignorance is that children in the early grade school years have difficulty estimating how many items they will be able to recall from a supra-span list. They typically overestimate their span and predict that they can remember all of the presented items. Examples of underestimation are extremely rare and the incidence of realistic estimation increases dramatically between kindergarten and fifth grade. If the young child is not aware of his own limitations it is scarcely surprising that he fails to initiate a plan to remedy his shortcomings. Flavell and Wellman (1977) have shown that the young child is not aware of many aspects of himself as a memorizer, and fails to appreciate the utility of strategies to help make remembering an easier task.

Such a state of ignorance concerning strategy usage should not seem surprising given the usual experiences of the preschool child. The young child is seldom, if ever, required to reproduce exact information or to rote learn or study. Prior to the school years, the child has existed without a pressing need to employ deliberate strategies of remembering. He has managed to acquire a language; he can comprehend an impressive set of conceptual relations; he can recognize familiar places and people and reconstruct meaningful events without the need to employ strategies. He can reconstruct the essential features of his past and deal intelligently with his present.

It is only when he encounters material which is not inherently meaningful or must be reproduced exactly that deliberate memorial skills become absolutely necessary. It takes time for him to recognize that these, in some sense artificial, situations exist and demand that he respond with something more than has been required in the past. He must, in fact, recognize that because of the nature of the material and the need for exact reproduction, he must apply a deliberate strategy or he will fail to retain the material. When repeatedly faced with these situations, as he is in school, the child gradually comes to know more and more about how to remember, and thereby achieves insight into himself as a memorizer.

E) Summary

In the previous section we have given a brief history of the way developmental psychologists have set about studying memory strategies. We know a considerable amount about the development of rudimentary memorization skills. Young and slow-learning children tend not to use them spontaneously or even to be fully aware that deliberate intervention on their part is a prerequisite for efficient performance. Training studies have shown that a specific deficit can be overcome quite readily but it is unlikely that the child will think to use a trained skill in appropriate new situations. As with the original passive behavior which necessitated training in the first place, this transfer failure is thought to stem from a lack of knowledge concerning oneself as a memorizer. Before proceeding to an examination of the question of what to train we will give two detailed examples of training programs, which illustrate the general points made in this section. These are case studies of prototypical programs which illustrate how we arrived at the general overview given here. In the first case study we will consider rehearsal as a prototypical strategy of rote recall; in the second we will consider the problems inherent in attempts to inculcate metamemorial awareness or general skills.

III. Rehearsal: A Case Study of a Mnemonic Skill

In its most general sense, rehearsal refers to a wide set of activities which can be used to maintain information in consciousness for a period of time. The most frequent form of rehearsal involves continued covert repetition of the material to be remembered; this activity is useful in at least two ways. First, if the amount of information to be remembered is relatively small, it can simply be kept "alive" from its initial presentation until it is needed. The classic example of this use of rehearsal is the constant repetition of a telephone number from the time it is first located in a telephone book until it is actually dialed. Alternatively, if the amount of information is too great to allow the memorizer to keep it all alive simultaneously, rehearsing portions of the material together can facilitate the formation of associations between items, thus enhancing subsequent recall even when rehearsal is terminated a considerable time prior to the moment of recall. For example, in attempting to remember a set of 16 items, rehearsing sets of, say, four items together results in much better recall than not rehearsing, even though not all of the items can be kept alive until the time when recall is required. Repeating the main points of a lesson prior to proceeding to the next section involves similar principles.

We have chosen rehearsal as one of our vehicles for a number of reasons. The main ones result from the fact that rehearsal has been subjected to extremely close empirical and theoretical scrutiny. As a result, we know a great deal about the development of rehearsal strategies. We have also learned that this apparently simple skill turns out to be much more complex, and its usages more varied and sophisticated, than originally anticipated. As a result, a consideration of rehearsal research highlights the amount of analysis and ingenuity needed to devise an effective training program. Finally, the major findings involving rehearsal are also applicable to other mnemonic skills (Campione & Brown, 1977), and the statements made in this section can be assumed to be generalizable.

Training programs generally begin with a theoretical analysis of some specified task or set of tasks. The aim of this analysis, referred to as a task analysis, is to specify how the memorizer should perform to maximize his or her performance. In the examples chosen here, one of the requirements identified as essential for effective retention is the use of a rehearsal strategy. Thus, if the target group, in our case slow-learning children, perform poorly on the task, it is at least possible that their recall level is depressed because they fail to rehearse properly, if at all. At this point in the research program, two questions must be asked. One is whether the task analysis seems accurate, i.e., whether rehearsal is necessary for efficient performance and whether mature memorizers actually do employ rehearsal strategies in the task. Assuming that the answer is positive, the second question concerns whether the target group does in fact fail to employ rehearsal. Assuming another affirmative answer, it then makes sense to embark upon a rehearsal training program.

It should be clear that the investigation of these questions requires the development of measures of rehearsal usage. Unless we can reliably infer the presence or absence of rehearsal processes, the research can never really be started. While a number of measures have been employed, each of them has a number of associated problems. For example, observation of lip movements has been used to infer rehearsal activity; however, with older children and adults, rehearsal processes need not be accompanied by lip movements, thereby precluding their use in developmental or comparative research. Another common measure of rehearsal has been the presence of a so-called primacy effect in a number of recall paradigms. Consider a general case where a number of to-be-recalled items are presented sequentially, and recall begins immediately after the presentation of the last item (i.e., there is no appreciable delay between the subject's seeing or hearing the items and his being asked to recall them). The typical finding with adults is that recall is best for the items from the beginning of the list (primacy items) and the items at the end of the list (recency items), and poorest for items in the middle. The recency effect is attributed simply to the fact that the delay between presentation of these items and their recall is sufficiently short that these items have not yet faded from the memory of even the most passive observer. In contrast, the primacy, or initial, items will have faded from memory unless some activity designed to maintain them has been carried out by the subject. A favorite theoretical candidate for this activity is rehearsal, and the appearance of a primacy effect has thus been taken as evidence for the presence of rehearsal processes. The problem here is that there are alternative theoretical accounts of the primacy effect which do not make recourse to rehearsal processes. Thus, primacy need not necessarily indicate rehearsal. This list of potential rehearsal indicators and their attendant problems could be continued, but hopefully the point is clear.

In our view, the best solution to this problem is to resort to the use of converging operations, i.e., arrange an experimental situation in which there are a number of different potential indicators of rehearsal processes. Even if none of the measures is perfect, if all the indicators agree, we can be much more confident about any inferences drawn from the data. As an example, in some research from our own laboratory, as many as four indicators have been used and found to agree within one experiment (Brown, Campione, Bray, & Wilcox, 1973).

At this point, we should like to describe one research program which has emphasized the development of a training program. The task employed consists of having the subject see a series of items (consonants, digits, etc.) presented in succession in a series of windows. After the last item has been displayed, a "probe item" is presented; this is simply a replica of one of the items the subject has just seen. His task is then to indicate the window in which that item had appeared. For example, if the series had been 6 1 2 4 5 3 8, and if the probe item were a 2, the subject should point to the third window from the left. In a number of experiments, Belmont and Butterfield (1969, 1971) have modified the task in one important way -- they allow the subject to determine the rate at which the items are presented. Thus, the subject presses a button exposing the first item (which remains visible for .5 second) and can then wait as long as he or she wants before proceeding to the second item, etc. The pattern of pauses, or delays following each item, is then used as an additional index of rehearsal usage. For example, consider a six-item list. A likely pattern for a college student might be to proceed quickly until the fourth item had been exposed, then delay for a much longer time. Following items 5 and 6, only brief pauses would be observed, with the probe item being called for immediately. Such a pattern would be taken to indicate that the subject rehearsed the first four items together and then simply viewed the last two. This strategy, termed a "cumulative rehearsal - fast finish" strategy, takes cognizance of the fact that the initial items must undergo rehearsal to be remembered, whereas the last items will still be alive in memory even if they are simply viewed without any accompanying activity, as long as the probe item is exposed quickly.

In this situation, the pause patterns shown by the subjects provide one source of evidence relevant to the possible use of rehearsal. Using this analytic procedure, Belmont and Butterfield (1969, 1971) have shown that college students employ a variety of rehearsal strategies in this task, whereas retarded adolescents do not. The pause patterns of the retarded subjects are relatively flat, and pauses after each item tend to be brief. The retarded subjects also perform more poorly than college students, and their performance is poorest on the primacy, or initially presented, items. Thus, the overall pattern of their recall is nicely consistent with a rehearsal deficiency notion.

When retarded subjects are trained to rehearse, their pause patterns look like those of college students, their overall recall accuracy increases, and the increase is most pronounced with the primacy items (Belmont & Butterfield, 1971). In this experiment, the retarded subjects' accuracy increased considerably, showing the beneficial effects of training, but was still well below that of college students, leading to a further series of experiments (Butterfield, Wambold, & Belmont, 1973) aimed at refining the training techniques.

To modify the training procedure, a more detailed task analysis served as the starting point. The specific task involved a six-item series, and the strategy to be employed consisted of rehearsing the first three items as a set, and then quickly viewing the last three. The detailed task analysis is shown in Figure 1. Briefly, the subject first views each of the three initial items,

---

Insert Figure 1 about here

---

then pauses and rehearses the set of items a number of times to prepare for future recall (steps 1 and 2). The second set of three items is then viewed (step 3), followed immediately by exposure of the probe item (step 4). This completes the study strategy. Once the probe is exposed, a retrieval plan must also be adopted, and the plan must conform to the study strategy. As indicated in step 5, the subject should first attempt to determine if the probe was contained in the second set of items, those which were viewed but not rehearsed. If it was, the subject responds (step 6): if it wasn't, the search continues to the set of rehearsed items to determine where the probe item occurred (step 7) before responding (step 8). What is crucial in the retrieval plan is the order of search. If the initial, rehearsed set of items is considered first, and if the probe item is not found there, the subject will be in trouble, as the second set of items will have faded from memory. The use of a passive viewing of the last three items is based on the assumption that the contents of memory will not have time to fade if the probe comes quickly enough. If, however, the subject himself imposes a retention interval by searching through the initial trio of items first, the main rationale for having used such a study strategy is violated.

In the first experiment reported by Butterfield et al. (1973), retarded adolescents were taught the "3-3" study strategy, and the result was a clear improvement in accuracy, from 36% correct to 65% correct. Even with this large increment, two points were of interest. First, performance was still well below that obtained with college students, and second, the relation between strategy use, as measured by pause patterns, and level of recall was not as strong as it might have been, suggesting the operation of some other factors. A likely candidate here appeared to be retrieval mechanisms. Training in the first experiment consisted of leading the subjects through steps 1-4 depicted in Figure 1. The implicit assumption was that steps 5-8 would be adopted spontaneously.

In the next experiments, steps 5-8 were trained explicitly, along with steps 1-4. As an example of the more detailed training, we take the following procedure used in their third experiment. In the first phase, the first step of the study strategy was taught. Each subject was trained to label each of three items and then to stop and repeat the set three times. They were then required to count to ten before exposing the probe item and making their response. After six consecutively correct responses, they proceeded to the next phase. Here the second half of the study plan was taught, as subjects exposed three items quickly, called for the probe item, and responded. Thus, the two study phases were trained separately. Following this, a series of six-item lists was presented in which the subjects were informed that the probe item would always be drawn from the second trio of items. After making their response, they were further required to repeat the rehearsed items in order. The point of this part of training was to explicitly teach the subjects to search the non-rehearsed set first. Finally, they were given a series of trials where the probe could come from any position, but the instructions to search the second set of items first were repeated. Following this training and one additional refinement, accuracy increased to over 80% correct. In summary, the "...final performance of these subjects was 114 percent of that obtained from nonretarded adolescents on uninstructed 6-item lists, and 97 percent of that from nonretarded adolescents given active-passive learning instruction with 6-item lists" (Butterfield et al., 1973, p. 667).

The results of this program indicate clearly that dramatic improvements in memory performance can be brought about through detailed instruction. Elation over this success is tempered somewhat by a number of considerations. First, the development of the final training technique took just over five years. Second, it is not clear how long-lasting the effects of training might be. At the longest retention interval tested, 1 week, performance was significantly lower than immediately following training, although it remained above untrained levels. This is probably not a problem, as long-lasting effects of rehearsal training have been obtained by Brown, Campione, and Murphy (1974). The trained subjects from an earlier experiment by Brown et al. (1973) were re-tested six months after the original training, and eight of the 10 subjects continued to rehearse. The training afforded subjects in the original experiment was extensive, stretching over 12 days, and durable effects of training apparently can be expected if the amount of training is sufficiently great.

Much more problematic, however, are questions concerning the generalized effects of training. That is, can any effects of training be detected on anything other than the specific task on which training occurred? Unless the answer is affirmative, the effects are sufficiently limited that they may not be of any instructional interest. While there has not been much relevant research to date, the indications are not promising. For example, the subjects in the Brown et al. research were given a generalization test after the six-month retention test. The training and generalization tasks, while different, are similar in a number of ways. In the training task, the subjects were shown a series of four items, each from a different category, and were then cued with a category name and asked to recall the item from that category. They were specifically taught to rehearse the first three items together and then just to view the fourth one. The generalization task was the same as the task employed in the Belmont-Butterfield research just described. On this task, we could discern no effects due to training. No signs of rehearsal were obtained, and the trained subjects performed at exactly the same level as a control group given no training at all originally. Thus, while the subjects continued to rehearse six months after training as long as the task remained the same, the introduction of a different task eliminated the benefits of training.

IV. Training Metamemory

The disappointing lack of convincing evidence of broad generalization of a trained mnemonic strategy indicated a poor prognosis for obtaining general educational benefits from such exercises. Training efforts were subsequently directed at general determinants of performance (such as metamemory) rather than specific skills or strategies. Instead of training only one domain-specific heuristic such as rehearsal, it seemed more profitable to direct training attempts at the development of knowledge concerning strategies in general. Procedurally, it is difficult to conceive of a method of inculcating knowledge concerning strategy use in individuals who lack even the rudimentary strategies which could form the basis of this knowledge. Yet, if we are interested in effecting improvement in the child's general performance on a variety of similar tasks, we must consider both the specific gains from training (trained strategy use) and the general benefits (improved knowledge concerning memory tasks, leading to flexible strategy use).

To investigate the feasibility of this alternate approach, a series of training studies concerned with metamemorial knowledge were conducted with educable retarded children (Brown,1977; Campione & Brown,1977). As in our case studies we have taken two programs conducted in our laboratory, one which was unsuccessful in terms of generating transfer and one which is showing early signs of success. We will begin with the unsuccessful attempt, give reasons why the attempt failed and then proceed to the more hopeful program.

A) Predicting One's Own Memory Span

As there were no data concerning educable retarded children's metamnemonic efficiency at the initiation of this research program, our investigations began with a very simple form of awareness - the ability to estimate how many items one can remember. This awareness must underlie subsequent attempts to introduce strategies for if the child is not aware of the limitations of his ability to rote learn lists of items, he can scarcely be expected to introduce steps to remedy his shortcomings.

The basic task was one adapted from a study conducted with normal grade school children (Flavell, Friedrichs & Hoyt,1970) who were asked to estimate their recall span for lists of up to ten pictures. On each trial, from one to ten items were presented (one on the first trial, two on the second, etc.) and the child's task was to indicate at each list length whether he could still recall each item on that list. Over half of the nursery and kindergarten children predicted that they could recall even ten pictures, the largest number presented, an unrealistic estimate even for an adult, whereas only a few of the older children overestimated their ability. If as a measure of realistic evaluation we take an estimation of the actual span plus or minus two, the group mean met this criterion at the second and the fourth grade levels but not at the younger ages. The majority of younger children dramatically overestimated their span.

The procedure we followed (Brown, Campione & Murphy,1977) was essentially similar. Two groups of inexperienced slow learning children (MAs = 6 and 8, IQs = 69 and 72 respectively) were shown several arrays of ten pictures (exposed simultaneously) and asked to predict how many they would be able to recall on each of these sets. Mean predictions were then compared with their (subsequently determined) mean actual recall. Individuals whose estimates were within two items of their actual recall were termed realistic estimators; those whose guesses were more than two items in error were termed unrealistic estimators. Only 31% of the older children and 21% of the younger ones could be classed as realistic, with the remainder overestimating their performance levels (most predicted they could recall all ten).

All children were then given two days of training, where, for many trials, they were required to estimate their performance and then to recall. For half the participants at each MA level, explicit feedback was given reminding them of their prediction and indicating visually (displaying the numbers on an abacus) and verbally ("that was good, you got four right that time") the number of items they had actually recalled. This feedback was given following each estimation-recall series. The remaining children predicted and recalled an equal amount, but no explicit feedback was provided. After training was completed, three post-tests were given, each consisting of multiple assessment trials, the first one day after training, the second two weeks after training, and the third approximately one year after original pretesting.

In Figure 2 are the main data of interest, those obtained from the originally

---

Insert Figure 2 about here

---

unrealistic children. Students classed as realistic initially remained so throughout the experiment. Luckily our training did not cause them to regress. Considering the first posttest, 65% of the older individuals became realistic independent of the feedback condition. Of the younger trainees, 62% of those given explicit feedback became realistic, whereas only 9% of those not given feedback improved the point of being realistic. Looking at the data from posttest 2, the older individuals remained unchanged; 60% were still realistic, and there was no effect of the feedback variable. However, for the younger children, only 18% of those given feedback remained realistic, and none in the no-feedback group could be classed as realistic. Thus, considering the performance of the older children on only the first two posttests, training, with or without explicit feedback, is sufficient to bring about realistic estimation, and the effect is found two weeks later. The pattern obtained with the younger students contrasts sharply: there is significant improvement on the first posttest only when explicit feedback is provided during training, and even in this case, the effects are not durable, as the proportion of realistic estimators drops from .62 on posttest 1 to .18 on posttest 2. The effect of providing explicit feedback for the older children is illustrated only on the final posttest, one year after training. The proportion of realistic estimators remains unchanged in the feedback condition, whereas for those not given feedback during training, only 20% remain realistic.

The results of this initial experiment indicate that mildly retarded children have problems estimating their own performance. It also seems clear that, for the younger children, information about their performance needs to be explicit before it will have any effect, and that continual prompting may be necessary to maintain efficiency. Also, a clear developmental trend was found regarding the durability of training effects. Whereas training had a relatively durable effect with the older children, the effects with the younger ones were extremely short-lived.

The older children did however, show evidence of impressive maintenance of training as, one year later, 56% of the trainees were still performing effectively.

Therefore, we decided to apply our third criterion of success and test for generalization. One major problem for researchers in this area, however, is the selection of a suitable transfer task. The problem is that unless the investigator fully understands all facets of his transfer task he would not be in a position to interpret failures to find generalization. Such failure could be the result of the trainee's inability to see the relation of the trained behavior to the new task, the usual interpretation, or it could be because the trainee could not perform some other component of the transfer task which would impede his ability to apply the trained behavior even if he thought to do so (Belmont & Butterfield,1977; Brown,1977; Campione & Brown, 1974).

The dilemma is difficult to deal with for a variety of reasons, which need not concern us here; however, we have adopted a pragmatic approach. We choose tests of generalization which seem reasonable to us intuitively, and judge our intuitions to be successful if those children who spontaneously adopt the target strategy prior to any training also attempt to use it on the class of tasks used for transfer, i.e., the training and transfer tasks both elicit the strategy in natural users.

The principal generalization task (there were several others) given to the children in the span estimation project consisted of a test for estimation of recall of numbers rather than pictures. The children were shown twenty 10-item cards each containing the numbers 1 to 10. Ten of the cards contained the numbers in numerical order, the remaining cards contained the numbers in a randomized order. The subjects went through the 20 cards and indicated how many they would be able to recall on each; then, actual recall was assessed on both types of materials. Thus two sets of cards were used, organized and disorganized. Predicting 10 items on an organized list (e.g., the numbers in serial order) could be a realistic estimate, while predicting this many would be unrealistic for the random lists. For this reason we considered the two list types separatel The data from random lists only are presented in Table 1. Consider first the originally unrealistic subjects. Clearly there is no evidence of generalization following training on the highly similar 10-item picture task. The proportion

Insert Table 1 about here

of realistic subjects is low for both the MA6 and MA8 groups and the number of children predicting that they could recall all ten (10 guessers) is very high. Consider next the originally realistic subjects. Here the picture is quite different. The mean difference scores (predicted vs. actual) for both MA6 and MA8 children fall within the realistic range of plus or minus two. Approximately two-thirds of the originally realistic children are also realistic on the number generalization tests and the number of 10 guessers is low.

Turning to predictions on the organized lists, a similar pattern emerges. The proportion of children who <u>accurately</u> predict they will recall 9 or 10 items (e.g., appreciate the organization of the lists) is .67 and .58 for the originall realistic MA6 and MA8 subjects. Of the originally unrealistic subjects, no young child, and only .26 of the older children, do this.

As with prior training studies concerned with specific mnemonic skills (see rehearsal), our first systematic attempt to find generalization was less than encouraging. Those subjects originally realistic on the training task did show transfer to a variety of generalization tasks (we have not described all of them here), which suggests that the tasks themselves were adequate tests of transfer; however, the trained subjects were not so flexible. It should be noted that the generalization tasks were highly similar to the training task; in all, the basic requirement was to estimate one's own span for various types of 10-item lists. All consisted of very mild changes from the training task, but still there was no evidence of generalization even in the older subjects.

The negative outcome obtained here caused us to think more about the kind of skills we were attempting to train. It is likely that, as with rehearsal, the ability to predict one's rote memory capability is of limited generality or applicability. It may be the case that such activities are less likely to be generalized than more context-free strategies, and it was to this type of activity that we turned next.

B) Predicting Readiness for Recall

In the second somewhat more successful training program (Brown & Barclay 1976; Barclay & Brown, 1976) we focused on a very simple general strategy which could reasonably be supposed to have a wide range of application. Basically, we attempted to train a "stop-check-and-study" routine. The specific task used, one of assessing readiness to recall, was also adapted from Flavell's original work with normal children (Flavell et al., 1970). On each of a series of trials, the child is given a list of pictures equal to one and one half times the mean number he actually recalled during a series of practice trials (e.g., 1½ times his span). He is instructed to continue studying the items until he is sure he can remember all of them perfectly, and then signal the experimenter when he is ready. Judging recall readiness for supra-span lists is an intriguing task for it demands a complex form of self-evaluation, involving both the use of a specific mnemonic strategy (introduced to effect learning) and the ability to monitor its success: to both behave strategically and to "self-test" the success of the strategy in order to terminate study activity. In addition, it requires not only the ability to differentially study difficult items, another metamemory ability sensitive to cognitive maturity (Brown & Campione, 1976), but it also requires that the subject engage in self-testing activities to determine which are the difficult items.

Not surprisingly immature children performed very poorly on the initial pre-testing phase of the study. Only [illegible]% of an MA6 sample and 12% of an MA8 sample gave even one perfect recall. This indicates poor performance considering the children were allowed as much time as they wanted. One reason why the developmentally young perform so poorly on this task could be that they do not tend to introduce strategies of deliberate memorization, such as rehearsal and anticipation, involving self-testing elements, which would alert them to their readiness for a test. If children do not use such self-testing devices, they can hardly be expected to monitor their own stage of learning.

For this reason we trained groups of children in the use of three strategies of remembering: anticipation and rehearsal, both of which involve self-testing elements; and labeling, which does not. The labeling condition essentially served as a control treatment. All were required to go through each list once, naming each picture. This labeling trial was followed by a series of three more trials on which the procedures differed between the groups. Those in the anticipation group were trained to anticipate the next picture by saying its name before exposing it. The rehearsal subjects were trained to rehearse the items in sets of three (cat, shoe, cup, cat, shoe, cap, etc.). Finally, the label group was told to go through the list three more times, labeling each item. All groups were further encouraged to continue with the instructed activity until they were sure they could recall all items. Training was continued for two days.

Following training, four posttests were given, a prompted posttest (one day after training) on which individuals were instructed to continue the trained strategy, and three unprompted posttests given one day, approximately two weeks, and approximately one year later. The main results are shown in Figure 3 which gives the percent of correct recall averaged across many trials.

Insert Figure 3 about here

The break in the curve between posttests 3 and 4 indicates that not all individuals were retested on the final posttest: however, 78% of the MA 6 and 90% of the MA8 children were available for retesting one year after the start of the study. As can be seen, both the younger and older children in the anticipation and rehearsal groups perform significantly better on the prompted posttest (posttest 1) than on the pretest. Additionally, if we consider the anticipation and rehearsal groups, 72% of younger subjects recalled perfectly on at least one trial, compared with none on the pretest; the corresponding figures for the older subjects are 92% on posttest 1 compared with 8% on the pretest. Thus, training the useful self-testing strategies results in both enhanced performance (percent recall data) and improved monitoring (data on number of perfect recalls), compared with the control labeling group.

The MA6 and MA8 groups differed considerably on the last three (unprompted) posttests. For the younger group, performance on posttests 2, 3, and 4 was not significantly different from the pretraining level, whereas for the older group, performance on all posttests differed significantly from the pretraining level. Thus, as in previous studies concerned with direct training of a strategy, training facilitates performance, with the effect being somewhat durable for the older children but transitory for the younger ones.

The younger child's dependency on continual prompting was particularly well-illustrated on the one-year follow-up tests, which consisted of four days of testing. On the two initial days, the children were given unprompted posttests identical to the previous unprompted tests, and it is these data that are included in Figure 3. On the third day, the experimenter reverted to the prompting procedure, demonstrating and reminding the child of his trained strategy and urging its continued use. The fourth day of the one-year follow-up was a further unprompted posttest. These data are included in Table 2. Note that both the

---

Insert Table 2 about here

---

younger and older children benefit from the prompting although the effect is less dramatic for the older children who were performing quite adequately without the prompts. Of main interest is the failure of the younger children to maintain their enhanced performance on the final nonprompted test. Without continual prompting, the younger children show little evidence of the effects of intensive training.

Given the poor performance of the younger group we made no attempt to test these children for evidence of generalization. The older children looked more promising, however, so we decided to see whether they would show the benefits of the recall readiness training on quite a different task. Systematically studying material until it is judged to be well enough known to risk a test, is, of course, a very general strategy, as any student could attest. Therefore, we were hoping that even with very different materials, the children who had received extensive training would show some generalized benefits.

The transfer task selected was one which we believed to be more representative of the type of study activity required in the classroom. Most studying requires the student to extract the main ideas of prose passages and regurgitate the gist of the ideas in his own words. Our question was, would training recall readiness on the simple rote-list learning task help children on the more typical school study activity? We reasoned that if we could find transfer under these conditions our training would really have practical utility; if we did not, we could always revert to less ambitious transfer tasks, those more like the training vehicle. It should be admitted, however, that before expending the valuable trained population, we did ascertain that a few selected children were performing very efficiently on our optimal transfer task.

The data are still being analyzed but we can give the main flavor of the results here. There were four groups of subjects, the older children who had been trained in the three groups, anticipation, rehearsal, and labeling, and a new group of children matched for IQ, MA, and reading scores with the trained subjects, and, in fact, selected from the same special education classrooms as the previously trained students. All students were reading at second to fourth grade level. The two successfully trained groups, anticipation and rehearsal, who had shown evidence of correctly estimating their readiness to recall were the groups from which we hoped to obtain transfer. The new students formed an obvious control group which would enable us to compare our trained children to others who shared important characteristics (age, IQ, class placement, reading scores) with the experimental groups, but had not received training. The fourth group, labeling, also served an important control function. They had been in as many sessions as our experimental groups and had interacted with the tester just as much, but they had not been trained in successful recall readiness, and had not improved notably above pretraining levels.

All students received six days of testing. On each day they were given two stories of approximately 100 words each, the stories were of second grade reading difficulty. On each trial the students read the story through with the experimenter and received help with any words they did not know. They were then told to continue studying the story until they were sure that they could retell the main events in their own words. During their study time the tester recorded any overt activity and the amount of time taken before the child indicated he was ready to test his memory.

To date we have compiled two indices of performance, the mean total study time and the mean number of words recalled. The second measure is only an indication of efficiency and we are currently scoring the number of idea units recalled, the usual practice in studies such as these (some people can effectively give the gist of an idea in far fewer words than others).

The major data of interest are given in Table 3. Both the amount of time

Insert Table 3 about here

spent studying and the number of words recalled were significantly greater in the two trained groups than in the two control groups. Those children who successfully maintained adequate recall readiness for a list learning task appeared to show the benefits of this training on a prose learning task, our first evidence of successful generalization.

Because of the importance of these data we are currently analyzing the results in greater depth and replicating the main features of the experiment. One additional indication of successful transfer which we will consider more fully is our first crude classification of the observed external study behaviors. The proportion of children showing any evidence (even once on twelve stories) of a few broad classes of activities relevant to studying, are also shown in Table 3. Such activities included underlining, circling key words, writing notes, rereading, self-testing, lip movements, etc. Even though evidence for strategic study activities was generally scarce, the difference between the trained and untrained groups was again apparent, with two-thirds of the trained children showing some relevant activity compared with one-third of the untrained subjects.

V. Practical Implications of Training Studies

Although we have concentrated on a few research programs, the information obtained from them is fairly representative of the state of the art. Now the question is, what, if anything can be learned from these basic research programs that could have any implications in terms of guiding educational practices?

First let us consider the successes achieved so far by training studies. We know a considerable amount about how to train basic memory strategies. Some improvement in performance tends to follow even quite cursory intervention.

When detailed task analysis of the type introduced by Butterfield, Wambold, and Belmont, are employed, one can effect dramatic improvement, such that retarded persons perform at least as well as untrained adults. The success of such detailed task analysis for effecting improvement is most encouraging.

At this point, however, it seems reasonable to consider the desired outcome of training. If the aim of training is to see how close to mature performance one can render children's behavior, the detailed task analysis approach is highly successful. Theoretically such data are invaluable for they demonstrate that one pervasive interpretation of a developmental deficit, the smaller capacity interpretation mentioned earlier, is incorrect. For if training fails, one should not implicate some fundamental capacity limitation of the child but attempt to refine training. Practically, the task analysis approach is invaluable, if the desired end-product is to improve performance on the training task. Gold's (1972) work with severely retarded individuals is an excellent case in point. Severely and profoundly retarded institutionalized people can be quickly trained to perform complex assembly jobs, if the task is broken into easily manageable subunits, an intelligent task decomposition achieved through detailed task analyses. The goal of the training procedure is to achieve quick, errorless performance on the training task, for, armed with this skill the hitherto unemployable individual can earn a living wage.

The aim of those engaged in cognitive instruction is generally assumed to be somewhat different. Rather than regarding the goal as excellent performance on a specific isolated task, the desired end-product is to effect a general improvement in understanding which would be reflected on a whole class of similar tasks, a much more demanding specification. This aim can again be defended both theoretically and practically. Theoretically, one could argue that without evidence of broad transfer, training may have resulted in the mastery of a rote rule, but may not have produced any real change, or general advancement in the child's knowledge of the world (Kuhn, 1974). Demonstrating adult-like performance on a single task is sufficient evidence for those who are interested in proving that intellectual immaturity is not necessarily an impediment to efficiency on any one specific task. However, there are strong reasons to believe that there are limitations to the young thinker's ability to reason. If this is true, mere training on a rote response will not affect this ability until an appropriate level of cognitive maturity is reached. Intellectual growth may be accelerated, but training can achieve only a small increment (Inhelder, Sinclair, & Bovet, 1974). Within the memory training field, advocates of this more conservative position look for generalization as the index of successful training. As we have seen the evidence for generalization following training on specific mnemonic strategies, such as rehearsal, is less than impressive.

And the cost of such training programs is great, the rehearsal training program of Belmont and Butterfield took years to complete as did the early metamemory training programs from our laboratory. If the aim is to bring children up to adult levels of performance on a particular task the Belmont and Butterfield program has succeeded admirably; but, if as a result the trainees do not evidence the effect of training in any situation other than the training vehicle, one must question the practical utility of what has been trained. In terms of cost effectiveness, the prognosis for educational gains from such programs appears limited, interesting as they are from a theoretical standpoint.

We would like to argue that in order to justify such detailed task analyses, efficiency in the skill that is the subject of training should be an end result in itself. There are two situations where this would be the case. The first is where mastery on the trained task is itself of great practical use, even in the absence of any generalization. An example of such a program would be Gold's assembly task training for severely retarded individuals. A second case where it would be worth the detailed task analyses approach is if the skill trained is by definition applicable to a great range of situations, for example, reading. Attempts to apply task analysis approaches to beginning reading skills have been less successful than one would like, largely because we do not understand the reading process clearly. Yet few would deny the practical utility of searching for a workable training program for reading, based on thoughtful and detailed task analyses. Reading, by definition is a generalizable skill, a perfectly desirable end-product of an intensive training program.

In terms of training strategies of learning and memory, however, the success of most training programs is limited, if practical outcomes are the main focus. This failure may result, in part, from the concentration on rote skills. The very young child seems not to benefit much from explicit training either in a rote skill or in feedback concerning the limitations of his own memory. The one hopeful sign has been the successful maintenance and generalization in the recall readiness task. And this success is particularly illustrative, not only because of its rarity, but also because the "skill" trained was decidedly different from those that have been the subject of previous training programs. The basic requirement in all phases of this program was that the child continue to study until he felt ready for a test; to stop and wait to respond until some effort at memory monitoring, or self-testing, had been undertaken. Such behavior would represent a generally useful strategy, applicable in a wide variety of study situations, from the practical to the academic.

We would be even more encouraged if we can find generalization to "real-life" situations. In all future studies we intend to observe trained and untrained children on classroom and resource room activities where our training skill should be appropriate to see if, indeed, the training has any worthwhile benefits in terms of generalized improvement. To effect this, we intend to train two general skills, one to half the children and the other to the remainder. Then we will look for experimental and real-life evidence of maintenance and generalization. Two skills will be the subject of study so that we can ourselves generalize about our results and so that children will not be placed into a no-training group. If our training is going to enhance classroom performance, children should not be denied access to it if possible. We do not lose experimental rigor, however, for children trained on A should show generalization of A and can act as a control group for skill B, where they have not received training. The reverse would be true of the subjects receiving training on skill B.

We believe that it is time to rethink the types of skills we have attempted to train. How often does the mature memorizer rehearse? Probably not often. If children do not generalize a rehearsal strategy because they fail to see its utility, this could be a realistic appraisal of the enterprise. After all, they all tell us that they write down telephone numbers (Brown, 1977); one of the authors writes down telephone numbers.

An alternative strategy would be to train general, metamemory skills, which could have great generality across a variety of problem-solving situations, skills such as checking, planning, asking questions, self-testing and monitoring. These skills are transsituations, i.e., they apply to many forms of problem-solving activity rather than being restricted to a certain limited task domain. Indeed, if one is interested in the ecological validity of the processes we select for study, the skills subsumed under the heading of metacognition (Brown, 1977) do appear to have recognizable counterparts in "real-world, everyday life" situations. Checking the results of an operation against certain criteria of effectiveness, economy and common-sense reality is a metacognitive skill applicable whether the task under consideration is solving a math problem, memorizing a prose passage, following a recipe, or assembling a piece of furniture. Self-interrogation concerning the current state of one's own knowledge during problem solving is an essential skill in a wide variety of situations, those of the laboratory, the school, or everyday life.

Thus, the types of cognitive activities which we believe suitable for intensive intervention should have certain properties, (a) they should have transsituational applicability, (b) they should readily be seen by the child to be reasonable activities that work, (c) they should have some counterpart in real-life experiences, and (d) their component processes should be well understood so that effective training techniques can be devised. Our bias directs us to a subset of general metacognitive activities which we feel admirably fit the prescription, checking, monitoring, and reality testing, etc. This is, of course, still too ambitious and we would advocate the selection of a few basic skills for intensive study. The ones we have chosen can be subsumed under the general heading self-interrogation.

The eventual aim is to train the child to think dialectically, in the sense of the Socratic teaching method. In the Socratic method, the teacher constantly questions the students' basic assumptions and premises, plays the devil's advocate, and probes weak areas, using such techniques as invidious generalizations and counter-example (Anderson, 1977; Brown, 1977; Collins, 1977). The desired end-product is that the student will come to perform the teacher's functions for himself via self-interrogation. Although the sophisticated skills described by Collins are obviously not directly applicable to young slow-learning children, the basic principles underlying the approach are. We have begun at the very simple level of teaching the child to self-interrogate when faced with a certain class of problems (instructions, math problems, a laboratory task, etc.). The type of self-interrogation which we think might work is to provide the child with a routine set of questions to ask himself before proceeding, e.g., (a) stop and think! (b) do I know what to do (i.e., understand the instruction, both explicit and implicit)? (c) is there anything more I need to know before I can begin? and (d) is there anything I already know that will help me (i.e., is this problem in any way like one I have done before)?

We are currently attempting to train educable retarded children to follow instructions both verbal and written and to perform a variety of simple prose comprehension tasks, all in the context of a meaningful activity, like assembling a toy or following a recipe. In the course of these activities, they must deliberately and overtly pass through a self-interrogation routine like the one described above. We believe that devising simple systems for eliciting self-awareness and conscious control over one's own activities is an important form of training because the end-product is desirable in its own right, it should have transsituational applicability and it should improve both the child's cognitive and metacognitive skills and his feeling of personal competence and control.

References

Anderson, R. C. The notion of schemata and the educational enterprise. In R. C. Anderson, R. J. Spiro, and W. E. Montague (Eds.), Schooling and the acquisition of knowledge. Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1977, in press.

Barclay, C. R., & Brown, A. L. Long-term maintenance of recall-readiness efficiency in educable retarded children. Unpublished manuscript, University of Illinois, 1976.

Belmont, J. M., & Butterfield, E. C. The relation of short-term memory to development and intelligence. In L. P. Lipsitt & H. W. Reese (Eds.), Advances in child development and behavior (Vol. 4). New York: Academic Press, 1969. Pp. 30-83.

Belmont, J. M., & Butterfield, E. C. Learning strategies as determinants of memory deficiencies. Cognitive Psychology, 1971, 2, 411-420.

Belmont, J. M., & Butterfield, E. C. The instructional approach to developmental cognitive research. In R. V. Kail, Jr., & J. W. Hagen (Eds.). Perspectives on the development of memory and cognition. Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1977, in press.

Binet, A., & Henri, V. La memoire des phrases (Memoire des idées). L'annee Psychologique, 1894, 1, 24-59.

Binet, A. Les frontières anthropometriques des anormaux. Bulletin de la Société libre pour l'étude psychologique de l'enfant, 1904, 430-438.

Brown, A. L. The role of strategic behavior in retardate memory. In N. R. Ellis (Ed.), International review of research in mental retardation (Vol. 1). New York: Academic Press, 1974. Pp. 55-111.

Brown, A. L. The development of memory: Knowing, knowing about knowing, and knowing how to know. In H. W. Reese (Ed.), Advances in child development and behavior (Vol. 10). New York: Academic Press, 1975. Pp. 103-152.

Brown, A. L. Knowing when, where, and how to remember: A problem of metacognition. To appear in R. Glaser (Ed.), Advances in instructional psychology. Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1977, in press.

Brown, A. L., & Barclay, C. R. The effects of training specific mnemonics on the metamnemonic efficiency of retarded children. Child Development, 1976, 47, 70-80.

Brown, A. L., & Campione, J. C. Training strategic study time apportionment in educable retarded children. Intelligence, 1977, in press.

Brown, A. L., Campione, J. C., Bray, N. W., & Wilcox, B. L. Keeping track of changing variables: Effects of rehearsal training and rehearsal prevention in normal and retarded adolescents. Journal of Experimental Psychology, 1973, 101, 123-131.

Brown, A. L., Campione, J. C., & Murphy, M. D. Keeping track of changing variables: Long-term retention of a trained rehearsal strategy by retarded adolescents. American Journal of Mental Deficiency, 1974, 78, 446-453.

Brown, A. L., Campione, J. C., & Murphy, M. D. Maintenance and generalization of trained metamnemonic awareness in educable retarded children. Journal of Experimental Child Psychology, 1977, in press.

Butterfield, E. C., & Belmont, J. M. Assessing and improving the cognitive functions of mentally retarded people. In I. Bailer & M. Steinlicht (Eds.), Psychological issues in mental retardation. Chicago: Aldine Press, 1976.

Butterfield, E. C., Wambold, C., & Belmont, J. M. On the theory and practice of improving short-term memory. American Journal of Mental Deficiency, 1973, 77, 654-669.

Campione, J. C., & Brown, A. L. The effects of contextual changes and degree of component mastery on transfer of training. In H. W. Reese (Ed.), Advances in child development and behavior (Vol.9) New York: Academic Press, 1974. Pp. 69-114.

Campione, J. C., & Brown, A. L. Memory and metamemory development in educable retarded children. In R. V. Kail, Jr., & J. W. Hagen (Eds.), Perspectives on the development of memory and cognition. Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1977, in press.

Cohen, L. B. & Gelber, E. R. Infant visual memory. In L. Cohen & P. Salapatek (Eds.), Infant perception. New York: Academic Press, 1975.

Collins, A. Processes in acquiring and using knowledge. In R. C. Anderson, R. J. Spiro, & W. E. Montague (Eds.), Schooling and the acquisition of knowledge. Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1977, in press.

Flavell, J. H. Developmental studies of mediated memory. In H. W. Reese & L. P. Lipsitt (Eds.), Advances in child development and behavior (Vol.5). New York: Academic Press, 1970. Pp. 181-211.

Flavell, J. H., Friedrichs, A. G., & Hoyt, J. D. Developmental changes in memorization processes. Cognitive Psychology, 1970, 1, 324-340.

Flavell, J. H., & Wellman, H. M. Metamemory. In R. V. Kail, Jr., & J. W. Hagen, (Eds.), Perspectives on the development of memory and cognition. Hillsdale, New Jersey: Lawrence Erlbaum Associates, in press.

Galton, F. Supplementary notes on 'prehension' in idiots. Mind, 1887, 12, 79-82.

Gold, M. W. Stimulus factors in skill training of the retarded on a complex assembly task: Acquisition, transfer and retention. American Journal of Mental Deficiency, 1972, 76, 517-526.

Hagan, J. W., Jongeward, R. H., Jr., & Kail, R. V., Jr. Cognitive perspectives on the development of memory. In H. W. Reese (Ed.), Advances in child development and behavior (Vol. 10). New York: Academic Press, 1975. Pp. 57-101.

Hunter, W. S. The delayed reaction in a child. Psychological Review, 1917, 24, 74-87.

Huttenlocher, J. The origins of language comprehension. In R. L. Solso (Ed.), Theories in cognitive psychology: The Loyola Symposium. Washington, D.C.: Winston, 1976. Pp. 331-368.

Inhelder, B., Sinclair, H., & Bovet, M. Learning and the development of cognition. Cambridge, Mass.: Harvard University Press, 1975.

Kuhn, D. Inducing development experimentally: Comments on a research paradigm. Developmental Psychology, 1974, 10, 590-600.

Meacham, J. A. Soviet investigations of memory development. In R. V. Kail, Jr., & J. W. Hagen (Eds.), Perspectives on the development of memory and cognition. Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1977, in press

Reitman, W. What does it take to remember? In Norman (Ed.), Models of human memory. New York: Academic Press, 1970. Pp. 470-509.

Ross, D. M., & Ross, S. A. An intensive training curriculum for the education of young educable mentally retarded children. Final report, Project Nos. 132106 and H932106A, DHEW, U.S. Office of Education, December 1972.

Shif, Z. I. Development of children in schools for the mentally retarded. In M. Cole & I. Maltzman (Eds.), A handbook of contemporary Soviet psychology. New York: Basic Books, 1969. Pp. 326-353.

Smirnov, A. A. & Zinchenko, P. I. Problems in the psychology of memory. In M. Cole & I. Maltzman (Eds.), A handbook of contemporary Soviet psychology. New York: Basic Books, 1969. Pp. 452-502.

Footnotes

[1]The preparation of this manuscript was supported by Grants HD 06864 and HD 05951, and a Research Career Development Award HD 00111 from the National Institutes of Child Health and Human Development.

The authors would like to extend their especial appreciation to Mrs. Wilma Noynaert, Assistant Director of Special Education for the Peoria Public Schools. She has continually provided support and encouragement and has made access to special education classes readily available. The authors would also like to thank Mrs. Carolyn Long for her patience and skill in testing the children and, of course, the children themselves for their willing and active participation.

Table 1

Number Generalization Test, Random Lists

(from Brown, Campione, & Murphy, 1977)

	Originally Realistic		Originally Unrealistic			
			No Feedback		Feedback	
	MA 6	MA 8	MA 6	MA 8	MA 6	MA 8
Mean Difference Score	1.75	1.08	5.09	3.64	5.00	4.42
Proportion Realistic	.67	.75	.09	.28	.08	.25
Proportion 10 Guessers	.17	.17	.73	.43	.67	.50

Table 2

Proportion Correct on Recall-Readiness Posttests (From Brown 1977)

		Posttests						
		Original Data			One year follow up			
Group	Condition	Prompt	No Prompt	No Prompt	No Prompt	No Prompt	Prompt	No Prompt
	Anticipation	.82	.62	.52	.50	.48	.81	.57
MA 6	Rehearsal	.77	.61	.49	.46	.50	.90	.63
	Label	.60	.56	.55	.46	.58	.78	.54
	Anticipation	.92	.84	.81	.80	.72	.95	.85
MA 8	Rehearsal	.89	.82	.81	.74	.73	.84	.83
	Label	.74	.65	.63	.60	.61	.67	.63

Table 3

Recall Readiness Generalization Test

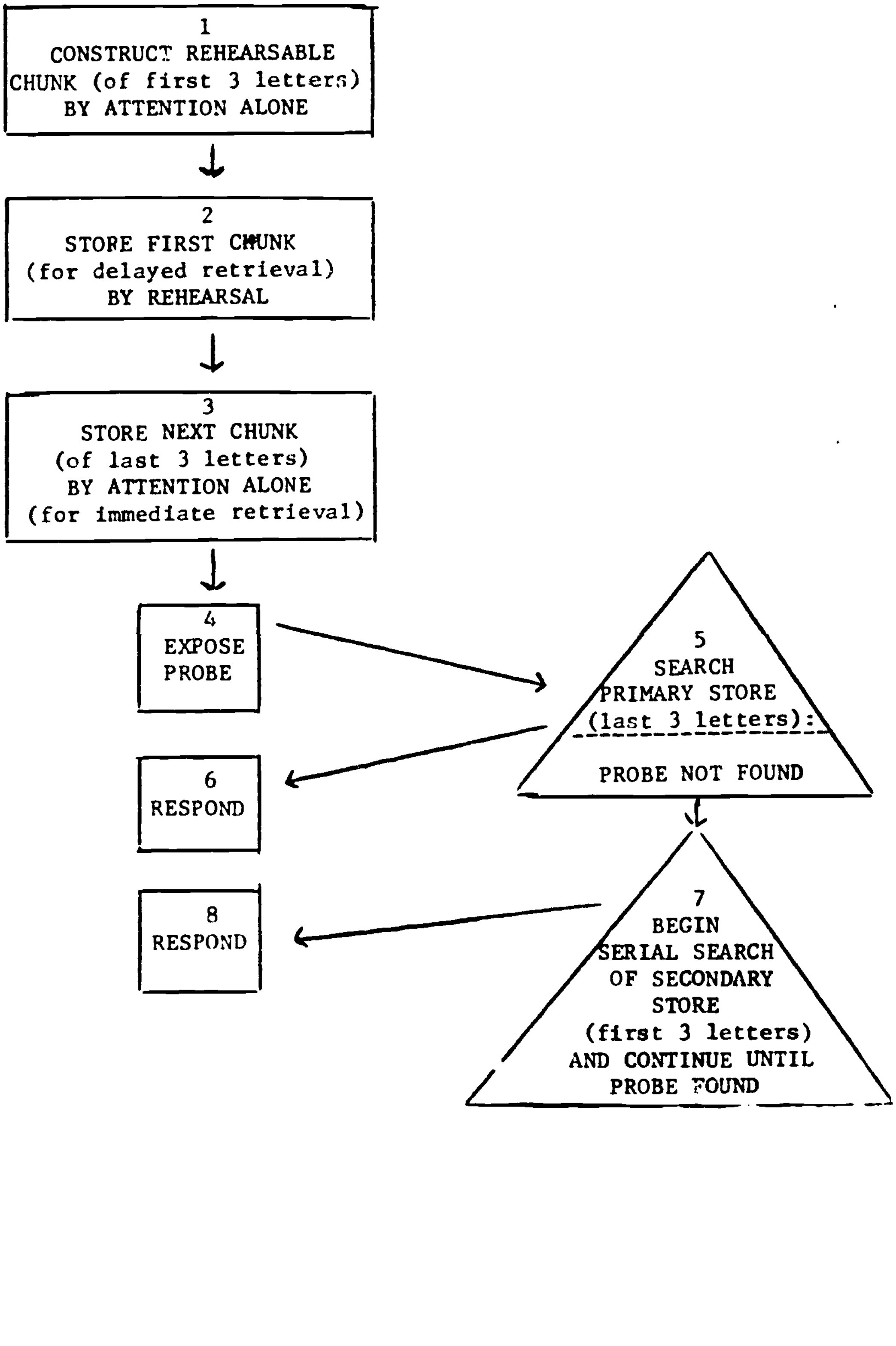
Groups	Anticipation	Rehearsal	Label	New
Mean Study Time (Sec.)	103.7	105.6	57.6	62.4
Mean Number Words Recalled	57.3	61.7	43.0	40.1
Correlation of Study Time and Words Recalled	.89	.67	.56	.94
Proportion Showing Some Overt Study Activity	.67	.64	.40	.29

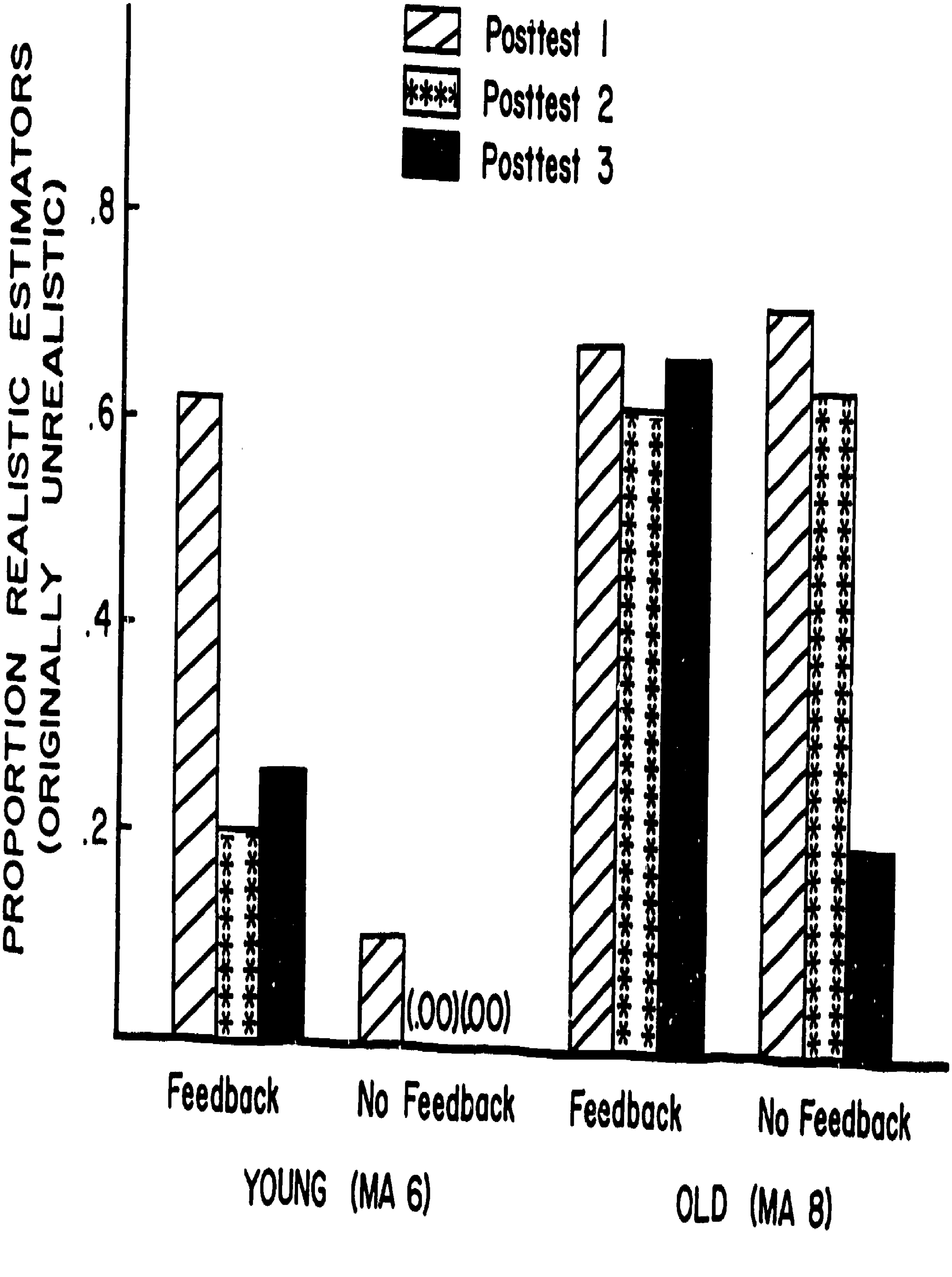
Figure Legends

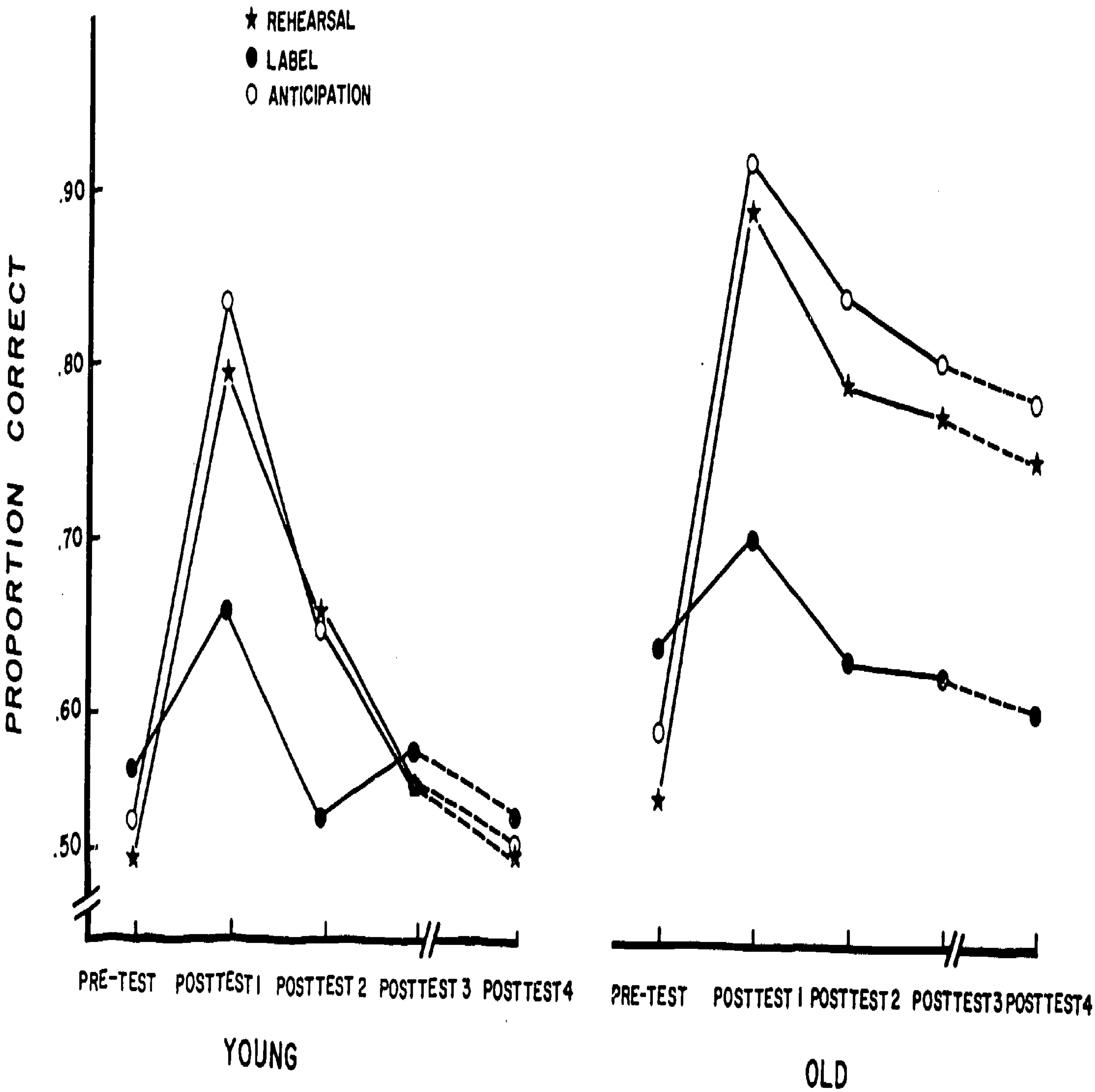
Figure 1. A task analysis of the six-item probed recall procedure (from Butterfield, Wambold, & Belmont, 1973).

Figure 2. The proportion of unrealistic estimators who become realistic following training as a function of MA and feedback condition (from Brown, Campione, & Murphy, 1977).

Figure 3. The proportion of items recalled as a function of mental age, training condition, and test phase (from Campione & Brown, 1977).


1
CONSTRUCT REHEARSABLE CHUNK (of first 3 letters) BY ATTENTION ALONE
2
STORE FIRST CHUNK (for delayed retrieval) BY REHEARSAL
3
STORE NEXT CHUNK (of last 3 letters) BY ATTENTION ALONE (for immediate retrieval)
4
EXPOSE PROBE
5
SEARCH PRIMARY STORE (last 3 letters):
PROBE NOT FOUND
6
RESPOND
7
BEGIN SERIAL SEARCH OF SECONDARY STORE (first 3 letters) AND CONTINUE UNTIL PROBE FOUND
8
RESPOND


Posttest 1
Posttest 2
Posttest 3
PROPORTION REALISTIC ESTIMATORS
(ORIGINALLY UNREALISTIC)
.8
.6
.4
.2
(.00)(.00)
Feedback
No Feedback
Feedback
No Feedback
YOUNG (MA 6)
OLD (MA 8)



REHEARSAL
LABEL
ANTICIPATION
PROPORTION CORRECT
.90
.80
.70
.60
.50
PRE-TEST
POSTTEST 1
POSTTEST 2
POSTTEST 3
POSTTEST 4
YOUNG
OLD