METAMEMORY, INCENTIVES AND THE USE AND GENERALISATION OF A CUMULATIVE REHEARSAL STRATEGY IN MILDLY RETARDED CHILDREN.

METAMEMORY, INCENTIVES AND THE USE AND GENERALISATION OF A CUMULATIVE REHEARSAL STRATEGY IN MILDLY RETARDED CHILDREN

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ABSTRACT

The major issue addressed in this study was the relationship between the use and generalisation of a trained mnemonic strategy and metamemory, knowledge of memory, obtained after training in the strategy, in mildly retarded children.

Twenty-five mildly retarded children were trained to use a cumulative rehearsal strategy in a free recall, list learning task. Use of the strategy in the training task and generalisation of the strategy to a novel task were assessed concurrently by two measures of rehearsal (overt rehearsal scores and linear trend in item exposure times), in conditions of high and low incentive to remember where subjects were respectively, either reinforced or not-reinforced for recall.

Three measures of different aspects of metamemory were obtained before and after training in strategy use. Only one of these measures indicated significant change in metamemory following training in the rehearsal strategy.

Canonical correlations were performed on the post-test independent measures (the three measures of metamemory) and the dependent measures (the two measures of rehearsal) obtained after training. These analyses did not indicate significant relationships between post-test metamemory and use or generalisation of the rehearsal strategy in either high or low incentive conditions. The findings of this study are discussed in relation to the involvement of automatic versus conscious control of strategy use.

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SOURCES STATEMENT

To the best of my knowledge and belief, the material contained in this thesis is original and has not appeared elsewhere unless acknowledged in the text.

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CHAPTER 1

INTRODUCTION

Findings from a large number of studies carried out over the past 15 years have consistently indicated that mentally retarded children experience difficulty in the acquisition stage of learning (e.g. Baumeister & Kellas, 1971; Kellas, Ashcraft & Johnson, 1973; O'Connor, 1973). It now appears that much of this difficulty can be attributed to a tendency of retarded children not to use active mnemonic strategies in the acquisition of new material (Kendall, Borkowski & Cavanaugh, 1980). While developmentally normal children may adopt such strategies as rehearsal and categorisation, retarded children of similar age tend to adopt a more primitive and less effective rote learning technique (O'Connor, 1973).

Mnemonic Strategies

Pressley, Heisel, McCormick and Nakamura (1982) have defined a mnemonic strategy as a "course of action or plan which is deliberately undertaken for the purpose of remembering" (p. 127). Mnemonic strategies are seen as voluntary activities, carried out by individuals to enhance the encoding, storage and/or retrieval of information (Brown, 1974). Although some work relating to the use of retrieval strategies in children has been reported (Kobasiquawa, 1977; Harris, 1978), the literature on strategy use in children has been primarily concerned with acquisition strategies, the major effects of which are on the encoding and storage of information. The present discussion is therefore limited to acquisition strategies. The following are the strategies which have been studied most often in normal and retarded children.

Rehearsal. Rehearsal involves simple repetition of the material to be remembered. Rehearsal appears to have a two-fold importance. It maintains information in short-term memory by ensuring a sufficiently high activation of that information, and it facilitates the transfer of information from short term memory to long term memory and subsequent retrieval of that information by allowing more elaborate item processing (Demster, 1981).

There appears to be a developmental progression in the complexity of rehearsal use by children. While a developmentally normal child in the early primary school grades may simply repeat in isolation each item in a list over and over again as it is presented, older children tend to cumulatively rehearse different items together, a more effective strategy (Cuvo, 1975; Ornstein, Nous & Liberty, 1975).

Category clustering. 'Category clustering' may occur in tasks where items are categorisable into qualitatively different groups. Imposing this sort of organisation on material has long been known to facilitate its storage in long-term memory (Kintsch, 1975).

Category clustering is often taught in combination with rehearsal; subjects being taught to rehearse items in each category of a list together (e.g. Cavanaugh & Borkowski, 1979). A procedural variant of category clustering is the strategy of 'abstraction', in which the subject must identify and verbalise one or more similarities between items in a list (e.g. Burger, Blackman & Clark, 1981). The use of category clustering appears to increase during the primary school years, and is commonly observed in adolescents (Moèly, 1977).

Elaboration. The strategy of 'elaboration' involves the carrying out of some kind of symbolic operation on items. The strategy may take the form of either 'imaginal elaboration' (use of interactive imagery), or 'verbal elaboration' (use of sentences and phrases). In using imaginal elaboration, for example, the subject might imagine a scene depicting a number of items from a list together. In using verbal elaboration, the subject might construct a story that connects several items in a list.

It appears that performance benefits associated with elaboration increase dramatically during the primary school years, and that spontaneous use of such strategies is not usually acquired before adolescence (Pressly et al, 1982). Even then, it appears that only some adolescents produce the strategy spontaneously (Rohwer, Raines, Eoff & Wagner, 1977).

Experimental Memory Tasks

The strategies described in the previous section have been studied in the context of a number of different experimental memory tasks. Pressley et al (1982) have described the most commonly used tasks. These are list learning, associative learning and prose learning tasks.

List learning tasks. In a list learning task, the subject is presented with lists of items to learn. Memory performance may be assessed by means of a number of different tests. In a 'recognition test' subjects may be required to discriminate between items which were present in the study list from those which were not present. In 'cued' or 'constrained' recall tests, subjects are given cues at the time of testing. 'Free recall', on the other hand, involves recall without the benefit of external cues. 'Serial recall' tests require the subject to recall items in order of presentation. A task is called 'central recall' when subjects must recall only the information that they were instructed to remember, while 'incidental recall' tasks require that the subject recall material which was present but which he or she was not instructed to recall.

Associative learning tasks. In associative learning tasks, subjects are presented lists of arbitrarily paired items (e.g. tree-snake). One of the pair of items is presented at the time of testing and the subject is required to recall the other.

Prose learning tasks. In prose learning tasks, subjects must remember sentences, paragraphs, or passages of text. Tests of recall may involve simple recognition, simple recall, or answering questions about the text.

Production and Mediation Deficiencies in Strategy Use.

Flavell (1970) has made the distinction between production deficiencies and mediation deficiencies in strategy use in children. The term 'production deficiency' refers to the inability of a child to spontaneously generate an appropriate strategy for a particular memory task. A child with a production deficiency is, however, able to behave strategically when a strategy is supplied to him or her in a training programme or an experiment. A 'mediation deficiency' on the other hand, involves an inability to use a strategy even where the strategy has been supplied and its function made explicit by the experimenter or trainer.

Evidence from recent training studies suggests that the strategic problems displayed by retarded children are production deficiencies, rather than mediation deficiencies (e.g. Turner, Buim & Thurber, 1976). It appears that these children can be trained to produce effective strategies appropriate to particular memory tasks (Brown, Campione & Murphy, 1977).

Mnemonic Strategy Training with Retarded Children

A large number of studies that have been directed at training retarded children to use mnemonic strategies have recently been published. This work has invariably been restricted to mildly retarded individuals (IQ 50-70). A variety of different strategies has been taught in these studies.

Burger, Blackman and Clark (1981), for example, demonstrated that retarded children with a mean chronological age of 12 years and a mean IQ of 62 could be taught to use an abstraction strategy. In this study, subjects were presented with groups of three items. The strategy involved labelling items, describing the items and then stating in what way items in each group were alike.

In another study, Kendall, Borkowski and Cavanaugh (1980) taught mildly retarded children to use a verbal elaboration strategy in an associative learning task. This strategy had four components. First, the subject was required to verbalise a relationship between the items to be recalled. For example, if a picture of a nurse and a picture of a toaster were the items to be learned, the child might say "the nurse is holding the toaster". Second, the child was required to form a 'why' question about the relationship between the pictures (e.g. "why is the nurse holding the toaster?"). Third, the subject performed a semantic analysis of the items, saying, for example, "a nurse looks after sick people, a toaster makes toast". Finally, the subject was required to form a reason for the relationship between the items (e.g. the nurse is using the toaster to make toast for sick people). After four sessions of training, children trained in the use of the strategy had significantly better recall than did children in a control group who received no training.

Finally, in two studies, Brown and Barclay (1976) and Brown, Campione and Barclay (1979) trained mildly retarded children to use a rehearsal strategy combined with self-checking of memory. The self-checking component of the strategy involved the subject indicating by ringing a bell that he or she had studied the test list sufficiently well to remember all items. The subject was required to recall the list immediately after ringing the bell. It was found that subjects with a mental age of 8 years maintained strategy use in the training task for more than a year after training had ceased.

In summary, mentally retarded children can be taught to use a variety of mnemonic strategies effectively, and there is some evidence that effects of such training may persist long after the cessation of training. However, the extent of generalisation of training typically observed in studies like these has been disappointing; trained strategy use has usually been restricted to the specific task used in training (Kramer, Nagle & Engle, 1980).

Generalisation of Training

Generalisation of training effects have been described as either 'far-generalisation' or 'near-generalisation' (Campione & Brown, 1974). Far-generalisation is said to be characterised by distinct changes in task characteristics between the task on which the subject is trained and the task to which the effects of training generalise (the 'generalisation task'), while 'near-generalisation' involves minimal changes between training and generalisation tasks.

A few studies have demonstrated near-generalisation effects in strategy use in retarded children. Kendall et al (1980), for example, demonstrated generalisation of a trained verbal elaboration strategy from a training task that involved the learning of pairs of items, to a generalisation task which involved the learning of triads of items. Similar near-generalisation effects have been reported by Engle, Nagle & Dick (1980) and by Ross and Ross (1978). Kramer et al (1980) have argued, however, that these studies are not pure tests of generalisation, because of the small differences between training and generalisation tasks.

One of the few studies where investigators claimed to show clear evidence of far-generalisation was that reported by Brown et al (1979). It appears that retarded children in this study with a mean mental age of 8 years generalised the use of a rehearsal strategy from a list learning training task to a novel task requiring the gist recall of prose passages, a task with very different contextual characteristics from the training task. The results of this study should be viewed with some caution, however, because Brown et al relied on only indirect measures of strategy use and generalisation.

Generalisation of Training and the Control of Strategy Use

Recently, a number of writers have suggested that the generalisation of training problem might be better dealt with by focusing training attempts on the control of strategy use, rather than by training strategy use per se. Burger, Blackman and Clark (1981), for example, trained mildly retarded children with a mean mental age of 7.6 years in the self control of an abstraction strategy. These children were taught a self-instruction procedure which involved talking aloud to themselves. The verbalisations were of three types; 1) a question about the task ("what does the teacher want me to do?"), 2) an answer to the problem (I'm supposed to tell how these three things are alike'), and 3) self instruction for guidance through the task phases of labelling, detailing and abstracting similarities between items.

In their study, Burger and Blackman concluded that training the control of strategy use was no more effective in achieving generalisation than simply teaching subjects a strategy that had been well designed on the basis of a thorough task analysis. However, a review of the relevant literature by Butterfield, Belmont and Siladi (1980) does seem to suggest the efficacy of training control processes in achieving generalisation. Of 114 training studies reviewed by Butterfield et al, only 7 clearly demonstrated generalisation of training. Only 6 of the 114 studies were directly concerned with the control of strategic behaviour, and strong generalisation effects were demonstrated in all six.

Butterfield et al (1980) proposed a conceptual model to describe the control of strategic behaviour. Their 'superordinate process' model is outlined in Table 1. The major components of this model are the definition of the best possible outcome of mnemonic behaviour (goal setting), the design and selection of an appropriate strategy, monitoring the effectiveness of strategy implementation, and the assessment of outcome. A primary feature of the model is that certain kinds of knowledge or information are required on the part of the individual for the initiation of the superordinate processes. The process of selecting strategies, for example, requires knowledge of the existence of appropriate strategies, and the estimation of probable outcomes of strategy implementation requires knowledge of the efficacy of strategies. This knowledge has been termed 'metamemory' (Flavell & Wellman, 1977).

Metamemory

It is usually assumed that the control of strategy use

Table 1. The Superordinate Process Model

(Butterfield et al, 1980, p. 135)

---

1. define best possible outcome

2. a) design/select strategy
   b) estimate probable outcome of implementing strategy
   c) compare estimates to goals
   d) if discrepancy in c), select alternative strategy with smaller estimate/goal discrepancy

3. a) while implementing selected strategy, note differences between implementation and design
   b) estimate response accuracy if implementation were stopped
   c) compare most recent accuracy estimate to prior estimates
   d) determine when accuracy estimates stop increasing, then respond

4. a) assess response accuracy (outcome)
   b) compare outcome to estimated outcome
   c) decide whether outcome reached estimate

---

is conscious and voluntary (Brown, 1974), and that metamemory, the store of knowledge by which the individual regulates his or her strategic behaviour, is conscious knowledge (Brown, 1978; Brown & Campione, 1977).

Metamemory may refer to knowledge of personal, task or strategy variables involved in memory (Flavell & Wellman, 1977). Examples of each of these three classes of metamemory that have been investigated in developmentally normal and in retarded children are respectively, knowledge of memory capacity (Kelly, Scholnick, Travers & Johnson, 1976), knowledge of effects on recall of various parameters of memory tasks, such as time on task and number of items (Yussen & Bird, 1979), and knowledge of the existence of strategies effective on particular tasks (Kreutzer, Leonard & Flavell, 1975).

The means by which the individual both acquires and applies metamemorial knowledge have been variously termed 'metamemory skills' (Brown & DeLoach, 1978), 'executive processes' (Cavanaugh & Perlmutter, 1982) and 'superordinate processes' (Butterfield et al, 1980). That these terms are synonymous is evidenced by three metamemorial skills listed by Brown and DeLoach (1978); predicting the consequences of one's mnemonic behaviour, checking the results of mnemonic activity, and monitoring one's ongoing mnemonic activity. These metamemory skills bear an obvious similarity to several of Butterfield et al's superordinate processes described in the previous section.

Flavell and Wellman (1977) have proposed an interactive model of metamemory and strategy control. In this model, knowledge of memory difficulty (a function of the interaction between items, characteristics and task demands) interacts with knowledge of memory ability (itself the interaction of personal attributes and strategy effectiveness) to influence strategic behaviour.

Experimental Investigations of the Metamemory-Strategy Use Relationship

Metamemory, conscious knowledge about memory, is considered to be important in the control of strategy use. A small number of studies have been directed at empirically determining the relationship between metamemory and actual mnemonic behaviour in normal and retarded children. Unfortunately these studies have failed to demonstrate consistent links between metamemory and behaviour.

Cavanaugh and Borkowski (1979) tested developmentally normal 8-year-old children to determine if children who knew that recall on a particular task could be enhanced by the use of a combined rehearsal and categorisation strategy were more likely to behave strategically during training in the use of the strategy than were children who believed passive behaviour to be more effective. Cavanaugh and Borkowski found that metamemory was related to strategy use during a maintenance session one week after the last training session, but was not related to strategy use during the training sessions themselves.

In a further study, Cavanaugh and Borkowski (1980) assessed metamemory in 178 developmentally normal children from kindergarten and first, third and fifth grades by an extensive introspective interview. The use of memory strategies was measured during a second session on each of three list-learning tasks; free recall, cued recall and incidental memory. It was found that the amount of knowledge displayed by the children about strategies failed to predict the extent and type of strategy use.

Kendall, Borkowski and Cavanaugh (1980) found that mildly retarded children's knowledge of a strategy (verbal elaboration) assessed before the commencement of training in the use of the strategy was not related to strategy use during early training sessions. Significant correlations were found, however, between the metamemory pretest and strategy use in post-training memory trials. Scores obtained in a post-training test of metamemory were also correlated with strategy use in post-training trials, but again, not with strategy use during early training sessions.

Cavanaugh and Borkowski (1979) and Kendall et al (1980) therefore found only partial relationships between metamemory and strategy use, while Cavanaugh and Borkowski (1980) found no relationship. Similarly, Salatas and Flavell (1976) failed to find a relationship between metamemory and the use of a categorisation strategy in developmentally normal first grade children.

Investigation of the Metamemory-Generalisation Relationship

There has been little direct investigation of the relationship between metamemory and generalisation of trained strategy use to novel tasks in either retarded or developmentally normal children, in spite of the hypothesised importance of this kind of knowledge in the control and generalisation of strategy use.

One study reported by Ringel and Springer (1980) does relate to this issue, however.

Ringel and Springer studied metamemory and the generalisation of the use of a categorisation strategy in first, third and fifth grade normal children (mean ages, 7, 9 and 11 years respectively). The training task and generalisation task used in this study were both list learning tasks and identical in form, the only difference being that new items of the same type were presented in the generalisation task. This must therefore be considered at best a study of near-generalisation effects, and it could be argued that because of the similarity of the training and generalisation tasks, the study relates to maintenance, rather than generalisation of strategy use.

Ringel and Springer's results suggested that when given feedback about the effectiveness of the strategy, older children in their sample were more likely to show generalisation effects than younger children. The results also indicated that children in the two older groups were generally more likely to know that categorisation was an effective strategy when they had received feedback to this effect during memory trials than were the younger children. However, the authors did not indicate whether subjects who possessed better developed metamemory were more likely to show generalisation effects than those who possessed poor metamemory. The question of whether metamemory is related to strategy generalisation therefore requires further research.

Conceptual and Methodological Issues in the Investigation of the Metamemory-Strategy Use/Generalisation Relationship

As Cavanaugh and Perlmutter (1982) have pointed out, the existing literature on the relationship between metamemory and strategy use is characterised by a number of conceptual and methodological deficiencies. Of prime importance is the issue of whether strategy use is consciously controlled or automatic, the issue of the goal of the memoriser and the problem that investigators have often proceeded to look for metamemory behaviour connections without clearly articulated reasons for why they chose the particular aspects of knowledge they have included in their studies as metamemory. There has also been little consensus about the methodology of assessing metamemory and a marked degree of inconsistency in the nature of the dependent measures used to gauge the extent of strategy use. These problems will be examined in turn in the following sections.

Conceptual Issues

Automatic versus consciously controlled strategy use. As noted previously, it is generally assumed that control processes and metamemory are conscious and deliberate, and therefore available to introspective probing. Recently, there has been much attention in the cognition literature focused on the issue of the extent to which cognitive processes are automatic, or consciously controlled (e.g. Kellogg, 1982; Shiffrin & Schneider, 1977). Metamemory researchers have not yet addressed themselves to this issue. The failure to find consistent links between metamemory and behaviour does, however, seem to beg the question of the extent to which automatic processing is involved in the control of mnemonic strategies.

The goal of the memoriser. In the existing conceptualisations of the control of strategic behaviour, little is said about how the memoriser sets his or her performance goal. In Butterfield et al's model, for example, the goal of the memoriser appears to be determined solely by whatever criterion for successful performance is set by the experimenter. If, however, goal-setting is affected by external reinforcement contingencies, as evidence suggests it is (Bandura, 1981; Locke, Bryan & Kendall, 1968), then incentive to do well, as determined by external reinforcement contingencies should influence the level at which an individual sets his or performance goal in a particular memory situation.

If incentive to perform is low, then goals may be set low. In terms of Butterfield et al's model, if the goal is set sufficiently low, the individual may not see a discrepancy in performance attainable by passive or strategic behaviour. The use of an active acquisition strategy requires the expenditure of energy (Gelabert, Torgensen, Dice & Murphy, 1980). The subject may therefore opt for the course of action involving the lesser amount of effort, passive behaviour, in spite of acknowledging in a metamemory assessment that he or she believes strategic behaviour to be more effective.

Research on the relationship between metamemory and behaviour has invariably failed to consider this issue of incentive to perform as a determinant of an individual's goal in a memory task. In a recent experiment, however, Gelabert et al (1980) have shown that once children have been trained to use rehearsal, they rehearse more when incentives are offered for correct recall than when they are not. It remains a theoretically important question whether manipulation of incentives can produce a correspondence between a child's metamemory and that child's strategic behaviour, both in training tasks and in generalisation tasks.

Choice of aspects of metamemory. As noted above, investigators of the metamemory-behaviour relationship have generally chosen to study particular aspects of metamemory without clearly articulated reasons for that choice. The superordinate model of strategy use proposed by Butterfield et al (1980) suggests two particular aspects of metamemory for study.

Part 2 of Butterfield et al's model is concerned with the selection of the strategy for a particular task. According to the model, the individual selects the strategy, from his or her repertoire of strategies, that enables performance to match the performance goal. In a training situation, where a production deficient child is supplied with a single strategy such as rehearsal, the model indicates that the child will choose to use the strategy, rather than behave passively, if he or she estimates that the strategy will enable performance to more closely approach the goal level than will passive behaviour. Conversely, it follows from the model that if the child predicts that he or she will more closely match the goal performance by behaving passively in the task than by applying the strategy, then the child will behave passively.

From this, it could be hypothesised that two aspects of metamemory may be important in determining whether or not the child uses and generalises a mnemonic strategy.

First, if a child has an unrealistically high estimate of his or her memory ability, in a particular task, then he or she might be expected not to use the strategy because he or she believes that passive behaviour will enable him or her to attain the performance goal. The importance of this issue is highlighted by a number of studies which have shown that young children have unrealistically high predictions about what they can remember, with increasingly accurate predictions offered by older children (Yussen & Levy, 1975; Flavell, Friedricks & Hoyt, 1979; Yussen & Berman, 1981). The same appears to be the case with the mentally retarded (Brown, 1978).

Second, the extent to which a child believes a particular strategy to be effective on a particular task relative to passive behaviour, should influence the use of that strategy in the task, and the amount of generalisation of that strategy observed from the training task to a novel task. If the child perceives that strategy use will enable him or her to more closely attain the goal performance than will passive behaviour, then the child might be expected to use the strategy, and generalise its use to a novel task in which the child also believed the strategy to be effective relative to passive behaviour.

Methodological Issues

Metamemory is assumed to be a conscious store of knowledge about memory. As noted above, this may not be a sound assumption. Apart from this question of the extent to which metamemory is conscious knowledge, however, Cavanaugh and Perlmutter (1982) have pointed out that there are problems inherent in the methodology used to assess metamemory relating to the extent to which cognitive porcesses are accessible to introspective analysis, and the veridicality and completeness of verbal reports of memory. The major problems associated with each of the most commonly used measures of metamemory will be examined in the following section.

Interview and Questionnaires. The extensive questionnaire administered by Kreutzer et al (1975) to a large sample of developmentally normal children has influenced the content of interview type metamemory assessments in many subsequent studies. Items in these interview assessments have been of two general types. First, metamemory has been assessed on the basis of verbal responses to open questions. An example is the item used by Cavanaugh and Borkowski (1979), which originally appeared in the Kreutzer (1975) questionnaire:

> "Which of two lists would be easier for you to learn; one list has words that can be put into groups of things that go together, the other list has words that can't be grouped together. Why would this list be easier to learn?" (P. 164.)

The second type of interview item often used has been a closed question requiring either a verbal response, like 'yes' or 'no', or a non-verbal response, like pointing to the alternative of choice. For example, Salatas and Flavell (1976) assessed young normal children's knowledge that a categorisable picture set is remembered better if grouped by category, and that a categorisable set of pictures is easier to remember than an uncategorisable set. Subjects were presented with picture sets of each type and asked to indicate the easier alternative.

There are problems associated with both of these assessment methods. Brainerd (1973) has pointed out that open questions assess only those aspects of knowledge that an individual can express linguistically. If open questions are the sole means of assessment in an investigation, as they were in the Cavanaugh and Borkowski (1979) study, then the probability of making type II errors may be high. In other words, a subset of subjects who possess a particular piece of metamemorial knowledge may not be identified as having that knowledge by the metamemory assessment.

Closed questions, on the other hand, are subject to the possibility of type I errors. As Kuhn (1974) has pointed out, some subjects may choose the correct alternative for ideosyncratic or extraneous reasons.

Kuhn (1974) has addressed these problems in relation to assessing children's knowledge in studies of the Piagetian concept of conservation. Kuhn concluded that the problems may be attenuated by employing a judicious mix of open and closed questions. This has been attempted in some studies of the metamemory-behaviour relationship (e.g. Cavanaugh & Borkowski, 1980). However, these studies have typically used only a single question on one occasion to assess a particular aspect of metamemory. Brown and Campione (1977) have provided evidence of the low reliability of this type of assessment, and have stressed the importance of sampling particular aspects of metamemory with more than one question and on more than one occasion.

Pictorial Techniques. Yussen and Bird (1979) have described a pictorial technique for assessing metamemory. In this technique, memory situations are presented as a series of pictures, rather than as verbal descriptions. To assess subjects' understanding of the effect of number of items on task difficulty, for example, a subject mught be presented with two pictures, one of a child attempting to learn the names of 5 objects, and the other trying to learn the names of 10 objects. The subject might be asked to indicate, by pointing, the more difficult task depicted.

This technique is likely to reduce the probability of making type II errors resulting from limited expressive and receptive language abilities. However, the probability of making type I errors may be higher with this technique than with open interview questions. The frequency of these errors may be reduced, however, by careful structuring of the task. For example, subjects might be required to respond by stating how much time each depicted child would require on task in order to learn all the items, rather than simply pointing to the more difficult task.

Measures of Strategy Use

A number of different methods have been developed for the measurement of strategy use. To assess rehearsal, for example, some investigators have recorded the number of overt verbalisations as subjects rehearse items (Kellas et al, 1973). In other studies, the serial position curve has been used as an index of rehearsal; the primacy effect being potentiated in subjects who rehearse (Demster, 1981).

Butterfield et al (1980) have advocated the use of subject paced exposure times as an index of cumulative rehearsal. With this measure, subjects who cumulatively rehearse items in a task where they themselves control the duration of item exposure tend to expose each subsequent item in the list for a longer time, as that item is added to the items they are already rehearsing.

As Demster (1981) has pointed out, each of the above methods has its limitations. Measures of verbalisations, for example, cannot assess covert rehearsal. Demster argues, however, that the problems involved with each method may be attenuated if several of the measures are employed concurrently.

Conclusions and Hypotheses

The area of mnemonic strategy training appears to hold some promise for improving memory performance in the mentally retarded. Approaching the generalisation of training problem through strategy control processes and metamemory may be a useful tactic.

However, a relationship between metamemory and strategic behaviour has not yet been convincingly demonstrated.

The present experiment was directed at examining the relationship between metamemory in mildly retarded children and their use and generalisation of a trained cumulative rehearsal strategy. The following hypotheses were tested:

1. That following training in the rehearsal strategy, three aspects of metamemory: 1. subjects' knowledge of the appropriateness of rehearsal to a memory task, assessed by an open question, 2. subjects' estimates of strategy effectiveness, and 3. subjects' estimates of their own memory ability, are related to the amount of use of the rehearsal strategy in the training task.

2. That following training in the rehearsal strategy, three aspects of metamemory: 1. subjects' knowledge of the appropriateness of rehearsal to a memory task, assessed by an open question, 2. subjects' estimates of strategy effectiveness, and 3. subjects' estimates of their memory ability, are related to the amount of generalisation of the rehearsal strategy from the training task to a novel task.

These hypotheses were tested in two conditions - a high incentive condition where subjects were reinforced for recall, and a low incentive condition where subjects were not reinforced for recall.

CHAPTER 2

METHOD

Subjects

Subjects were 25 male and female students from three special schools in the Hobart area. Subjects chosen for the study were those whose chronological and mental ages fell into the general ranges included in previous studies in the area, and whose class timetables made them available for the experimental sessions. Chronological ages of the subjects ranged from 8 years 4 months to 14 years 0 months (mean of 10 years 7 months). Mental ages, assessed on the Slossen Intelligence Test, ranged from 5 years 7 months to 10 years 0 months (mean of 7 years 5 months).

Design

The experiment was a repeated measures design. All subjects were exposed to the same procedure and experimental conditions. Each subject participated in five sessions. Whenever possible, consecutive sessions were conducted on consecutive days. Because of illness or clashes with scheduled school activities this was not always possible. However, experimental sessions were never separated by more than two days. Two subjects were excluded from the study as a result of extended illnesses.

The rehearsal strategy. Subjects were trained in the use of a cumulative rehearsal strategy. This strategy required subjects to rehearse aloud lists of four, five or six items (depending on the subject's memory span) in the following way: The name of the first item in a list was verbalised once. The name of the second item was repeated with the name of the first item three times. The name of the third item was repeated three times with the names of the first and second items. The name of the fourth item was verbalised once by itself. For subjects with a list length of five items, the fourth and fifth items were rehearsed aloud together three times. Subjects with a list length of six items rehearsed the fourth, fifth and sixth items together three times. Subjects themselves controlled the duration of presentation of each item in the lists (ie. exposure time).

Dependent measures. Two measures of the rehearsal strategy comprised the dependent measures of the study. One measure was the item exposure time; subjects who rehearsed were assumed to expose each subsequent item in a list for a longer time as that item was added to the items they were already rehearsing. The second measure of rehearsal was the 'overt rehearsal'measure, which involved the scoring of verbalisations made by subjects as they rehearsed.

Two list learning tasks were used in the study. One task, the 'training task', on which subjects were trained in the use of the rehearsal strategy, involved the learning of stimuli which were outline drawings of common objects. The second task, the 'generalisation task', involved the learning of stimuli which were cartoons of Charlie Brown performing different actions.

Rehearsal was assessed in probe trials in each of the five experimental sessions. In half of these probe trials subjects were rewarded for their memory performance (reinforced trials), and in the other half of the probe trials performance was not rewarded (non-reinforced trials).

Independent measures. Three measures of different aspects of metamemory comprised the independent variable of the study: 1. subjects' responses to an open question about what they would do to help them remember items in memory tasks ('open question about choice of strategy'), 2. subjects' estimates of their own memory ability ('memory ability'), and 3. subjects' estimates of how effective rehearsal is as a strategy relative to passive behaviour ('strategy effectiveness').

The following indicates the content of the five experimental sessions:

Session 1.
1. Metamemory pretest
2. Estimation of memory span
3. Pretraining in labelling memory task stimuli
4. Reinforced and non-reinforced probe trials on training and generalisation tasks.

Session 2.
1. Training in use of the cumulative rehearsal strategy
2. Reinforced and non-reinforced probe trials on the training task only.

Session 3. As in Session 2.

Session 4. As in Session 2.

Session 5.
1. Training in the use of the cumulative rehearsal strategy
2. Reinforced and non-reinforced probe trials on the training task and reinforced and non-reinforced probe trials on the generalisation task.
3. Metamemory post-test.

In the second session, subjects were also administered the Slossen Intelligence Test. Mental ages were calculated using this test to help describe the sample of subjects, but mental age was not a variable in the study.

In the first and fifth sessions, probe memory trails were given in the following order: training task (non-reinforced), generalisation task (non-reinforced), training task (reinforced), generalisation task (reinforced). In the second, third and fourth sessions, non-reinforced memory trials on the training task were always followed immediately by reinforced trials on the same task. It is acknowledged that the fact that reinforced trials always followed non-reinforced trials may have confounded reinforcement effects with order effects. It is considered that the effect of practice was potentially the most serious of such effects; rehearsal might have been greater in reinforced trials than non-reinforced trials simply because of the practice received on the task during non-reinforced trials. However, controlling for this effect by counter-balancing the order of reinforced and non-reinforced trials would have been impractical in this study. It was considered that if subjects were given reinforced trials before non-reinforced trials, the discriminability of reinforced from non-reinforced trials would have been lowered becasue of exposure to the reinforcer during reinforced trials immediately prior to performance in non-reinforced trials. Making reinforced trials discriminable from non-reinforced trials was one of the major problems in the design of the experiment.

It is considered, however, that practice effects would have been minimal because in all but the first session subjects had practice with the memory task and apparatus during training on five lists of items immediately prior to the probe memory trials in each session. It is considered that practice effects would probably have reached a ceiling in each of these sessions before subjects were required to perform in the probe trials.

Materials and Apparatus

Memory task stimuli. A pool of items for the training tasks was compiled by copying onto slides the set of 260 outline drawings of common objects compiled by Snodgrass and Vanderwort (1980). Only items which subjects could readily label with a single syllable label were used in the training task.

A set of stimuli for the generalisation task was compiled by copying onto slides 53 cartoon drawings, each showing Charlie Brown performing a different action. These stimuli appear in Appendix A.

Measuring rehearsal. Stimuli were projected from a Kodak Courousel projector onto a small back projection screen mounted directly in front of the subject. The subject controlled the time each item was exposed with a small hand-held button control. A light sensor on the projector was connected to a multiple choice reaction timer which provided a printout of the time each item in a list was exposed. Exposure times provided one measure of rehearsal.

All sessions were recorded using a Sony model TC-105 reel-to-reel audiotape recorder. The recordings of probe trials were later scored to provide the overt rehearsal data.

Procedure

Metamemory assessment. Three measures of metamemory were included; memory ability, strategy effectiveness and one open question about choice of strategy. To assess subjects' estimates of memory ability two sets of 12 stimuli were drawn up on 8x13 cm cards. One set of stimuli was selected from the pool of training task items. The second set of items was selected from the pool of generalisation task stimuli.

To obtain subjects' estimates of their own memory ability the following procedure was followed for each of the two sets of stimuli: One of the stimulus cards was placed face up on the table in front of the subject and covered with a black card of the same size. The subject was told:

> If I asked you to remember the thing on this card/what Charlie Brown is doing, and you could look at the card as long as you like (experimenter lifts black card), would you be able to remember what was on the card/s?"

The number of cards on the table was then increased by one and the procedure repeated until all 12 cards from the set were arranged on the table, or until the subject had stated on three consecutive trials that he/she would not remember all the items. The highest number of items that the subject stated he/she could remember was recorded as that subject's estimated memory ability for that set of items.

It was considered that asking the above question might produce a demand effect, with children overstating the number of items they could remember to create a favourable impression for the experimenter. To control for a possible demand effect of this kind, a second memory ability question was asked of the children immediately following the first.

> If someone as old as you are was asked to remember the thing on this card/what Charlie Brown is doing, and they could look as long as they liked at the card (experimenter lifts black card), would they be able to remember what was on the card/s?"

The procedure for this question was the same as for the first memory ability question, with the question being asked for both sets of stimuli in the order: question 1 training stimuli, question 1 generalisation stimuli, question 2 training stimuli, question 2 generalisation stimuli. Thus, for each subject four pretest estimates of memory ability and four post-test estimates of memory ability were obtained.

Open question about choice of strategy. The open question about choice of strategy included in the metamemory assessment took the following form. When an estimate of memory ability had been obtained for the first memory ability question, the experimenter pointed to the array of stimulus cards still in place on the table and asked the subject, for both sets of stimuli:

> If you had to remember what was on all these cards, and you could look at each for as long as you liked, what would you do to help you remember them?

Thus, for each subject, there were two pretest measures of 'choice of strategy', one for training stimuli and one for generalisation stimuli, and two corresponding post-test measures.

Strategy effectiveness. To obtain subjects' estimates of strategy effectiveness, a procedure adapted from that employed by Yussen and Bird (1979) was followed. Two sets of three stimulus cards measuring 21x30 cm were drawn up. Each card of the first set depicted a girl seated in front of a board on which was displayed outline drawings of 11 objects. On the first card of this set, the 'passive stimulus', the depicted girl was dressed in red. The subject was told:

> This girl is trying to remember all the things on the board. She has as long as she likes to look, but then I am going to cover up the board and she must tell me what was on the board. While the picture is not covered up she is just looking at the things.

The second card, the 'rehearsal stimulus', depicted a girl dressed in blue and a speech bubble was drawn on the card to suggest that the girl was rehearsing items. The subject was told:

> The girl in blue has as long as she likes to look at the board, and while she looks she is saying the things over and over again like this, 'pipe, pipe hat, pipe hat...'. Then I cover up the board and she must remember what was there.

The third card, the 'control stimulus' depicted a girl dressed in green. The subject was told:

> The girl in green has as long as she likes to look at the board, then I am going to cover the board and she must remember what was there. While this girl looks at the board she pretends that each of the things is covered with an apple.

A clear plastice mask with 11 red cut out apple shapes positioned so that all of the items would be covered from view was then placed on the stimulus card. The subject was then asked to indicate how many of the items each of the three depicted girls would remember. The stimulus card with the apple was included to control for any demand effect that might result in the subject indicating that the child depicted rehearsing would remember more than the child depicted as passively looking, simply because more activity was implied in the former picture. The whole procedure was repeated for stimulus cards which depicted children attempting to remember actions performed by Charlie Brown. This gave estimates of strategy effectiveness for stimuli similar to those used in the training task, and for stimuli similar to those used in the generalisation task. The two sets of stimulus cards appear in Appendix B.

Pretraining in labelling stimuli. At the commencement of the first session, subjects were given training in labelling stimuli. For training task stimuli, subjects were shown slides of stimuli from the training task and were prompted to verbalise the name of the item. For generalisation task stimuli, the experimenter said aloud the action performed by the cartoon character and the subject was required to repeat aloud the one-word label for the action used by the experimenter. Pretraining in item labelling was discontinued when the subject correctly labelled items on five successive trials for each stimulus type.

Span estimation. In previous studies in this area, investigators have determined the length of lists of items presented to subjects in memory tasks as 1½ times the length of the individual's memory span, to allow for improvement in memory due to strategy training. The procedure for estimating subjects' memory span in the present study was similar to that employed by Brown and Barclay (1976).

To estimate memory span, subjects were shown a series of four slides of stimuli similar to those used in the training task. A red slide was placed at the beginning and the end of the series. Subjects were instructed to recall as many of the items as possible when they reached the red slide at the end of the series. If subjects recalled all items they were then required to recall a series of five stimuli. The number of slides in the series was increased until subjects failed to recall all items in a list. When a subject consistently failed to recall all items at a particular list length the immediately preceding list length was taken as that subject's span. No subject recalled more than four stimuli. The number of items to be presented to subjects in subsequent training and probe trials was calculated to conform as closely as possible to the $1\frac{1}{2}$ x memory span formula, with the provision that no subject received lists of less than four items. Subjects with spans of two, received lists of four items. Subjects with spans of three items received lists of five stimuli, and those with spans of four items received lists of six stimuli.

Rehearsal training. Training in the cumulative rehearsal strategy took place at the beginning of the second, third, fourth and fifth training sessions. The procedure followed the overt shadowing technique described by Kellas et al. (1973). During each training session, the subject received training on five lists of whatever length had been previously determined for that subject. One red slide was placed at the beginning and at the end of each list. At the beginning of each session of training, the subject was told:

> We are going to go through this list of things and say the names over and over again to help you remember what is there. I want you to say everything I say.

The subject was then instructed to press the control button to expose the first slide. The name of the first item was verbalised once, and the subject was prompted to expose the next stimulus. The name of the next stimulus was then repeated with the name of the first stimulus three times, and the third stimulus was then exposed. When the subject exposed the fourth stimulus, he/she was prompted to verbalise the name of that item once only by itself, and then to press the control button. For subjects with a list length of five or six items, upon exposure of the fifth item, the subject was prompted to rehearse the fourth and fifth items together three times. Subjects with a list length of six items rehearsed the fourth, fifth and sixth items together three times. Upon exposure of the red slide which signalled the end of a list, the subject was prompted to to recall all items from the list. This rehearsal strategy thus required that no subject rehearse more than three items together at the one time. Results from previous studies have indicated that three items is about the maximum number of items that similar subjects can rehearse concurrently (eg. Butterfield et al. (1980)). Prompts were faded as rapidly as possible as training progressed, but at a rate sufficiently slow to keep errors in strategy use to a minimum.

Probe trials. Immediately before the probe trials in a particular session, subjects viewed each of the stimuli to be used in the training task probe trials and were required to verbalise the label for each stimulus. If a subject showed any difficulty in supplying a one word label for any item that item was replaced.

Following the metamemory pretest in the first session, subjects were given non-reinforced probe trials on the training task. The subject received one list of training task items at that subject's list length. Subjects were instructed:

> You are going to see a list of things. I want you to try and remember as many of the things as possible. When you get to the next red slide, I'm going to ask what was there. This is just a practice, and you are not going to get anything for remembering the things, but I want you to say the names over and over again to help you remember.

At the end of the non-reinforced trial on the training task, the subject was given a non-reinforced trial on the generalisation task (one list). He/she was told:

> You are going to see pictures of Charlie Brown doing different things. Each time you press the button, I'm going to say what Charlie Brown is doing and I want you to remember the doing word. When you get to the next red slide, I'm going to ask what was there. This is just a practice and you're not going to get anything for remembering, but I want you to say the doing words over and over again to help you to remember.

After each non-reinforced list of the training and generalisation tasks, the subject was clearly informed of how many items he/she had recalled. When the subject had completed non-reinforced trials on the generalisation task (ie. one list of generalisation task stimuli), he/she was shown a selection of small plastic toys and asked to choose the one that he/she liked best. The subject was then shown a 15x20 cm card that was ruled into five sections. He/she was told:

> On each of the five days that I see you I'm going to give you a star for each thing that you remember. Then, on the last day, if you've got enough stars on the card, you can have this toy to keep.

The subject was then given one reinforced list on the training task, followed by one reinforced list on the generalisation task. Instructions to the subject and procedure were identical to the non-reinforced trials, except that prior to each list the subject was clearly instructed that he/she would receive a star on the card for each item in the list correctly recalled, and at the end of the list, after being informed of how many items he/she had recalled, the subject was given that number of stars to place in the appropriate position on the reinforcement card.

The same procedure was followed for probe trials in all other sessions. At the conclusion of non-reinforced trials, the reinforcement card and the toy that the subject had chosen in the first session were placed on the table in the subject's view. In the fifth session, unreinforced and reinforced trials on the training and generalisation tasks were given in the same sequence as in the first session. In the second, third and fourth sessions trials were given on the training task only. At the conclusion of the fifth session all subjects were given the toy of their choice regardless of their performance.

<u>Measures of rehearsal</u>. Two measures of rehearsal were employed. For the 'overt rehearsal' measure, tape recordings of probe trials were scored in the following way: Subjects were awarded one point for each verbalisation that they made which conformed to the trained rehearsal strategy. For example, a subject with a list length of four items might be presented with a list containing the items - tree, dog, hat, peg - in that order. To gain maximum points

the subject's verbalisations as each item was exposed would have to include the following words: tree, tree dog, tree dog, tree dog, tree dog hat, tree dog hat, tree dog hat, peg. If all these words were present the subject would receive 17 points. The subject would not receive points for any additional words verbalised. For example, if on the exposure of the fourth item 'peg', the child verbalised 'peg, tree, dog, hat, he/she would receive only one point, for verbalising the word 'peg'. The total number of points earned by a child on a list was expressed as a percentage of the maximum score for the particular list length.

The second measure of rehearsal involved the stimulus exposure time data. In scoring the exposure data, the linear trend over the first three items in each list was taken as the measure of cumulative rehearsal; subjects exposing each subsequent item in the first three items for progressively longer durations as that item was added to the items they were already rehearsing.

CHAPTER 3

RESULTS

Metamemory

Open question about choice of strategy. Table 2 summarises responses to the open question about choice of strategy. Responses were coded into seven different categories of strategies; rehearsal, looking at items, looking longer at items, labelling items, thinking about items, miscellaneous strategies, and 'no strategy'. Several subjects responded that they would 'think of items over and over again'. These responses were treated as instances of covert rehearsal, and were coded as 'rehearsal'. Responses were coded as 'no strategy' when subjects stated that they were unable to think of a strategy. Responses coded as 'miscellaneous' were those mentioned by only one or two subjects and included categorisation, performing the actions depicted on stimulus slides, elaboration and several more idiosyncratic responses, like 'asking Jesus'.

Coding of responses into the seven categories was done independently by three raters, two of whom were naive to the experimental hypotheses. Inter-rater agreement was 100%. Subjects' responses appear in Appendix C.

For statistical analysis, subjects' pre- and post-test responses were coded as '0' if they did not state they would use rehearsal for either generalisation or training task stimuli. Responses were coded '1' if subjects stated they would use rehearsal for either training or generalisation task stimuli.

Table 2. Numbers of subjects indicating by a verbal response to an open question that they would use a particular strategy type, or who were not able to think of a strategy for memory tasks similar to the training and generalisation tasks at pre- and post-test.

	pre-test		post-test	
	training	generalisation	training	generalisation
overt and covert rehearsal	2	2	7	9
looking at items	6	5	2	3
looking at items longer	2	1	3	1
labelling items	0	1	1	0
thinking about items	5	5	4	5
miscellaneous strategies	6	2	4	3
no strategy	4	9	4	4

Memory ability. Inspection of the data suggested that there were no consistent differences in estimates of memory ability between training task stimuli and generalisation task stimuli, so the mean of these two estimates was calculated for each subject. This gave one estimate of memory ability for each of the two memory ability questions from the pretest and one estimate of memory ability from each of the two memory ability questions from the post-test for each subject.

The two measures of memory ability (how many times the child him/herself could remember, and how many items a child of the same age could remember) were compared with a related samples t test. The analysis indicated that there was not a significant difference between scores for question 1 and scores for question 2, ($t(24) = 0.05$, $MSe = 0.41$, $p > .05$). The scores for question 1 and question 2 were therefore combined for the subsequent analysis, by calculating the mean of four scores for each subject (question 1 training stimuli, question 1 generalisation stimuli, question 2 training stimuli, question 2 generalisation stimuli). This yielded, for each subject, one memory ability score for the pretest and one memory ability score for the post-test; each a mean of four raw scores. This is in agreement with the approach to metatmemory assessment recommended by Brown and Campione (1977), which stresses the importance of sampling particular aspects of metamemory with more than one question on more than one occasion to increase reliability of assessment. Memory ability scores appear in Table 3. Raw scores are presented in appendix D.

Strategy effectiveness. Subjects often appeared confused by the control stimulus used in obtaining estimates of strategy effectiveness. For example, several subjects stated that they thought the girl depicted on this stimulus was adopting a self-testing strategy, and would therefore recall more items than the child depicted rehearsing. Responses to the control stimuli were therefore dropped from the analysis. The estimates of strategy effectiveness were calculated by subtracting the estimate for the passive stimulus from the estimate for the 'rehearsal stimulus', and dividing by the sum of those two estimates.

Table 3. Pre- and post-test estimates of memory ability for question 1 (number of items the subject him/herself could remember) and question 2 (number of items another child of the same age could remember).

Subject	1	2	3	4	5	6	7
Pretest							
Question 1	8.50	4.00	6.00	5.00	3.50	10.00	3.00
Question 2	8.00	5.00	6.00	6.50	3.00	9.50	3.50
$\bar{X}$	8.25	4.50	6.00	5.75	3.25	9.75	3.25
Post-test							
Question 1	10.00	4.00	12.00	6.00	12.00	10.00	5.50
Question 2	10.50	6.00	12.00	6.00	10.50	9.50	6.00
$\bar{X}$	10.25	5.00	12.00	6.00	11.25	9.75	5.75

Subject	8	9	10	11	12	13	14
Pretest							
Question 1	3.50	7.50	6.50	12.00	9.50	10.00	3.00
Question 2	4.50	11.00	5.50	12.00	10.50	7.50	4.00
$\bar{X}$	4.00	9.25	6.00	12.00	10.00	8.75	3.50
Post-test							
Question 1	7.00	9.00	12.00	12.00	12.00	7.50	5.50
Question 2	7.00	9.00	12.00	12.00	12.00	8.00	6.50
$\bar{X}$	6.50	9.00	12.00	12.00	12.00	7.75	6.00

Subject	15	16	17	18	19	20	21
Pretest							
Question 1	4.50	11.00	12.00	4.50	12.00	3.00	2.50
Question 2	5.00	12.00	12.00	4.00	12.00	3.00	2.75
$\bar{X}$	4.75	11.50	12.00	4.25	12.00	3.00	2.75
Post-test							
Question 1	12.00	12.00	12.00	4.50	7.50	7.50	1.50
Question 2	12.00	12.00	12.00	4.50	2.50	8.00	0.00
$\bar{X}$	12.00	12.00	12.00	4.50	5.00	7.75	0.75

continued...

Table 3. (continued)

Subject	22	23	24	25
Pretest				
Question 1	3.00	12.00	4.00	5.00
Question 2	2.50	12.00	3.00	5.00
$\overline{X}$	2.75	12.00	3.50	5.00
Post-test				
Question 1	3.00	1.50	10.00	10.00
Question 2	3.00	4.00	9.00	10.50
$\overline{X}$	3.00	2.75	9.50	10.25

Again, inspection of the data suggested that there were no consistent differences between estimates of strategy effectiveness for training task stimuli and those for generalisation task stimuli, so the mean of these two estimates was calculated for each subject, giving one estimate of strategy effectiveness for each subject from the pretest and one from the post-test. These estimates appear in Table 4. Raw scores are presented in Appendix E.

Changes in metamemory. Pre- and post-test metamemory scores were compared in three related sample t tests to determine if there were changes in metamemory over the period of training. The Type 1 error rate for these tests was calculated, using the Bonferroni Test (Keppel, 1982), to be .05/3 = .02.

Estimates of strategy effectiveness did not change significantly between pre- and post-test ($t(24) = 0.04$, $MSe = 0.04$, $p = 0.84$). Estimates of memory ability similarly did not change significantly between pre- and post-test ($t(24) = 3.36$, $MSe = 8.03$, $p = 0.08$). Responses to the open question about choice of strategy did, however, change significantly between pre- and post-test ($t(24) = 9.33$, $MSe = 0.11$, $p = 0.005$), a significantly greater number of subjects indicating that they would use rehearsal in the memory tasks at post-test than at pretest.

Table 4. Subjects' estimates of strategy effectiveness from pre- and post-test metamemory tests.

Subject	1	2	3	4	5	6	7
Pretest	-0.12	0.33	0.85	1.00	-0.29	1.00	-0.01
Post-test	-0.19	0.10	0.69	1.00	0.00	1.00	0.21

Subject	8	9	10	11	12	13	14
Pretest	0.21	0.50	0.00	0.42	1.00	-0.13	0.85
Post-test	0.63	1.00	0.55	0.16	1.00	0.08	0.34

Subject	15	16	17	18	19	20	21
Pretest	0.27	-0.07	0.21	0.57	1.00	0.30	0.00
Post-test	0.19	0.43	0.13	-0.11	1.00	0.30	0.00

Subject	22	23	24	25
Pretest	0.46	0.16	1.00	1.00
Post-test	0.18	0.16	1.00	0.92

Strategy Use

Exposure time data. Figure 1 shows the exposure times for the first three items in lists of items, averaged over subjects for reinforced and non-reinforced probe trials. Rehearsal scores for the analysis were obtained from exposure time data by multiplying the first three items in lists of items by the orthogonal polynomial coefficients for linear trend (-1 0 1) and summing the products. A 2x7 (reinforcement condition x probe trials) repeated measures analysis of variance was then carried out on this data.

Two planned comparisons (Keppel, 1982) were also carried out between the levels of the probe trials factor. Comparison 1 examined the linear trend in rehearsal over sets of training task probe trials. Comparison 2 compared amount of rehearsal in the first set of generalisation task probe trials with the second set of generalisation task probe trials. The coefficients for the two comparisons are set out below:

Probe Trials

	training					generalisation	
	1	2	3	4	5	1	2
Comparison 1	-2	-2	0	1	2	0	0
Comparison 2	0	0	0	0	0	1	-1

The analysis indicated that the reinforcement main effect was significant ($F(1,24) = 17.81$, $MSe = 6.36$, $P<.01$), indicating that the increase in rehearsal in reinforced compared to non-reinforced trials apparent in Figure 1 was significant.

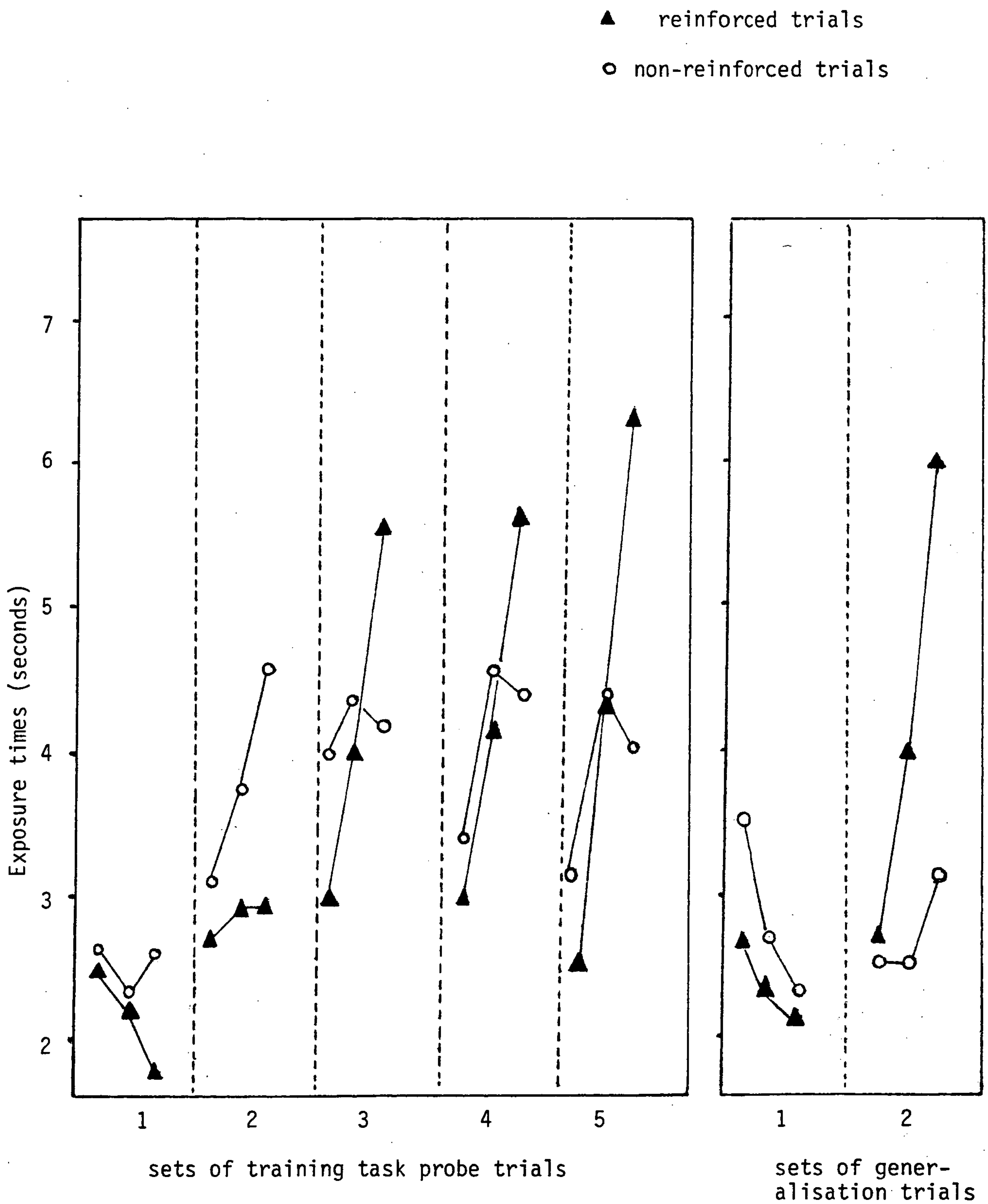

Figure 1. Mean Exposure Times for the First Three Stimuli in Sets of Probe Trials.

In Comparison 1, the probe trials main effect was significant ($F(1,24) = 11.94$, $MSe = 20.13$, $p<.01$), indicating that the linear increase in rehearsal over successive training task probe trials apparent in Figure 1 was significant.

In Comparison 2, the probe trials main effect was also significant ($F(1,24) = 11.76$, $MSe = 17.13$, $p<.01$). This indicates that the increase in rehearsal scores in the second compared to the first set of generalisation task probe trials apparent in Figure 1 was significant.

ANOVA summary tables appear in Appendix F. Raw data are presented in Appendix G.

Overt rehearsal data. Figure 2 shows the overt rehearsal scores averaged over subjects for reinforced and non-reinforced probe trials. A 2x7 (reinforcement condition x probe trials) repeated measures analysis of variance was carried out on the overt rehearsal scores.

As with the exposure time data, two planned comparisons were carried out between levels of the probe trials factor. Comparison 1 examined the linear trend in rehearsal over sets of training task probe trials, while Comparison 2 compared the amount of rehearsal in the first set of generalsiation task probe trials with the second set of generalisation task probe trials.

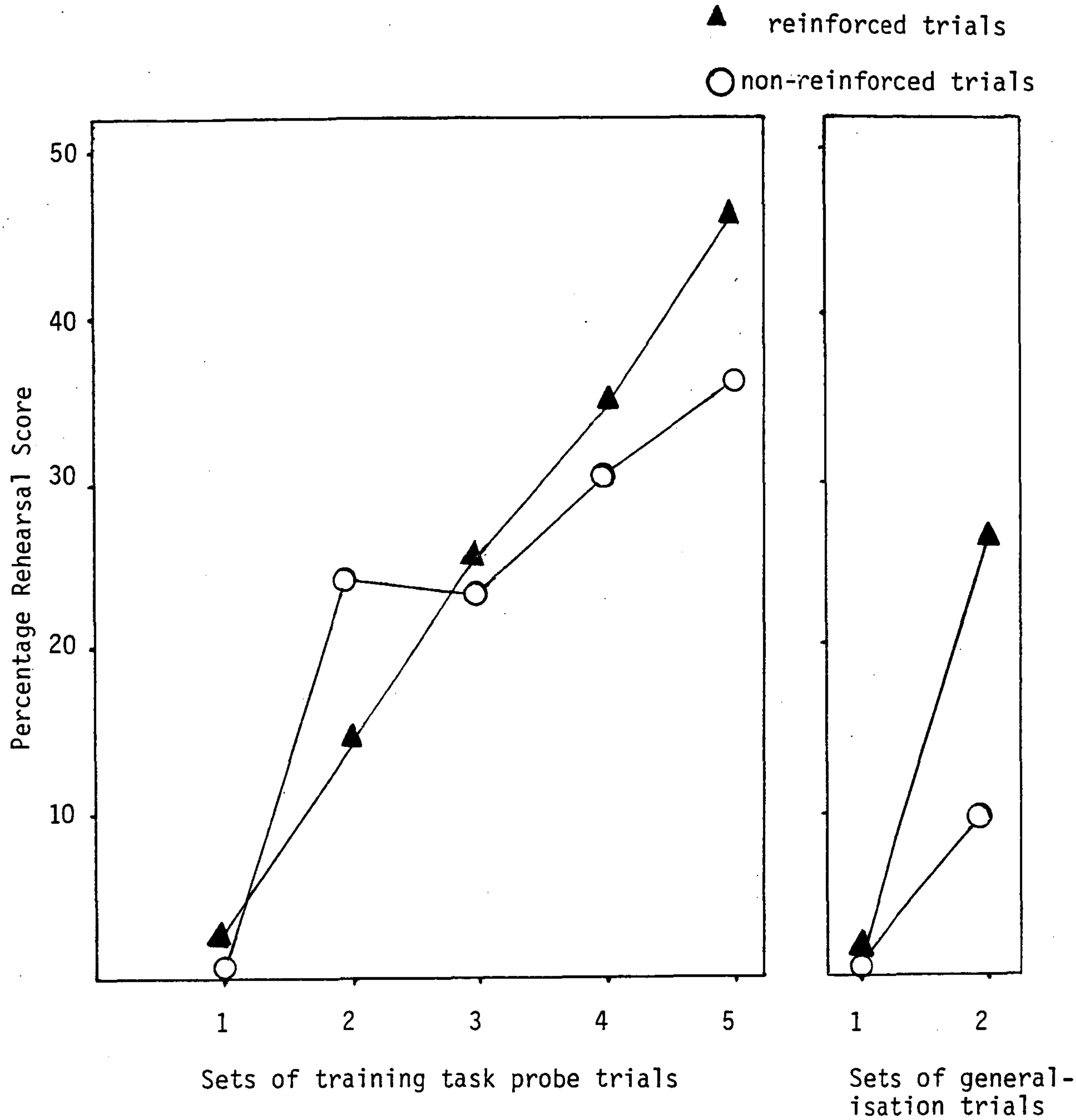

Figure 2. Mean Percentage Overt Rehearsal Scores

The coefficients for these comparisons are set out below:

	Probe trials training 1	2	3	4	5	generalisation 1	2
Comparison 1	-2	-1	0	1	2	0	0
Comparison 2	0	0	0	0	0	1	-1

The analysis indicated that the reinforcement main effect was not significant at the $\alpha = 0.05$ level ($F(1,24) = 3.30$, $MSe = 433.77$, $p > .05$). That is, rehearsal scores from reinforced probe trials were not significantly greater than rehearsal scores from non-reinforced trials.

In Comparison 1, the probe trials main effect was significant ($F(1,24) = 27.10$, $MSe = 1,661.88$, $p < .01$). This indicates that the increase in overt rehearsal scores over successive sets of training task probe trials which is apparent in Figure 2 was significant.

In Comparison 2, the probe trials main effect was significant ($F(1,24) = 15.88$, $MSe = 461.1852$, $p < .01$). This indicates that the increase in overt rehearsal scores in the second compared to the first set of generalisation task probe trials apparent in Figure 2 was significant.

ANOVA summary tables appear in Appendix H. Raw data appear in Appendix I.

Correlation Between Measures of Rehearsal

As a check on the strength of the correlation between the two measures of rehearsal used in the study, the product-moment correlation between these two measures from the fifth reinforced training task probe trial was calculated. The correlation between these two measures was not significant ($r = .28$, $p > .05$).

Metamemory-Rehearsal Relationship

Table 5 shows correlations between the dependent variables (overt rehearsal scores, linear trend in exposure times) from the fifth set of training task probe trials and the second set of generalisation task probe trials, and the independent variables (memory ability, strategy effectiveness, open question about choice of strategy) from the post-test metamemory assessment. In assessing the significance of these correlations, a family-wise error rate of 0.05 was adopted for the matrix of 24 correlations by setting the probability of rejection of the null hypothesis for each correlation at 0.05/24 = 0.002. This is the Bonferroni procedure (Keppel, 1982).

None of the correlations between dependent and independent variables was significant at the 0.002 level.

In Chapter 1 it was hypothesised that, following training in the use of a rehearsal strategy, knowledge of the appropriateness of rehearsal to a memory task, assessed by an open question, and subjects' estimates of the effectiveness of rehearsal and their own

Table 5. Pearson correlation coefficients and levels of statistical significance for correlations between the dependent variables (overt rehearsal scores, linear trend in exposure times) from the fifth set of training task probe trials and the independent variables (memory ability, strategy effectiveness, open question about choice of strategy) from the post-test metamemory assessment.

	strategy effectiveness	memory ability	open question about choice of strategy
exposure times training task probe trial #5	0.161	0.167	0.199
non-reinforced	p = 0.221	p = 0.212	p = 0.169
exposure times generalisation task probe trial #2	0.127	0.071	0.315
non-reinforced	p = 0.273	p = 0.368	p = 0.062
exposure times training task probe trial #5	-0.118	-0.313	0.025
reinforced	p = 0.287	p = 0.060	p = 0.453
exposure times generalisation task probe trial #2	0.152	0.050	0.361
reinforced	p = 0.235	p = 0.406	p = 0.038
overt rehearsal training task probe trial #5	0.199	0.049	0.303
non-reinforced	p = 0.170	p = 0.420	p = 0.071
overt rehearsal generalisation task probe trial #2	-0.039	-0.023	0.083
non-reinforced	p = 0.444	p = 0.447	p = 0.346
overt rehearsal training task probe trial #5	0.055	0.286	0.359
reinforced	p = 0.399	p = 0.083	p = 0.039
overt rehearsal generalisation task probe trial #2	0.001	-0.044	0.239
reinforced	p = 0.499	p = 0.417	p = 0.124

memory ability would be related to the amount of strategy use on the training task and to the generalisation of strategy use to a novel task. This implies that the dependent variables (overt rehearsal scores and the linear trend in exposure times) should be correlated with the independent variables (memory ability estimates, strategy effectiveness estimates and responses to the open question about choice of strategy). The appropriate means of testing this hypothesis is via a set of canonical correlations (Cohen & Cohen, 1983) between the sets of dependent and independent variables. Four such analyses were carried out:

1. Overt rehearsal data from reinforced training task probe trial #5, exposure time data from reinforced training task trial #5
   WITH
   Open question about choice of strategy, memory ability estimates and strategy effectiveness estimates obtained in the metamemory post-test.

2. Overt rehearsal data from reinforced generalisation task probe trial #2 and exposure time data from reinforced generalisation task probe trial #2
   WITH
   Open question about choice of strategy, memory ability estimates and strategy effectiveness estimates obtained in the metamemory post-test.

3. Overt rehearsal data from non-reinforced training task probe trial # 5 and exposure time data from non-reinforced training task probe trial # 5
WITH
Open question about choice of strategy, memory estimates and strategy effectiveness estimates obtained in the metamemory post-test.

4. Overt rehearsal data from non-reinforced generalisation task probe trial #2 and exposure time data from non-reinforced generalisation task probe trial #2.
WITH
Open question about choice of strategy, memory ability estimates, and strategy effectiveness estimates obtained in the metamemory post-test.

The results of these analyses are summarised in Table 6.1 - 6.4. None of the canonical correlations were significant at the .05 level of significance.

Table 6.1. Result of canonical correlation 1:

Overt rehearsal data from reinforced training task probe trial #5 and exposure-time data from reinforced training task probe trial #5

WITH

Open question about choice of strategy, memory ability estimates and strategy effectiveness estimates obtained in the metamemory post-test.

	Eigen value	Canonical correlation	Wilks Lambda	Chi-square	DF	Significance
Variate pair 1	0.370	0.609	0.602	10.657	6	0.100
Variate pair 2	0.044	0.210	0.956	0.944	2	0.624

Coefficients for canonical variables (independent variables) for the first canonical variate

Strategy effectiveness	0.055
Memory ability	0.836
Open question	0.604

Coefficients for canonical variables (dependent variables) for the first canonical variate

Exposure times	-0.684
Overt rehearsal	0.948

Table 6.2. Result of canonical correlation 2:

Overt rehearsal data from reinforced generalisation task probe #2 and exposure time data from reinforced generalisation task probe trial #2

WITH

Open questions about choice of strategy, memory ability estimates and strategy effectiveness estimates obtained in metamemory post-test.

	Eigen value	Canonical correlation	Wilks Lambda	Chi-square	DF	Significance
Variate pair 1	0.162	0.403	0.825	4.038	6	0.671
Variate pair 2	0.015	0.123	0.985	0.319	2	0.853

Coefficients for canonical variables (independent variables) for the first canonical variate

Strategy effectiveness	0.387
Memory ability	0.110
Open question	0.930

Coefficients for canonical variables (dependent variables) for the first canonical variate

Exposure times	0.989
Overt rehearsal	0.020

Table 6.3. Result of canonical correlation 3:

Overt rehearsal data from non-reinforced training task probe trial #5 and exposure time data from reinforced training task trial #5

WITH

Open question about choice of strategy, memory ability estimates and strategy effectiveness estimates obtained in the metamemory post-test.

	Eigen value	Canonical correlation	Wilks Lambda	Chi-square	DF	Significance
Variate pair 1	0.147	0.383	0.833	3.848	6	0.697
Variate pair 2	0.024	0.155	0.976	0.510	2	0.775

Coefficients for canonical variables (independent variables) for the first canonical variate

Strategy effectiveness	0.541
Memory ability	0.181
Open question	0.832

Coefficients for canonical variables (dependent variables) for the first canonical variate

Exposure times	0.335
Overt rehearsal	0.786

Table 6.4. Result of canonical correlation 4:

Overt rehearsal data from non-reinforced generalisation task probe trial #2 and exposure time data from non-reinforced generalisation task probe trial #2

WITH

Open question about choice of strategy, memory ability estimates and strategy effectiveness estimates obtained in the metamemory post-test.

	Eigen value	Canonical correlation	Wilks Lambda	Chi-square	DF	Significance
Variate pair 1	0.134	0.367	0.862	3.130	6	0.792
Variate pair 2	0.005	0.069	0.995	0.099	2	0.952

Coefficients for canonical variables (independent variables) for the first canonical variate

Strategy effectiveness	0.390
Memory ability	0.227
Open question	0.905

Coefficients for canonical variables (dependent variables) for the first canonical variate

Exposure times	1.098
Overt rehearsal	-0.323

CHAPTER 4

DISCUSSION

The two hypotheses tested in this study were: 1. that following training in the rehearsal strategy, the amount of rehearsal in the training task would be related to metamemory, and 2. that following training in the rehearsal strategy, the amount of generalisation of rehearsal to a novel task would be related to metamemory. Neither of these hypotheses were supported by the results of the study. There are a number of important issues relating to these results which warrant examination.

Metamemory

A wide range of strategies was elicited in the metamemory pretest in response to the open question about what subjects would do to remember stimuli of the same type used in the training and generalisation tasks (i.e., open question about choice of strategy). These included a number of strategies generally considered to be more effective than cumulative rehearsal alone (Pressley et al., 1982), including categorisation and elaboration.

Estimates of memory ability obtained in the metamemory pretest were often much higher than subjects' actual memory span. A number of subjects stated that they could remember 12 items in a list, although no subject's memory span, as assessed in the first session, exceeded four items. This finding is consistent with evidence from previous studies that the developmentally immature tend to overstate their memory ability (e.g., Brown, 1978).

There were no significant improvements in subjects' estimates of memory ability or strategy effectiveness over the period of training between metamemory pretest and post-test. According to existing conceptualisations of metamemory (e.g., Brown & DeLoach, 1978) appropriate changes in metamemory should be expected to occur as a result of feedback from performance in memory tasks.

Findings from previous studies relating to the effectiveness of feedback in improving metamemory have been somewhat contradictory (e.g., Kreutzer et al, 1975; Kennedy & Miller, 1976). With regard to the lack of improvement in subjects' estimates of memory ability in the present study, subjects were provided with clear feedback concerning their memory ability immediately following each performance in a memory task. That their memory ability estimates did not become more realistic following the sessions of training, appears to support the findings of Kreutzer et al. (1975), that the developmentally immature may be insensitive to feedback about at least some aspects of their memory.

The picture is not so clear with regard to the lack of change in estimates of strategy effectiveness over the period of training in strategy use. The experimenter did not provide subjects with direct feedback about improvements in memory performance when they used the rehearsal strategy, relative to performance when they did not use the strategy. Although the present study was not concerned with subjects' recall accuracy per se, improvements in recall accuracy were observed to be typically small, and subjects may therefore not have been aware of such improvements. That is, it is possible that estimates of strategy effectiveness did not change between pre- and post-test because of lack of feedback to subjects that rehearsal was an effective strategy relative to passive behaviour.

Responses to the open question about choice of strategy did significantly improve between metamemory pretest and post-test. The finding that this measure of metamemory changed after experience in the memory task while the others did not, may be the result of this type of measure tapping aspects of metamemory which are more sensitive to feedback. Alternatively, the open question about choice of strategy may have elicited stronger demand effects than the other two metamemory measures. Instructions given to subjects prior to each set of probe trials stressed that they were to "say the names/ doing words over and over again to help them remember", and the effect of these instructions may have been to suggest to them the appropriate response during the metamemory post-test, regardless of whether they actually believed that use of the rehearsal strategy was the most appropriate way of performing in memory tasks.

Use of Rehearsal Strategy

Scores for both measures of rehearsal increased significantly in a linear fashion over the five sets of training task probe trials, indicating that the children were learning to use the strategy as training progressed. This finding is in agreement with the large number of studies that have shown that mildly retarded children can be trained to use a variety of mnemonic strategies (e.g., Brown & Barclay, 1976; Brown, Campione & Barclay, 1979; Kendall, Borkowski and Cavanaugh, 1980).

Analysis of exposure time data indicated a significantly greater amount of rehearsal in reinforced probe trials than in non-reinforced probe trials. This agrees with the findings of Gelabert et al. (1980) with developmentally normal children. Gelabert et al.'s subjects used a trained rehearsal strategy more when incentives were provided for recall than when they were not. In contrast, overt rehearsal scores in the present study were not significantly greater when recall was reinforced than when it was not. A possible reason for this lack of agreement between the two measures of rehearsal will be discussed later.

As a check on the relationship between the two measures of rehearsal used in the study, the correlation between the two measures for the fifth reinforced training task probe trial was calculated. This correlation was found to be low. There are two obvious reasons for this low correlation. First, while the exposure time measure used in the study assesses rehearsal over only the first three items in lists, the overt rehearsal measure assesses rehearsal over the entire list. Children received lists of four, five or six items in the study. If those children who received five or six items in lists failed to maintain rehearsal over the last two or three items but rehearsed over the first three items, then their overt rehearsal scores would be relatively lower than their exposure time scores. Conversely, if children who received lists of five or six items failed to rehearse over the first three items in lists, but rehearsed over the last three items, then their overt rehearsal scores would be relatively higher than their exposure time scores. These two different styles of rehearsing were not considered to be an important factor in reducing the correlation between measures of rehearsal, however, because during the course of the experiment children were observed to adopt them on relatively few occasions.

A second, and it is considered more important, reason for the low correlation observed between the two measures of rehearsal is that each of the measures has its own strengths and limitations in assessing rehearsal. This is the reason, as pointed out previously, why the two measures of rehearsal were employed concurrently in the present study. It appeared that a shortcoming of the exposure time measure in the present study was its failure to accommodate subjects who rehearsed, but did not rehearse cumulatively according to the method taught them in training sessions. Subjects were often observed to repeat each item alone upon its presentation or to follow some other deviation from the cumulative rehearsal strategy taught to them. This still represented rehearsal, but did not result in a linear increase in exposure times. The overt rehearsal measure, on the other hand, does take account of subjects who follow some variant of the rehearsal strategy which does not produce a linear trend in exposure times, but it cannot assess covert rehearsal. This might help to explain why the exposure time measure detected significantly greater rehearsal in the reinforced probe trials than in non-reinforced probe trials, while the overt rehearsal measure did not. In the Gelabert et al. study, cited above, greater rehearsal was observed in reinforced than in unreinforced trials. The measure of rehearsal used in that study was subjects' lip movements. Observed lip movements and exposure times are both measures which can detect covert rehearsal, and these were the measures which, in both Gelabert et als' study and the present study, indicated significantly greater rehearsal in reinforced trials. This suggests the possibility that reinforcement produces an increase in covert rehearsal to a greater extent than overt rehearsal, although the reason for this is by no means clear.

Relationship Between Metamemory and Strategy Use

Findings from previous studies of the metamemory-strategy use relationship in developmentally normal and retarded children have been inconsistent. Some investigators have reported partial relationships (e.g., Kendall et al., 1980; Cavanaugh & Borkowski, 1979), while other investigators have found no relationship (e.g., Salatas & Flavell, 1970). Earlier it was argued that this lack of evidence in the literature of consistent relationships between metamemory and strategy use may result from investigators selecting the particular aspect of metamemory they have chosen to study on arbitrary grounds, and because they have invariably failed to consider the level of incentive of children to perform in memory tasks. This, however, was not supported by the results of the present study. No significant relationships between metamemory and strategy use emerged, although the aspects of metamemory selected for study were those considered on theoretical grounds to be aspects of metamemory likely to be related to strategy use, and although strategy use was studied in both memory trials where memory preformance was non-reinforced and memory trials where performance was reinforced.

Generalisation of Strategy Use

Scores for both measures of rehearsal were significantly greater in the second set of generalisation task probe trials than in the first. This suggests that generalisation of the trained rehearsal strategy from the training task to the generalisation task took place. It should be noted, however, that the design of the experiment did not include controls for factors other than generalisation of training which could possibly have produced the increase in rehearsal in the second generalisation session. Thus, the increase in rehearsal could conceivably have been simply the result of subjects' practice with the generalisation task in the first generalisation session. This is considered unlikely, however, because rehearsal, as assessed by both measures, occurred at an extremely low level in the first generalisation session, and increased in the second session, particularly in the reinforced condition, to a level that was higher than would be expected if the increase were simply the result of practice with the task.

No definite parameters have been applied to the terms 'near generalisation' and 'far generalisation', beyond the statement that far generalisation is characterised by distinct changes in task characteristics between the task on which the subject is trained and the task to which the effects of training generalise. This makes the classification of the generalisation task used in the present study as a near or far generalisation task difficult.

The generalisation task used by Kendall et al. (1980), which was described as a near generalisation task, involved the learning of triads of items, while the training task used in that study involved the learning of pairs of items. The generalisation task used by Brown et al. (1979), described as a far generalisation task, involved the gist recall of prose passages, while the training task used in that study was a list learning task. It is considered that the extent of differences between training and generalisation tasks used in the present study more closely matches the extent of differences between the tasks used by Kendall et al. than the tasks studied by Brown et al. On this basis, the generalisation task used in the present study is seen as a near generalisation task, rather than a far generalisation task.

Relationship Between Metamemory and Generalisation

One of the more disappointing aspects of the present study was the lack of a clear relationship between metamemory and generalisation of strategy use. This is an area that has not previously been examined in the literature. Ringel and Springer (1980) showed that older children in their sample of 7 - 11 year old developmentally normal children were more likely to show generalisation of a categorisation strategy than younger children when provided with feedback about the effectiveness of the strategy. However, the authors did not address the question of whether or not children who possessed better developed metamemory were more likely to show generalisation effects than those who possessed poor metamemory.

It is probable that any relationship between metamemory and generalisation is influenced by the extent to which the generalisation task is different from the training task. Generalisation of a trained strategy to a far generalisation task might require that the child have considerable knowledge of memory, whereas this might not be the case for a near generalisation task. It is possible that a relationship might have emerged in the present study between generalisation and metamemory if the generalisation task had differed to a greater extent from the training task. This issue might be clarified in future studies if several generalisation tasks are employed, differing to varying extents from the training task,

Incentive to Remember

It could be argued that the fact that a relationship between strategy use and generalisation and metamemory did not emerge in reinforced trials might have been the result of subjects failing to discriminate between reinforced and non-reinforced trials, or because reinforcers used in the study were otherwise not effective. However, a number of precautions were taken to reduce these possibilities. To increase the effectiveness of reinforcers, subjects were allowed to choose their own reinforcers from a large variety of reinforcers. Reinforcement procedures were devised to make reinforced trials highly discriminable from non-reinforced trials. Non-reinforced trials were always followed by reinforced trials. Immediately before non-reinforced trials, subjects were instructed clearly that they would not earn anything for their performance. At the commencement of reinforced trials, subjects were instructed clearly that they would earn something for their performance. At the commencement of reinforced trials, the reinforcement cards and the reinforcers were placed in the subject's view, and he/she was clearly informed of the contingencies. Finally, the finding that the linear trend in item exposure times was significantly greater in reinforced trials than in non-reinforced trials is evidence that reinforcers were effective and that subjects could discriminate between reinforced and non-reinforced trials.

Strategies Other Than Rehearsal

In the metamemory pretest and post-test, responses to the open question about choice of strategy indicated that a number of subjects knew about the appropriateness to the memory task of several strategies that are considered to be generally more effective than cumulative rehearsal, including categorisation and elaboration. Pressley et al. (1982) have argued that subjects will tend not to use a trained mnemonic strategy if prior to training they used strategies more effective in the memory tasks under study. It is possible that in the present study some subjects failed to use and generalise the trained rehearsal strategy because they were using a more effective strategy, like elaboration, while acknowledging in the metamemory assessment that rehearsal would be more effective than passive behaviour. Clearly this possibility should be borne in mind in future studies in the area.

Sample Size

The relatively small number of subjects participating in the present study is likely to have limited the potential for finding statistically significant relationships between metamemory-strategy use and generalisation. However, excessive importance should not be placed on sample size. Experimental effects on strategy use were observed in the present study. For example, significantly greater rehearsal was observed when subjects were reinforced for memory performance than when they were not. If metamemory is important in retarded children's use and generalisation of mnemonic strategies, it could be expected that metamemory-strategy use and generalisation relationships could be detected with a sample size of the same magnitude needed to detect strategy use effects. This, however, assumes that metamemory in retarded children can be reliably measured. The issue or reliability of metamemory will be examined further.

Reliability of Metamemory Measures

It could be argued that failure to find significant relationships between metamemory and strategy use and generalisation in the present study might have been the result of low reliability of the metamemory measures. Brown and Campione (1977) have pointed out the problems of low reliability involved in the assessment of metamemory in young children. In the present study, however, the procedures for measuring metamemory were carefully chosen in an attempt to achieve maximum reliability. Both open and closed questions were used. Metamemory questions were accompanied by visual materials designed to be as unambiguous as possible. Metamemory scores used in the analyses were averages of at least two raw scores. This is in agreement with the recommendation of Brown and Campione (1977), that reliability be increased by assessing particular aspects of metamemory with more than one question on more than one occasion. The possibility remains, however, that low reliability of the metamemory measures may have contributed to the lack of a relationship between metamemory and strategy use.

Conscious Versus Automatic Processes

The lack of significant relationships between metamemory and strategy use and generalisation may be taken as suggesting that the control of rehearsal strategies involves automatic processes, in the sense of the term used by Kellogg (1982). Kellogg proposed a dual process model of how individuals learn rule governed concepts. Kellogg noted that in the past cognitive theorists have adopted one or the other of two view points in regard to concept acquisition; the 'frequency theory' position, or the 'hypothesis theory' position.

Frequency theorists, according to Kellogg, argue that individuals form concepts by isolating the defining features of a concept through the passive accumulation of the relative number of times that the various features occur among the exemplars of a particular category. According to this position, the cognitive processes (concept formation) determining an individual's performance in a given task are automatic and unconscious and therefore not open to introspective probing.

In contrast, according to Kellogg, hypothesis theorists have argued that individuals form rule governed concepts through a search for defining features of categories. This search involves the conscious sampling, storing and testing of hypotheses. According to this position, the relevant processes in concept formation are usually consciously controlled and cen be detected by asking the individual to introspect.

Kellogg has proposed a synthesis of these two positions. His view is that performance in a particular cognitive task may be entirely mediated by automatic learning processes if the task is one that does not encourage the individual to allocate conscious attention to the relevant cognitive processes. However, if the task does place emphasis on allocating conscious attention to learning processes, then the relevant cognitive processes will be conscious and deliberate and open to introspection.

The control of mnemonic behaviour may be considered to involve concept formation. For example, learning that certain types of material may be better remembered in certain situations if that material is rehearsed can be said to involve the acquisition of the concept that those types of material fall into the category of 'suitable for rehearsal'. Acquisition of this type of concept might occur through a conscious process of storing and testing hypotheses. If this were the case, then metamemory, or the knowledge about memory gained through hypothesis testing, would serve in the conscious and deliberate application of strategies to memory tasks, and be open to instrospection.

Alternatively, the formation of concepts about memory might proceed automatically, and the subject might have little or no awareness of this process. To extend Kellogg's dual process model to the area of metamemory, performance with different types of mnemonic strategies and memory tasks may involve either conscious or automatic processes, depending on their characteristics. This should apply to both use of a trained strategy in the task in which training took place, and to generalisation of that strategy to other, novel tasks.

The results of the present study add to the growing number of studies that have failed to find consistent links between metamemory and mnemonic behaviour in normal and retarded children. There has been a tendency in the literature to attribute much of this failure to inadequacies in the methodology used to assess metamemory (e.g., Cavanaugh & Perlmutter, 1982). It might be the case that low reliability of measures of metamemory has contributed to the failure to find consistent relationships between metamemory and strategy use. More research effort should be directed at determining the reliability of the various measures of metamemory. The study of mnemonic behaviour and its application to the remediation of memory problems in the retarded might be better served, however, if the issue of the extent to which the control of strategy use is a conscious or automatic process is dealt with directly in future studies. It should be noted that the extension of Kellog's dual factor approach to the study of the metamemory-mnemonic behaviour relationships in retarded children implies a more complex view of the area. The important issue for research, according to this perspective, is not simply whether or not metamemory is related to strategy use and generalisation, but which strategies, in which tasks, in which conditions are consciously controlled.

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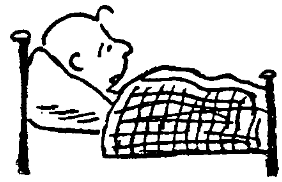
APPENDICES

APPENDIX A: Stimuli Used in the Generalisation Task

digs



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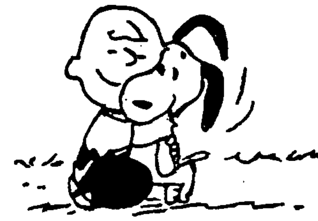
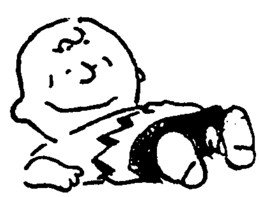


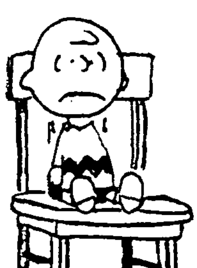
hugs

finds



lies

pats



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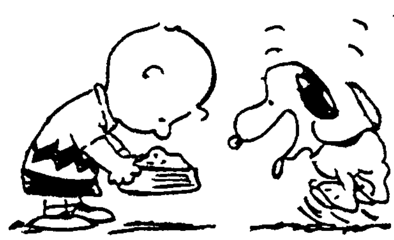
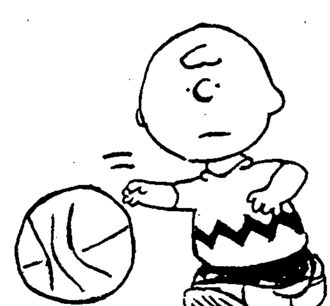


feeds

kicks

shouts

crawls



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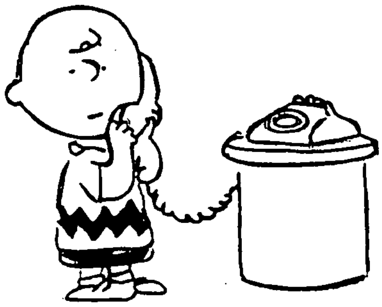
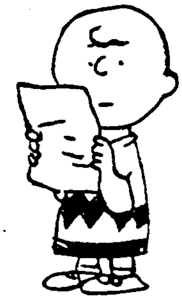


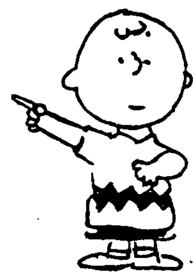
talks

drinks



reads

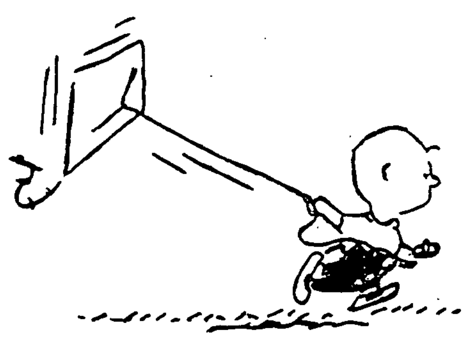
swims



points

plays

blows

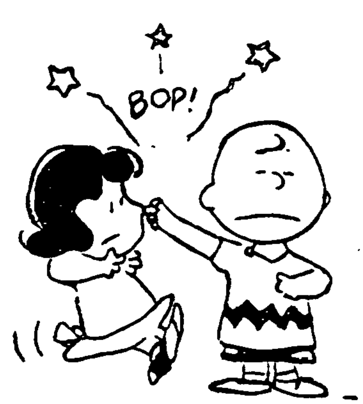


flies

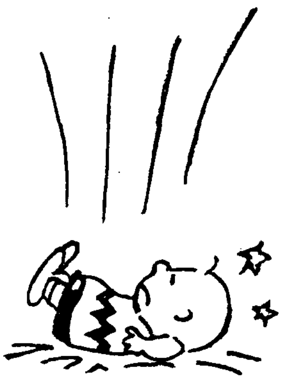
frowns

writes

chops



hits



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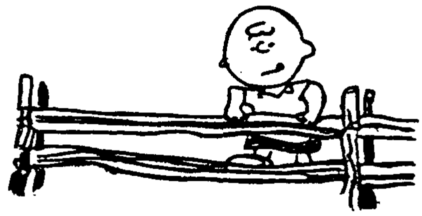
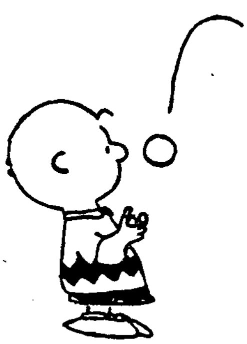


climbs

hides



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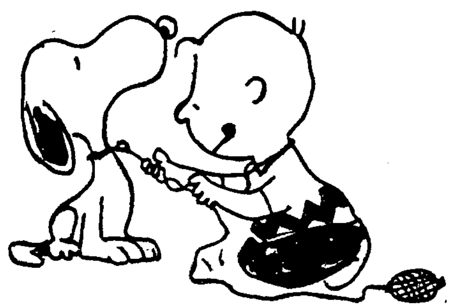

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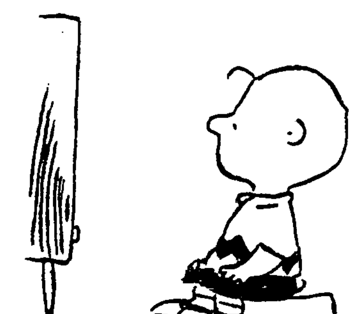

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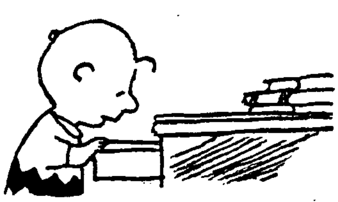

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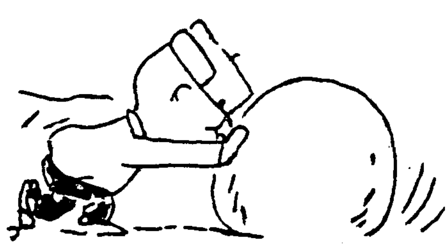

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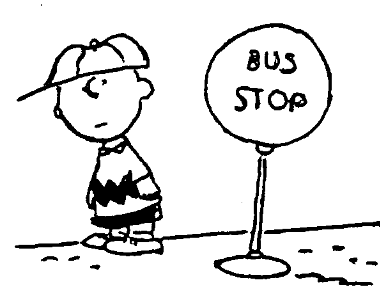
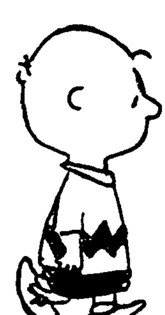
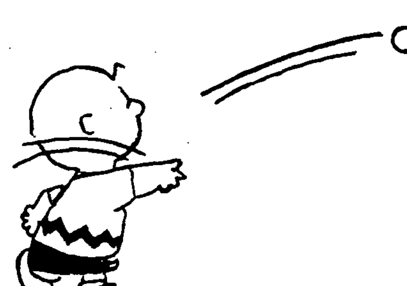


waits

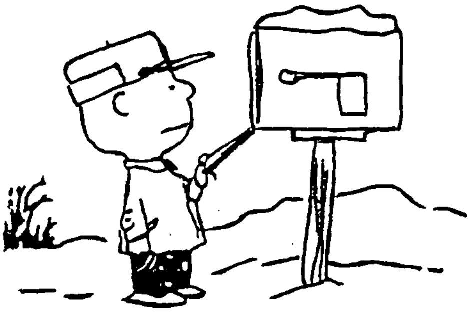
jumps



walks



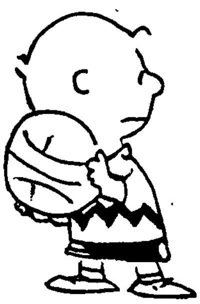
throws



opens

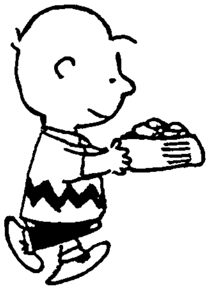
runs

smiles

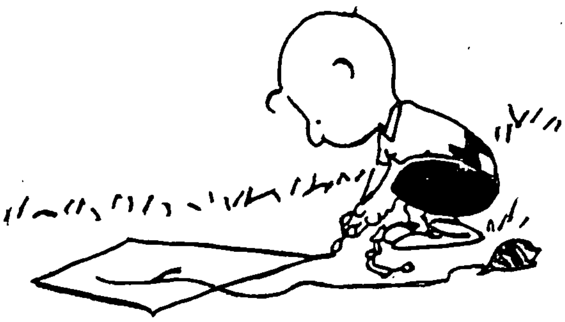


holds

cries



carries



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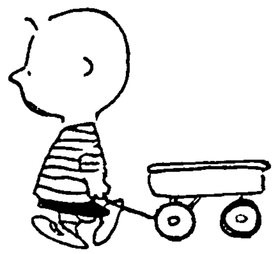

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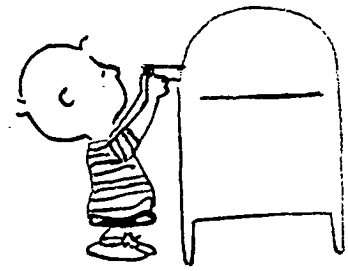

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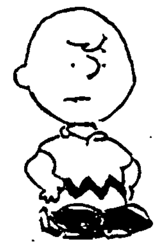
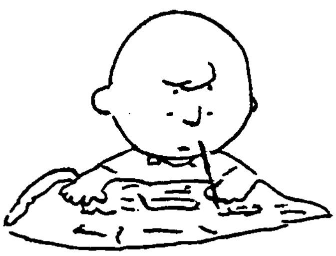


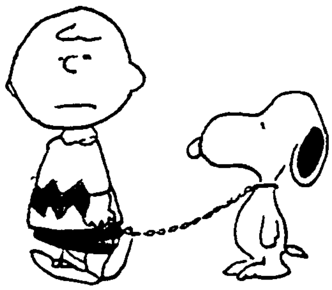
kneels

reaches

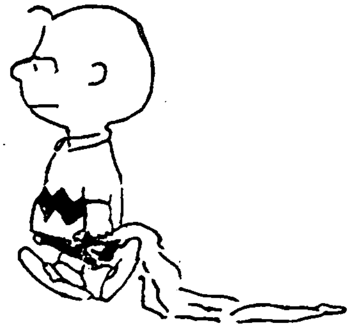


draws

cooks



leads



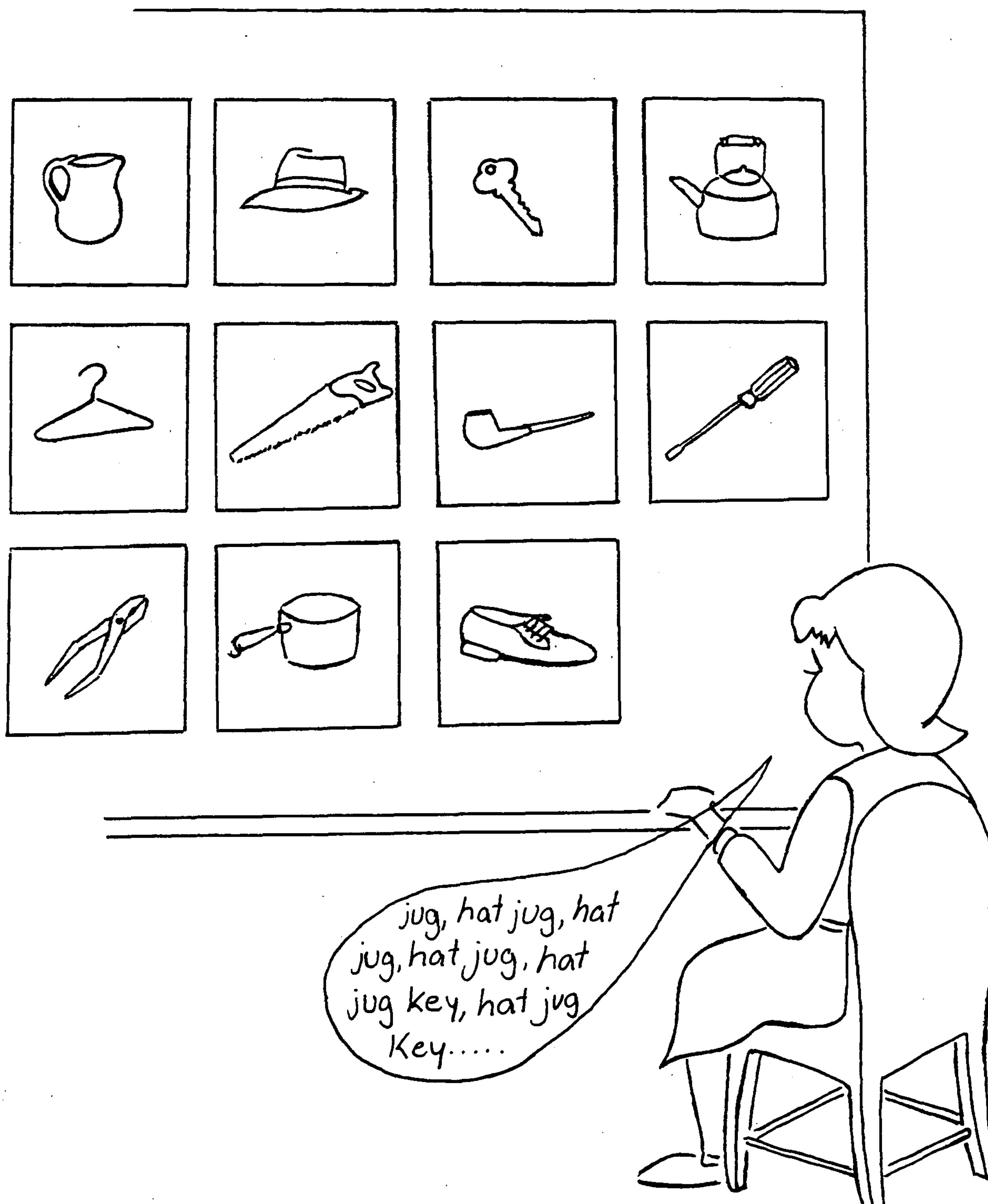
drags

yawns

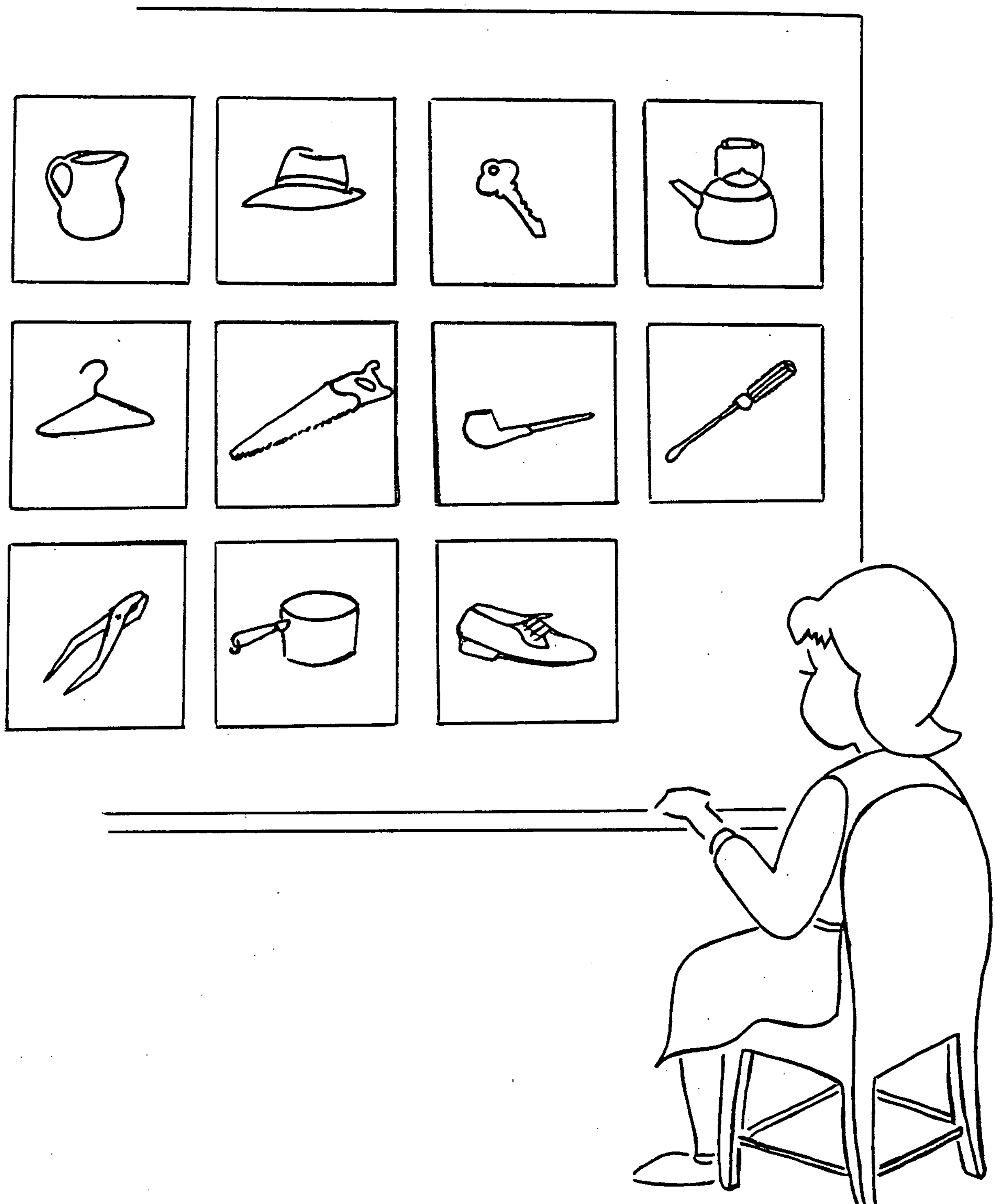
eats

APPENDIX B: Stimulus Cards for Assessing Strategy Effectiveness

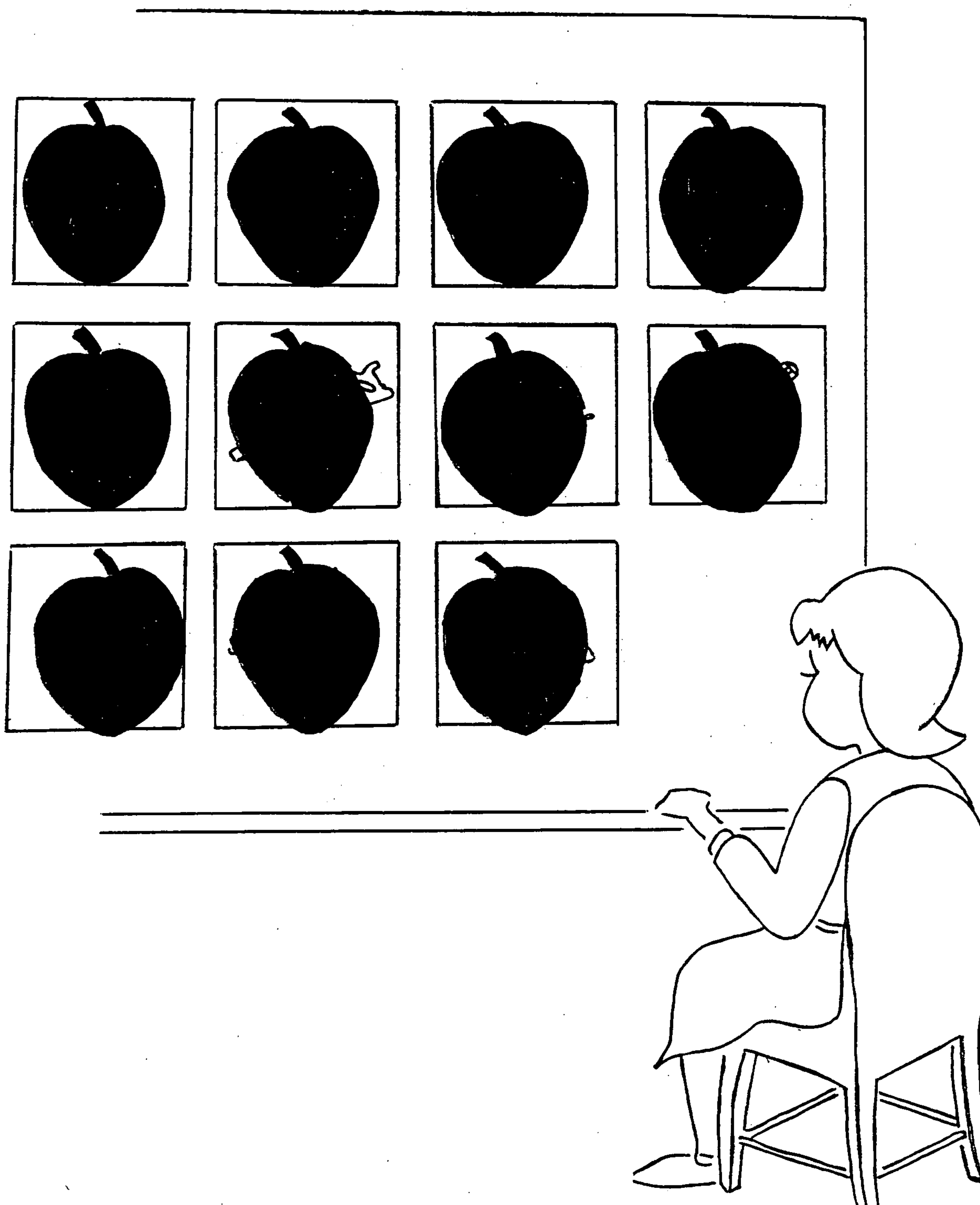
TRAINING TASK: rehearsal stimulus



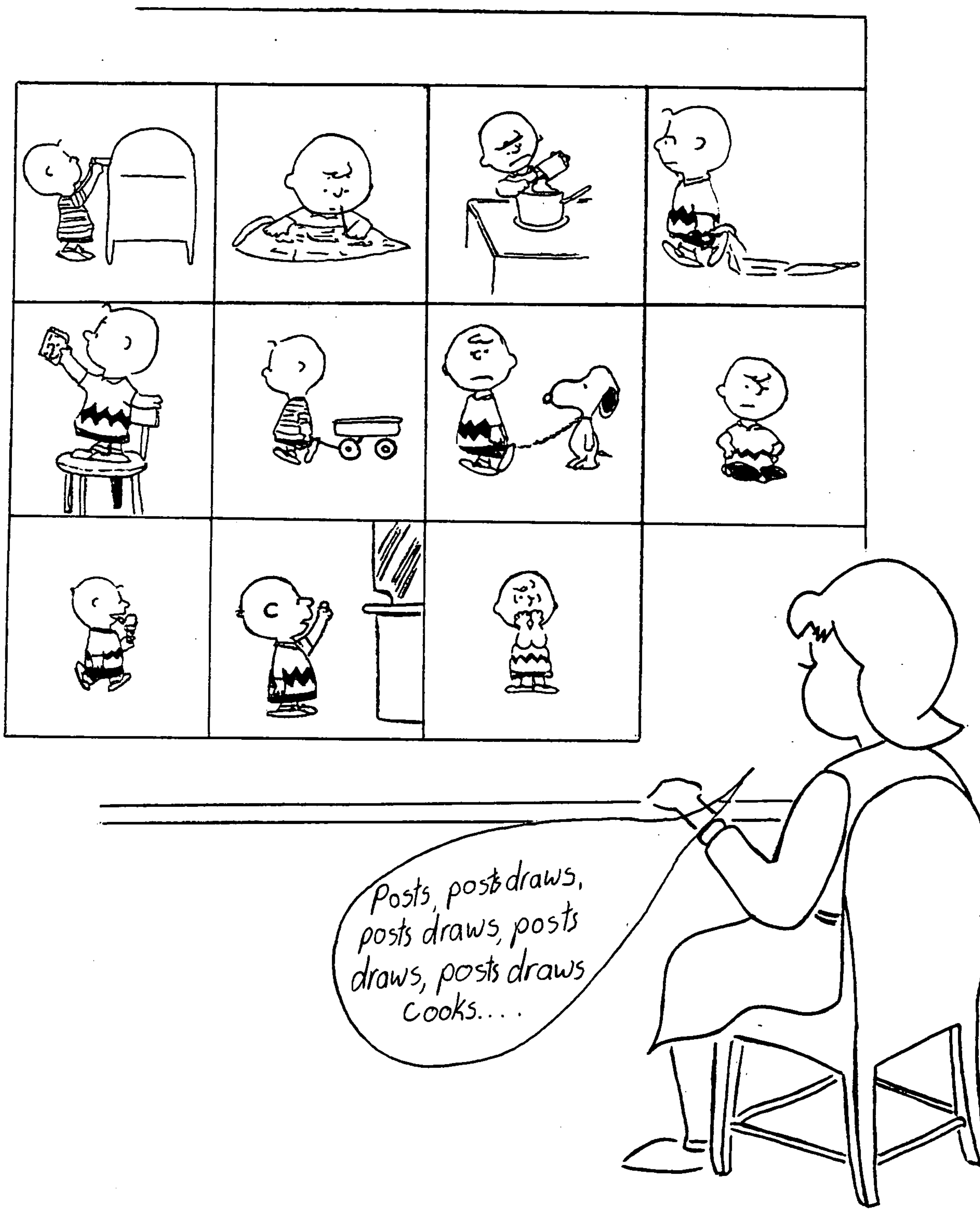
TRAINING TASK: passive stimulus



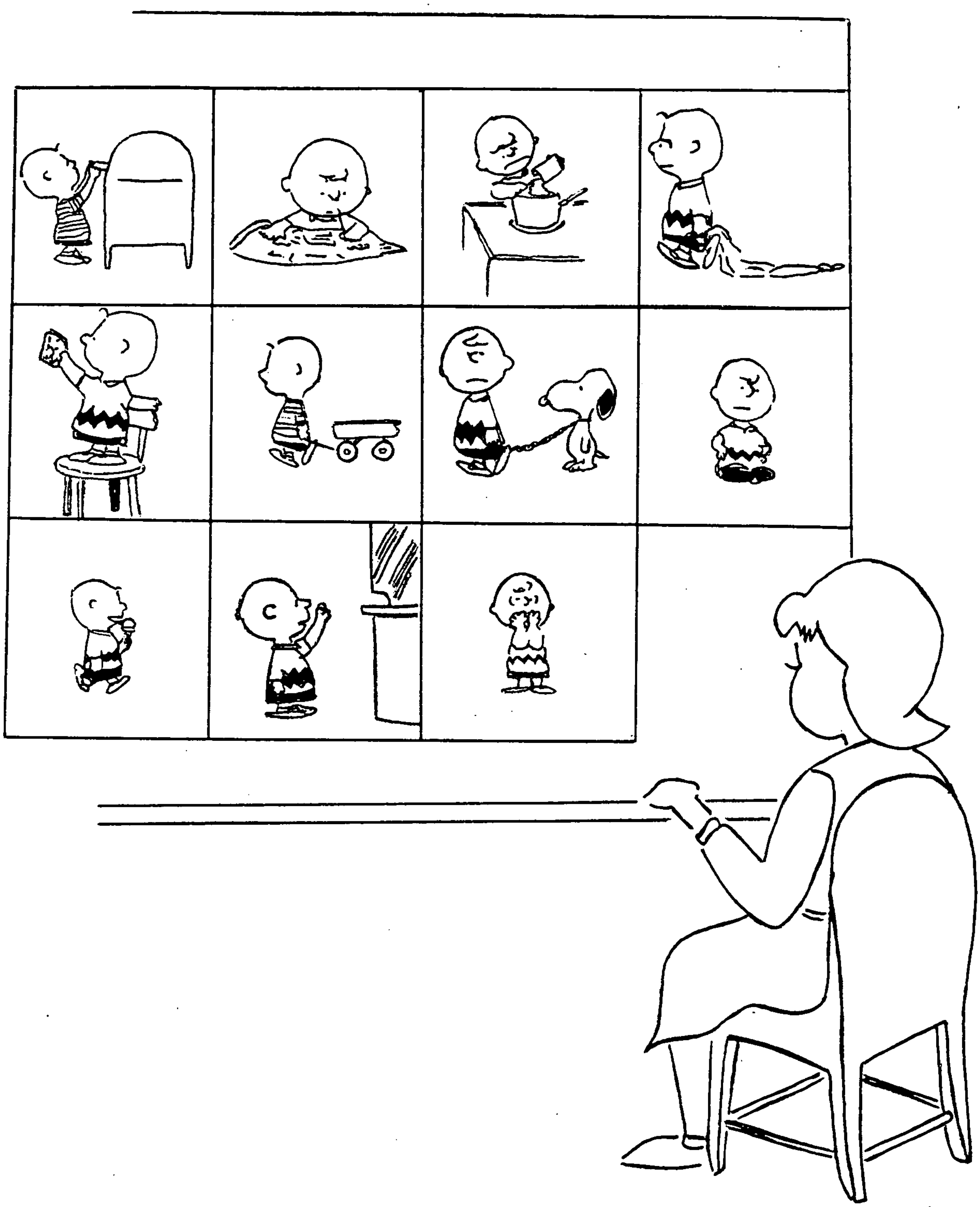
TRAINING TASK: control stimulus



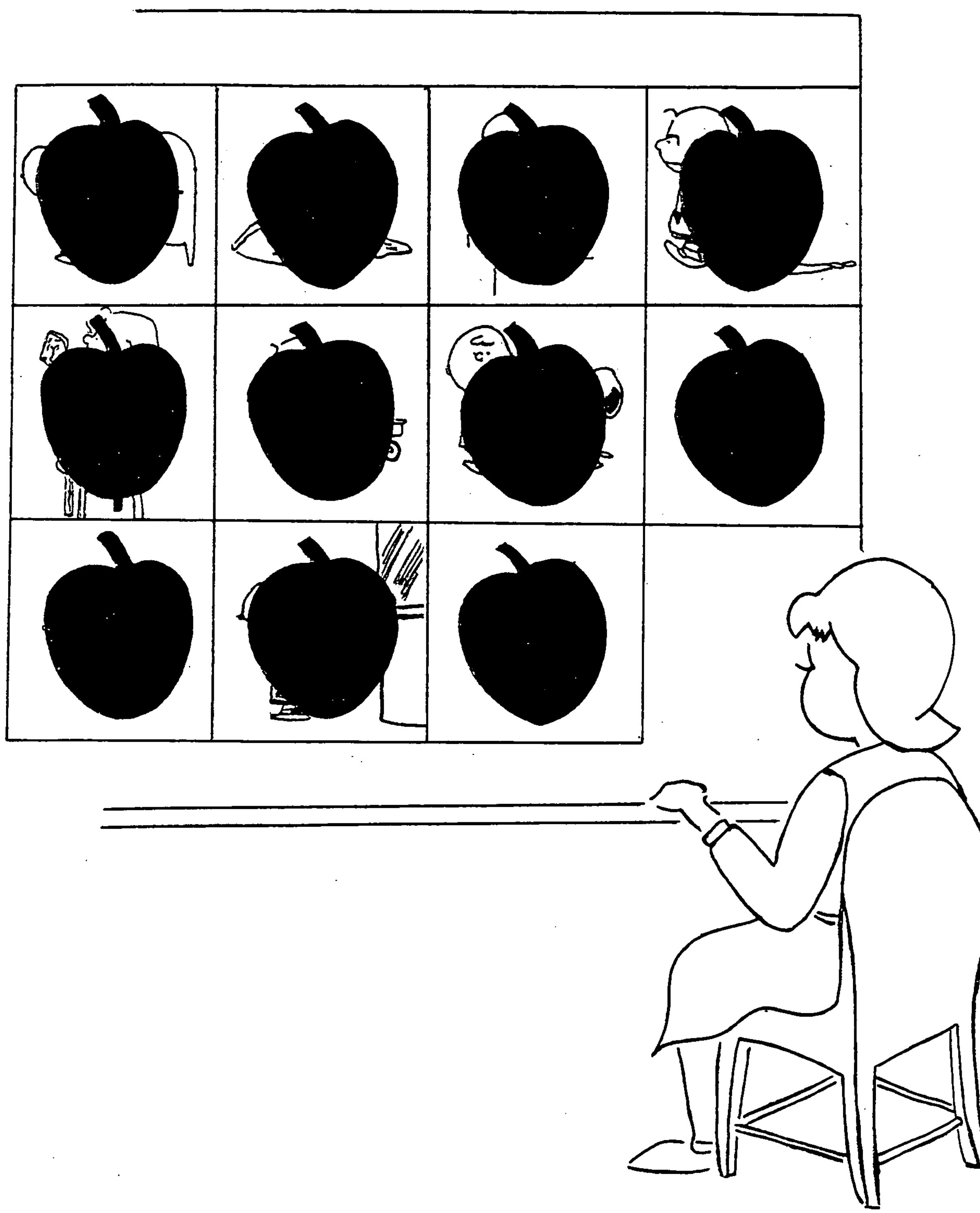
GENERALISATION TASK: rehearsal stimulus



GENERALISATION TASK: passive stimulus



GENERALISATION TASK: control stimulus



APPENDIX C: Responses to the Open Question About Strategy Use

Statements of what subjects would do to remember training task and generalisation task stimuli, from pre- and post-test assessments.

subject	Pre-test: Training task	Pre-test: Generalisation task	Post-test: Training Task	Post-test: Generalisation task
1	think about the items	think about the items	can't think of anything	ask someone else
2	keep saying the items in my mind	say items over and over again	say items over and over again	say items over and over again
3	look through items	can't think of anything	can't think of anything	can't think of anything
4	keep saying items to myself	keep thinking about items	say items over and over again	say items over and over again
5	look at items	think about items	say items three times each	say items three times each
6	thing about items	think about items	think about items	think about items
7	think about items	think about items	say items over and over	say items over and over
8	ask Jesus	can't think of anything	think about items	say items over and over
9	write items on paper	can't think of anything	say items over and over	say items over and over

10	look at items	look at items	look at items	look at items
11	can't think of anything	say items once	say items once	say items over and over
12	look at items longer	look at the items	look as long as I like	look as long as I like
13	look at items and if I can't remember, look again	can't think of anything	can't think of anything	can't think of anything
14	pretend to use the things	do the actions	pretend to use the things	do the actions
15	put the items together	put the items together	think about what the things are used for	can't think of anything
16	can't think of anything	can't think of anything	say items over and over	say items over and over
17	think about items	look at items	think about items	look at items
18	can't think of anything	think about items	would pretend to use the things	would do the actions
19	look at items and look again	look at items and look again	look at items	look at items

20	think about items	can't think of anything	think about items	think about items
21	look at items	can't think of anything	can't think of anything	think about items
22	write items down	can't think of anything	write a note	think about items
23	look at items	look at items	say items over & over	say items over and over
24	look at items	look at items	look as long as I like	look at the items
25	can't think of anything	can't think of anything	look at items longer	can't think of anything

APPENDIX D: Responses to Memory Ability Questions

Subject		Question 1 Training 1	Question 1 Generalisation 2	Question 2 Training 3	Question 2 Generalisation 4
1.	Pretest	9	8	7	9
	Post-test	9	11	10	11
2.	Pretest	4	4	6	4
	Post-test	5	3	7	5
3.	Pretest	6	6	6	6
	Post-test	12	12	12	12
4.	Pretest	5	5	7	6
	Post-test	6	6	6	6
5.	Pretest	3	4	3	3
	Post-test	12	12	11	10
6.	Pretest	10	10	9	10
	Post-test	10	10	11	8
7.	Pretest	2	4	4	3
	Post-test	6	5	6	6
8.	Pretest	4	3	5	4
	Post-test	6	8	6	6
9.	Pretest	3	12	12	10
	Post-test	11	7	9	9
10.	Pretest	8	5	7	4
	Post-test	12	12	12	12
11.	Pretest	12	12	12	12
	Post-test	12	12	12	12
12.	Pretest	8	11	11	10
	Post-test	12	12	12	12
13.	Pretest	10	10	7	8
	Post-test	7	8	10	6

continued...

Subject		Question 1 Training 1	Question 1 Generalisation 2	Question 2 Training 3	Question 2 Generalisation 4
14.	Pretest	3	3	4	4
	Post-test	6	5	6	7
15.	Pretest	4	5	5	5
	Post-test	12	12	12	12
16.	Pretest	11	11	12	12
	Post-test	12	12	12	12
17.	Pretest	12	12	12	12
	Post-test	12	12	12	12
18.	Pretest	5	4	4	4
	Post-test	5	4	5	4
19.	Pretest	12	12	12	12
	Post-test	8	7	5	0
20.	Pretest	4	2	3	3
	Post-test	7	8	9	7
21.	Pretest	3	2	3	3
	Post-test	0	3	0	0
22.	Pretest	3	3	3	2
	Post-test	3	3	3	3
23.	Pretest	12	12	12	12
	Post-test	0	3	3	5
24.	Pretest	4	4	3	3
	Post-test	9	11	8	10
25.	Pretest	6	4	5	5
	Post-test	10	10	11	10

APPENDIX E: Strategy Effectiveness Estimates.

Subject		Training Task Stimuli		Generalisation Task Stimuli	
		Rehearsal Stimulus	Passive Stimulus	Rehearsal Stimulus	Passive Stimulus
1.	Pretest	6	8	9	11
	Post-test	6	9	7	10
2.	Pretest	10	5	10	5
	Post-test	11	9	11	9
3.	Pretest	6	0	11	2
	Post-test	8	2	8	1
4.	Pretest	11	0	11	0
	Post-test	10	0	10	0
5.	Pretest	6	10	5	10
	Post-test	7	7	5	5
6.	Pretest	8	0	8	0
	Post-test	11	0	11	0
7.	Pretest	7	11	3	2
	Post-test	5	3	7	5
8.	Pretest	8	4	6	5
	Post-test	11	2	11	3
9.	Pretest	8	2	7	3
	Post-test	11	0	9	0
10.	Pretest	11	11	11	11
	Post-test	11	9	11	0
11.	Pretest	11	3	7	4
	Post-test	11	5	8	9
12.	Pretest	9	0	6	0
	Post-test	11	0	10	0
13.	Pretest	8	11	9	11
	Post-test	10	8	10	9
14.	Pretest	11	2	6	0
	Post-test	10	6	10	4
15.	Pretest	10	4	10	8
	Post-test	6	4	10	7

continued...

Subject		Training Task Stimuli		Generalisation Task Stimuli	
		Rehearsal Stimulus	Passive Stimulus	Rehearsal Stimulus	Passive Stimulus
16.	Pretest	6	5	5	8
	Post-test	5	2	5	2
17.	Pretest	11	5	11	10
	Post-test	11	9	11	8
18.	Pretest	11	3	11	3
	Post-test	4	5	4	5
19.	Pretest	11	0	11	0
	Post-test	11	0	11	0
20.	Pretest	11	5	11	7
	Post-test	9	6	7	3
21.	Pretest	11	11	11	11
	Post-test	11	11	11	11
22.	Pretest	5	3	5	1
	Post-test	6	5	7	4
23.	Pretest	11	7	11	9
	Post-test	7	1	2	5
24.	Pretest	11	0	11	0
	Post-test	11	0	11	0
25.	Pretest	11	0	11	0
	Post-test	11	0	11	1

APPENDIX F: ANOVA Summary Tables - Exposure Time Data

A = Reinforcement condition

B = Probe trials

Source	SS	DF	MS	F	
A	113.2026	1	113.2026	17.81	p<.01
B	490.7535	6	81.7923		
AB	211.8833	6	35.3139		
S	1139.9734	24	47.4989		
AS	152.5218	24	6.3551		
BS	2461.5225	144	17.0939		
ABS	1558.5809	144	10.8235		
Total	6128.4380	349	17.5600		

Comparison 1 (-2 -1 0 1 2 0 0)

Source	SS	DF	MS	F	
A	107.4125	1	107.4125		
Bcomp	1201.3156	1	1201.3156	11.94	p<.01
AxBcomp	632.0196	1	632.0196		
S	2819.5374	24	117.4807		
AxS	827.5721	24	34.4822		
BcompxS	2415.1811	24	100.6325		
AxBcompxS	1061.3790	24	44.2241		
Total	9064.4173	99	91.5598		

SSBcomp (normalised) = 240.2631 MS = 240.2631
SSBcompxS (normalised) = 483.0362 MS = 20.1265

Comparison 2 (0 0 0 0 0 1 -1)

Source	SS	DF	MS	F	
A	75.4987	1	75.4987		
Bcomp	201.3845	1	201.3845	11.76	p<.01
AxBcomp	24.0590	1	24.0590		
S	341.6025	24	14.2334		
AxS	126.1357	24	5.2557		
BcompxS	411.0810	24	17.1284		
AxBcompxS	121.9391	24	5.0808		
Total	1301.7005	99	13.1485		

APPENDIX G: Exposure times in seconds for the first three items in lists of stimuli.

S = Subject

RN = Not Reinforced

R = Reinforced

L = Set of probe trials

L1 - L5 = Training task trials

L6 & L7 = Generalisation task trials

			ITEM		
			1	2	3
S1	RN	L1	2.0700	1.8800	2.9200
S1	RN	L2	3.6600	2.5400	2.0800
S1	RN	L3	2.1100	2.4200	1.3300
S1	RN	L4	1.7300	2.5200	1.5100
S1	RN	L5	1.8600	2.7300	1.4500
S1	RN	L6	1.3200	1.7500	1.7800
S1	RN	L7	2.8700	3.0500	2.0000
S1	RR	L1	1.7000	2.1400	1.1800
S1	RR	L2	2.4300	1.7100	2.3300
S1	RR	L3	1.2400	1.1900	1.1700
S1	RR	L4	1.2300	1.2500	0.9400
S1	RR	L5	3.7500	2.0900	3.9600

S1	RR	L6	4.0200	2.2400	1.8200
S1	RR	L7	1.7300	2.0200	1.5900
S2	RN	L1	2.7300	3.8900	5.5300
S2	RN	L2	1.7600	0.7400	2.8600
S2	RN	L3	7.2800	4.1000	2.2200
S2	RN	L4	5.4500	6.7200	4.0100
S2	RN	L5	4.1200	5.6200	4.3000
S2	RN	L6	2.2900	3.7700	3.0000
S2	RN	L7	3.5800	5.4800	4.3100
S2	RR	L1	3.0200	1.4000	1.4200
S2	RR	L2	1.9600	1.5900	0.0600
S2	RR	L3	2.6100	2.7200	3.7800
S2	RR	L4	2.5600	3.1800	6.3200
S2	RR	L5	2.3800	6.9100	2.4900
S2	RR	L6	2.8900	2.8200	2.0700
S2	RR	L7	3.2600	3.5800	2.7300
S3	RN	L1	2.4800	2.2600	2.0100
S3	RN	L2	3.8600	2.0300	3.4700
S3	RN	L3	2.2150	3.3600	3.4400
S3	RN	L4	3.3400	3.0800	1.7600
S3	RN	L5	2.1600	1.9500	3.1800
S3	RN	L6	4.8800	3.3000	5.1500
S3	RN	L7	2.3900	2.4900	2.6200
S3	RR	L1	3.4600	2.2500	1.6900
S3	RR	L2	3.8100	1.3700	2.1500
S3	RR	L3	3.4000	3.5500	4.1000
S3	RR	L4	2.4100	3.4000	1.3200
S3	RR	L5	4.2200	5.8400	6.7000
S3	RR	L6	2.3200	2.7300	2.4800
S3	RR	L7	2.5900	2.6800	2.3800
S4	RN	L1	3.5200	2.7100	3.2400
S4	RN	L2	1.9100	3.2600	2.4600
S4	RN	L3	1.7900	5.9600	8.1400
S4	RN	L4	1.8000	5.7600	8.4400
S4	RN	L5	2.4700	6.6700	11.5500
S4	RN	L6	3.9300	3.1300	3.5100
S4	RN	L7	1.8400	9.1300	12.0700
S4	RR	L1	2.2400	2.0800	2.7600
S4	RR	L2	2.1200	2.2200	5.7800
S4	RR	L3	2.8500	5.6600	9.0500
S4	RR	L4	2.9100	8.0500	11.8000
S4	RR	L5	3.3900	9.2100	11.3000
S4	RR	L6	2.5700	2.7200	1.8600
S4	RR	L7	2.8000	9.9300	25.1200
S5	RN	L1	7.7900	4.2000	6.4900
S5	RN	L2	5.1200	11.9000	17.2800
S5	RN	L3	5.9100	6.2900	3.5400
S5	RN	L4	4.8200	7.1700	4.3400
S5	RN	L5	5.0200	7.0500	4.2000
S5	RN	L6	10.0000	4.6500	4.0800
S5	RN	L7	6.3000	5.5400	8.9000
S5	RR	L1	7.2400	4.9700	1.9800
S5	RR	L2	2.4300	3.1400	3.0800
S5	RR	L3	5.9300	2.3200	1.5500
S5	RR	L4	2.8300	6.6000	8.5200
S5	RR	L5	4.0700	5.4600	4.7700
S5	RR	L6	3.6100	2.1600	1.2100
S5	RR	L7	3.5300	6.4800	13.4900
S6	RN	L1	2.8900	0.0000	2.3300
S6	RN	L2	3.0800	9.5500	8.2200

S6	RN	L3	2.4800	5.6200	10.1200
S6	RN	L4	2.4600	4.8200	4.6500
S6	RN	L5	1.8700	4.3400	8.5100
S6	RN	L6	4.2700	4.1200	2.4000
S6	RN	L7	2.9500	2.0600	2.1400
S6	RR	L1	3.1100	3.2900	2.4300
S6	RR	L2	2.5800	5.2400	7.5500
S6	RR	L3	1.9600	10.5300	11.2900
S6	RR	L4	1.8700	4.3000	9.9500
S6	RR	L5	1.4700	5.3900	6.5200
S6	RR	L6	2.8400	4.7200	2.4800
S6	RR	L7	2.4600	2.4800	2.5500
S7	RN	L1	3.0100	2.3000	3.2500
S7	RN	L2	3.3800	7.4200	9.5500
S7	RN	L3	2.9800	7.1700	11.9000
S7	RN	L4	2.9100	6.7400	12.1000
S7	RN	L5	3.8000	9.1400	10.1000
S7	RN	L6	4.2400	3.6700	2.2700
S7	RN	L7	4.0500	5.0800	3.5100
S7	RR	L1	2.9000	4.5800	0.0000
S7	RR	L2	3.8100	6.3500	7.0800
S7	RR	L3	4.3200	6.3400	10.0300
S7	RR	L4	3.0500	7.4800	10.1100
S7	RR	L5	2.9900	7.1000	9.9600
S7	RR	L6	4.7800	2.9000	2.0300
S7	RR	L7	3.5400	12.7600	13.0700
S8	RN	L1	2.0200	1.6500	1.4500
S8	RN	L2	2.6500	5.1000	6.7900
S8	RN	L3	2.5500	4.6100	5.6400
S8	RN	L4	1.5100	4.2400	10.2300
S8	RN	L5	1.4700	5.0500	5.0700
S8	RN	L6	1.6600	1.6900	1.7000
S8	RN	L7	1.6500	4.2000	3.3600
S8	RR	L1	1.6300	1.6900	1.6400
S8	RR	L2	2.8500	6.5200	2.5200
S8	RR	L3	0.0100	4.3500	8.5700
S8	RR	L4	1.4200	5.2400	5.6900
S8	RR	L5	1.7700	3.3700	13.1800
S8	RR	L6	1.3400	1.8800	2.2600
S8	RR	L7	2.0400	5.9700	4.2300
S9	RN	L1	1.5300	1.6500	5.3200
S9	RN	L2	8.2300	5.1400	16.2500
S9	RN	L3	2.8700	18.6600	5.4300
S9	RN	L4	5.1500	2.1900	2.8100
S9	RN	L5	4.6000	3.1300	3.2900
S9	RN	L6	4.4200	3.0700	2.3400
S9	RN	L7	5.0500	2.1600	3.0300
S9	RR	L1	2.6600	1.5600	1.5200
S9	RR	L2	2.7800	2.7500	0.0000
S9	RR	L3	7.8100	13.3700	44.4300
S9	RR	L4	2.6700	8.9400	10.5600
S9	RR	L5	2.9600	1.6400	1.1900
S9	RR	L6	2.5100	2.8800	2.2300
S9	RR	L7	2.8100	2.8300	5.5600
S10	RN	L1	1.1200	1.6000	2.0000
S10	RN	L2	0.0000	3.5300	1.0600
S10	RN	L3	5.9200	7.1400	14.2500
S10	RN	L4	3.4300	7.1500	11.0200
S10	RN	L5	3.2200	4.8200	9.1100
S10	RN	L6	3.3200	3.0200	2.2100

S10	RN	L7	2.7300	4.9800	9.5000
S10	RR	L1	1.4800	2.4800	1.9800
S10	RR	L2	2.5800	4.6200	1.1000
S10	RR	L3	0.0100	0.9300	0.8600
S10	RR	L4	1.6700	5.4400	8.4500
S10	RR	L5	1.9200	6.9100	9.0800
S10	RR	L6	1.8200	0.6700	1.4700
S10	RR	L7	2.6800	4.6100	10.3400
S11	RN	L1	2.0500	1.4800	1.4100
S11	RN	L2	2.4500	3.5600	2.3300
S11	RN	L3	1.7000	2.5000	1.1000
S11	RN	L4	3.8500	4.2000	2.5200
S11	RN	L5	2.7800	2.0700	3.5200
S11	RN	L6	2.0400	1.5900	1.5900
S11	RN	L7	4.4800	3.5800	2.6400
S11	RR	L1	1.4900	1.2400	1.6200
S11	RR	L2	2.0500	2.0300	1.8800
S11	RR	L3	2.2600	2.2500	3.2700
S11	RR	L4	1.6900	2.0600	2.7100
S11	RR	L5	2.1400	6.4300	8.4200
S11	RR	L6	2.0500	2.0300	1.8800
S11	RR	L7	3.0100	6.0300	8.4300
S12	RN	L1	2.4800	2.2600	1.9500
S12	RN	L2	4.3300	2.4100	1.4900
S12	RN	L3	4.3300	1.8900	1.2800
S12	RN	L4	1.9900	3.2800	3.9100
S12	RN	L5	2.5500	2.9400	1.5600
S12	RN	L6	1.7200	1.9900	1.5800
S12	RN	L7	3.5900	2.1100	1.9100
S12	RR	L1	3.6200	2.9600	1.3500
S12	RR	L2	2.6600	5.9300	7.1100
S12	RR	L3	2.2200	4.2800	2.5700
S12	RR	L4	2.7800	3.9900	3.9400
S12	RR	L5	1.3900	3.5300	4.9000
S12	RR	L6	2.8800	1.9200	4.1100
S12	RR	L7	2.2000	7.0700	8.2900
S13	RN	L1	2.5100	4.4500	5.9100
S13	RN	L2	2.4200	4.9700	7.4600
S13	RN	L3	2.4200	7.6700	5.8600
S13	RN	L4	2.2000	4.4600	6.7000
S13	RN	L5	2.5100	2.4800	2.2500
S13	RN	L6	2.2300	2.1400	0.0000
S13	RN	L7	3.8600	4.1900	4.3800
S13	RR	L1	1.8700	1.5600	2.0500
S13	RR	L2	3.2600	2.9600	2.9500
S13	RR	L3	4.5400	7.6000	6.4500
S13	RR	L4	4.9300	2.2200	16.1600
S13	RR	L5	3.3700	4.1300	7.7100
S13	RR	L6	3.1400	2.7800	1.9800
S13	RR	L7	2.9300	7.9400	13.2900
S14	RN	L1	0.0100	2.4000	2.5100
S14	RN	L2	4.2500	3.4300	2.4800
S14	RN	L3	2.2100	1.9700	1.9200
S14	RN	L4	2.6600	2.0600	2.7400
S14	RN	L5	2.5500	3.4100	2.2900
S14	RN	L6	7.0100	3.7400	4.6200
S14	RN	L7	4.5100	2.0300	1.5700
S14	RR	L1	4.5900	3.3300	3.3300
S14	RR	L2	3.4300	3.3100	2.8000
S14	RR	L3	2.8100	2.1900	1.9500

S14	RR	L4	4.2900	6.3800	3.1000
S14	RR	L5	2.9000	2.4200	1.3300
S14	RR	L6	3.8700	2.8900	2.2900
S14	RR	L7	4.1900	2.8700	3.6600
S15	RN	L1	2.5400	1.8900	2.2200
S15	RN	L2	3.7000	2.3700	1.6000
S15	RN	L3	3.0300	1.9400	1.0100
S15	RN	L4	2.9100	2.9400	2.0000
S15	RN	L5	2.5500	2.9400	1.5600
S15	RN	L6	1.9900	1.9500	2.5500
S15	RN	L7	2.3800	2.6800	2.4300
S15	RR	L1	3.0600	2.9600	3.1900
S15	RR	L2	6.9600	3.1000	1.3800
S15	RR	L3	2.4000	3.5500	4.4300
S15	RR	L4	2.9000	1.9000	3.7300
S15	RR	L5	2.5600	3.9300	3.1800
S15	RR	L6	4.0300	1.8100	2.8900
S15	RR	L7	2.3700	3.3900	1.9200
S16	RN	L1	2.1600	0.8000	0.5700
S16	RN	L2	1.6000	4.7400	0.8200
S16	RN	L3	2.2400	1.9900	1.4300
S16	RN	L4	2.8800	4.6700	4.2300
S16	RN	L5	2.1300	2.5200	4.5000
S16	RN	L6	2.8400	2.0800	1.3000
S16	RN	L7	4.6200	6.1100	9.9400
S16	RR	L1	0.9200	0.9500	0.8500
S16	RR	L2	2.1900	3.4300	5.3200
S16	RR	L3	1.8800	5.3100	0.0000
S16	RR	L4	0.0100	3.1800	4.2800
S16	RR	L5	1.6200	4.0600	6.1000
S16	RR	L6	1.5300	1.6300	1.6700
S16	RR	L7	2.8800	2.5100	3.3200
S17	RN	L1	6.3600	1.9800	3.7400
S17	RN	L2	3.8000	1.8000	2.0600
S17	RN	L3	2.8800	1.6100	2.5800
S17	RN	L4	2.3000	9.3400	5.8000
S17	RN	L5	1.7300	8.5700	7.9400
S17	RN	L6	5.6800	2.1600	1.6800
S17	RN	L7	1.7700	2.6500	1.8100
S17	RR	L1	1.5900	1.6200	0.8600
S17	RR	L2	1.3800	1.4600	1.3700
S17	RR	L3	1.7500	1.4400	1.7300
S17	RR	L4	2.3800	5.6400	7.0700
S17	RR	L5	1.1800	4.5300	8.9400
S17	RR	L6	1.6000	1.2600	1.0800
S17	RR	L7	1.8200	1.5400	1.4700
S18	RN	L1	1.8800	2.1500	2.0000
S18	RN	L2	2.6600	1.3700	1.7500
S18	RN	L3	3.3900	3.8400	4.3800
S18	RN	L4	2.6500	4.1700	2.9400
S18	RN	L5	1.6900	1.6700	1.4800
S18	RN	L6	1.5500	1.4800	1.4900
S18	RN	L7	1.6400	2.0000	1.5800
S18	RR	L1	2.0000	2.1800	1.0400
S18	RR	L2	1.7500	0.0000	0.8200
S18	RR	L3	3.8900	0.1100	4.1000
S18	RR	L4	4.0600	3.0200	3.8800
S18	RR	L5	1.3600	3.2700	2.2200
S18	RR	L6	2.1200	1.5300	2.0300
S18	RR	L7	1.2200	2.9000	4.5500

S19	RN	L1	1.8000	3.0400	1.0500
S19	RN	L2	2.6700	2.0800	6.7600
S19	RN	L3	9.3500	3.5500	2.5200
S19	RN	L4	6.2000	5.2600	3.0700
S19	RN	L5	6.5400	6.6400	2.6400
S19	RN	L6	2.4000	1.5000	1.1900
S19	RN	L7	2.7100	1.9000	2.9100
S19	RR	L1	1.5900	0.9000	0.8600
S19	RR	L2	1.5400	2.0700	2.9200
S19	RR	L3	5.2300	3.3300	3.3200
S19	RR	L4	5.8300	5.4700	6.5500
S19	RR	L5	1.9800	6.9900	6.4300
S19	RR	L6	2.7200	3.0600	1.7700
S19	RR	L7	2.1500	2.8200	3.7400
S20	RN	L1	3.2600	2.2800	1.9500
S20	RN	L2	2.9500	3.8400	2.4800
S20	RN	L3	5.6500	2.6600	3.5900
S20	RN	L4	4.7000	6.8100	4.2100
S20	RN	L5	3.9600	3.6800	4.1100
S20	RN	L6	5.8600	3.3800	2.4500
S20	RN	L7	2.6400	2.4800	2.8200
S20	RR	L1	2.7700	2.4300	2.7000
S20	RR	L2	2.3500	2.2600	1.7800
S20	RR	L3	4.8700	3.3200	4.1200
S20	RR	L4	3.1200	4.0100	5.5900
S20	RR	L5	4.3000	3.1700	4.2800
S20	RR	L6	2.8500	2.4700	2.1100
S20	RR	L7	2.6900	2.4000	7.0500
S21	RN	L1	2.3100	1.5900	1.8000
S21	RN	L2	2.2100	2.8100	2.5700
S21	RN	L3	7.9800	3.1200	2.9800
S21	RN	L4	0.8000	1.2400	3.0600
S21	RN	L5	2.1400	2.5200	2.9700
S21	RN	L6	3.4900	2.8500	2.2000
S21	RN	L7	2.3100	2.1000	2.2600
S21	RR	L1	2.1300	1.3200	0.7400
S21	RR	L2	2.1800	2.0600	1.3300
S21	RR	L3	2.6000	1.8200	1.2400
S21	RR	L4	4.7600	1.9300	1.3700
S21	RR	L5	1.5100	1.5100	29.5000
S21	RR	L6	2.3700	2.5800	1.9000
S21	RR	L7	5.3400	1.8700	1.5600
S22	RN	L1	3.0200	3.0700	3.8200
S22	RN	L2	4.0500	2.4400	4.8600
S22	RN	L3	2.2900	2.2000	2.6200
S22	RN	L4	4.4900	4.4800	2.2100
S22	RN	L5	5.4000	7.7000	3.0200
S22	RN	L6	4.1400	4.1600	3.0200
S22	RN	L7	2.9400	2.0500	2.2200
S22	RR	L1	1.8500	2.3700	2.6600
S22	RR	L2	3.0700	1.7900	2.2000
S22	RR	L3	1.5800	2.7800	1.9500
S22	RR	L4	3.0600	4.3300	1.0100
S22	RR	L5	1.9000	3.6700	2.6100
S22	RR	L6	1.9000	2.4100	1.4000
S22	RR	L7	3.4200	0.0000	4.9400
S23	RN	L1	1.3900	1.3600	1.0600
S23	RN	L2	2.8200	2.2000	3.7700
S23	RN	L3	10.7200	3.2500	3.3500
S23	RN	L4	0.0100	5.1400	2.0200

S23	RN	L5	3.8200	2.9600	3.2000
S23	RN	L6	1.8600	1.8400	1.5400
S23	RN	L7	3.7200	3.1500	3.8400
S23	RR	L1	2.9600	2.1700	2.8800
S23	RR	L2	2.6400	1.7000	3.6300
S23	RR	L3	3.1000	2.7900	3.6500
S23	RR	L4	5.7900	1.7000	2.1100
S23	RR	L5	1.9000	2.7300	3.2600
S23	RR	L6	3.2700	2.8400	6.3300
S23	RR	L7	1.3700	1.9700	2.3200
S24	RN	L1	1.9000	2.4200	1.8200
S24	RN	L2	2.2700	1.9800	1.8700
S24	RN	L3	2.5900	2.4400	1.6900
S24	RN	L4	6.6800	3.9900	2.3600
S24	RN	L5	2.2000	2.8100	1.9300
S24	RN	L6	2.2400	3.1300	1.6000
S24	RN	L7	2.9800	3.5700	1.7000
S24	RR	L1	1.4000	1.3900	1.3000
S24	RR	L2	1.7400	2.2200	2.2300
S24	RR	L3	2.0800	1.9700	2.2500
S24	RR	L4	2.5600	2.7500	2.8500
S24	RR	L5	2.9200	1.6700	1.1400
S24	RR	L6	1.9500	1.6200	1.6200
S24	RR	L7	2.1000	1.8000	2.9700
S25	RN	L1	1.9800	1.6900	0.0800
S25	RN	L2	0.7500	1.5100	0.9700
S25	RN	L3	1.7500	1.4100	1.2700
S25	RN	L4	0.5200	0.3100	0.7200
S25	RN	L5	1.4600	1.3400	0.9100
S25	RN	L6	2.1900	1.4300	1.2500
S25	RN	L7	1.4300	0.7900	0.9000
S25	RR	L1	0.6400	0.6600	0.7000
S25	RR	L2	1.0200	0.7000	0.6500
S25	RR	L3	0.9900	3.8600	1.8100
S25	RR	L4	0.7800	0.8900	0.8800
S25	RR	L5	0.7900	0.8100	0.5900
S25	RR	L6	0.6800	1.0800	0.5400
S25	RR	L7	1.3300	1.1200	1.2200

APPENDIX H: ANOVA Summary Tables - Overt Rehearsal Data

A = Reinforcement condition

B = Probe trials

Source	SS	DF	MS	F	
A	1430.5246	1	1430.5246	3.30	p >.05
B	71034.6865	6	11839.1144		
AxB	5011.2166	6	835.2028		
S	108965.4802	24	4540.2283		
AxS	10410.5510	24	433.7730		
BxS	137922.4276	144	957.7946		
AxBxS	61000.5057	144	423.6146		
Total	395775.3922	349	1134.0269		

Comparison 1 (-2 -1 0 1 2 0 0)

Source	SS	DF	MS	F	
A	2072.9729	1	2072.9729		
Bcomp	225170.1794	1	225170.1794	27.10	p<.01
AxBcomp	5709.2279	1	5709.2279		
S	347423.2668	24	14475.9695		
AxS	39733.1425	24	1655.5476		
BcompxS	199425.4192	24	8309.3925		
AxBcompxS	61661.3907	24	2569.2246		
Total	881195.5994	99	8900.9657		

SSBcomp (normalised) = 45034.0365 MS = 45034.0365
SSBcompxS (normalised) = 39885.0838 MS = 1661.8785

Comparison 2 (0 0 0 0 0 1 -1)

Source	SS	DF	MS	F	
A	2196.7969	1	2196.7969		
Bcomp	7322.9095	1	7322.9095	15.88	p<.01
AxBcomp	1584.8361	1	1584.8361		
S	11391.7063	24	474.6544		
AxS	7987.2460	24	332.8019		
BcompxS	11068.4452	24	461.1852		
AxBcompxS	9014.5113	24	375.6046		
Total	50566.4513	99	510.7722		

APPENDIX I: Overt Rehearsal Data

SS = Subject

NR = Not Reinforced

R = Reinforced

		Sets of training task probe trials					Sets of generalisation task trials	
SS		1	2	3	4	5	6	7
1	NR	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	R	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	NR	17.390	60.870	0.000	0.000	100.000	4.350	4.350
	R	13.040	21.740	17.390	0.000	8.690	4.350	0.000
3.	NR	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	R	0.000	0.000	0.000	0.000	69.520	0.000	0.000
4.	NR	0.000	0.000	100.000	100.000	100.000	0.000	0.000
	R	0.000	0.000	100.000	100.000	100.000	0.000	43.480
5	NR	0.000	100.000	0.000	15.630	75.000	0.000	9.380
	R	0.000	0.000	25.000	75.000	100.000	0.000	3.130
6	NR	0.000	100.000	86.920	86.920	100.000	0.000	0.000
	R	0.000	100.000	100.000	100.000	78.260	0.000	0.000
7	NR	0.000	76.470	100.000	100.000	41.180	0.000	0.000
	R	0.000	41.180	52.940	100.000	100.000	0.000	100.000
8	NR	0.000	29.410	82.350	100.000	88.240	0.000	23.530
	R	0.000	64.710	76.470	94.120	94.120	0.000	88.240
9	NR	0.000	86.960	17.340	0.000	0.000	0.000	0.000
	R	0.000	0.000	86.960	0.000	0.000	0.000	0.000
10	NR	0.000	0.000	60.870	86.960	86.960	0.000	78.260
	R	0.000	0.000	0.000	17.390	86.960	0.000	43.480
11	NR	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	R	0.000	0.000	0.000	0.000	76.470	0.000	82.350
12	NR	0.000	0.000	0.000	0.000	100.000	0.000	0.000
	R	0.000	100.000	29.910	0.000	100.000	0.000	100.000
13	NR	0.000	82.350	76.470	82.350	0.000	0.000	23.53
	R	0.000	0.000	50.000	76.470	100.000	0.000	76.470

continued

Continued

		Sets of training task probe trials					Sets of generalisation task trials	
SS		1	2	3	4	5	6	7
14	NR	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	R	0.000	0.000	0.000	23.530	5.880	0.000	0.000
15	NR	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	R	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	NR	0.000	58.820	0.000	47.060	17.650	0.000	17.650
	R	0.000	29.410	29.410	47.060	76.470	0.000	0.000
17	NR	0.000	0.000	0.000	94.120	76.470	0.000	0.000
	R	0.000	0.000	0.000	76.470	70.590	0.000	0.000
18	NR	0.000	0.000	23.530	5.880	0.000	0.000	0.000
	R	0.000	0.000	0.000	5.880	35.290	0.000	52.940
19	NR	0.000	0.000	17.650	17.650	11.760	0.000	17.650
	R	17.650	0.000	35.290	82.350	5.880	17.650	17.650
20	NR	0.000	0.000	0.000	0.000	52.940	0.000	0.000
	R	0.000	0.000	0.000	52.940	5.880	0.000	17.650
21	NR	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	R	0.000	0.000	0.000	0.000	11.760	0.000	0.000
22	NR	0.000	0.000	0.000	5.880	23.530	0.000	11.760
	R	0.000	0.000	0.000	0.000	11.760	0.000	17.650
23	NR	0.000	29.410	35.290	17.650	64.710	0.000	47.060
	R	29.410	35.290	58.820	23.530	47.060	17.650	23.530
24	NR	0.000	0.000	0.000	5.880	5.880	0.000	0.000
	R	0.000	0.000	0.000	17.650	0.000	0.000	0.000
25	NR	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	R	0.000	0.000	0.000	0.000	0.000	0.000	0.000