

# Teaching short term memory skills to children with Down's syndrome

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**This study investigates a range of short term memory skills and the effectiveness of memory training procedures in improving these skills. The initial sample was 63 children with Down's syndrome, aged 4-18 years, from two geographical areas in the UK. Phase 1 of the study assessed each child on a battery of tests including short term memory skills in different modalities, language skills, speech rate, word identification and a number of general IQ measures. Two groups were formed, one from one geographical area identified as the experimental group (n=25). A control group was formed from a subset of the remainder of children (n=26). Analysis verified that the two groups were similar and matched in terms of age and abilities. Phase 2 of the research consisted of a longitudinal training study of two memory strategies (rehearsal and organisation) which lasted for six weeks. For the experimental group (n=25), a cross-over design was employed to assess the effect of each strategy independently. Half the group received the rehearsal training first and the other half, the organisation-based training. Fifteen children from the group were taught by the first author and the rest by "keyworkers". In Phase 3 the initial assessment battery was repeated. The results demonstrated that each training programme was effective and enhanced only those specific memory skills addressed.**

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## Introduction

### Research on Down's syndrome and short term memory

The ability to hold information in memory for brief periods of time, i.e. over a few seconds, has been shown to be an important aspect of cognitive functioning. The efficiency and capacity of short-term memory (STM) has been shown to be related to a wide range of cognitive abilities. For example low STM capacity is associated with developmental dyslexia (Jorm, 1983) and language disorders (Gathercole and Baddeley, 1990).

In normally developing children short term memory capacity increases rapidly throughout childhood. At the age of three years it is equal to about 3 digits, and at 16 years it is 7 or 8 digits (Chi, 1977). Children and adults with Down's syndrome have a short term memory delay (Bilovsky and Share, 1963). Their digit span does not develop at the expected rate. For teenagers with Down's syndrome, digit span typically reaches only 3 or 4 digits (Hulme and Mackenzie, 1992). According to these authors the cognitive strategies which help people to remember information are not developing.

This restricted development appears to be more severe in children and adults with Down's syndrome than in children with other types of learning difficulties (Marcell and Armstrong, 1982). Mackenzie and Hulme (1987) in a longitudinal study have demonstrated that auditory short term memory span is poor compared to other measures of cognitive development throughout childhood. The cause of this delay seems to come from within memory functioning, as it is not solely an attention/concentration problem (Marcell, Harvey and Cothran, 1989). It has been found to specifically effect the auditory modality (Marcell and Armstrong, 1982). There is substantial evidence for deficits in the use of memory strategies by individuals with learning difficulties (Belmont and Butterfield, 1971; Bray, 1979; Ellis, 1970). O'Conner and Hermelin (1965) state that verbal encoding of stimulus material is limited in people with learning difficulties.

Young children and children with Down's syndrome do not seem to engage in incidental learning of memory strategies, in that they do not seem to learn and memorise in a way that facilitates recall. Two techniques often used to remember information are rehearsal and organisation. Rehearsal is silently repeating information to ourselves to remember it and organisation includes categorising, chunking and grouping similar items together to aid recall.

## Attempts to improve memory in children with learning difficulties

### Rehearsal training

Most normally developing children start to use mnemonic strategies spontaneously between the ages of 5 and 10 years. Rehearsal is one of the strategies that has been widely researched. Flavell (1970) taught normally developing children who did not spontaneously rehearse to actively rehearse, and found that their memory performance was then equal to that of those children who did rehearse. If such children can be taught to rehearse, the question arises whether the same could be done for children with learning difficulties. Several studies have attempted this.

Farb and Throne (1978) conducted a training programme to improve the generalised mnemonic performance of memory of a child with Down's syndrome called Molly. Training was directed at digit span performance. The results of the study demonstrate the effectiveness of the training procedure in improving Molly's generalised mnemonic performance.

Bowler (1991) taught 8 children with learning difficulties to rehearse lists of 5 manual sign labels or 5 word labels during the delay periods of a short-term, free-recall task. The results showed that the rehearsal training had an overall facilitatory effect on recall and that this effect was more pronounced for signs than for words. Three weeks later the differential facilitatory effect for signs was maintained. The most important finding was that explicit training in the use of rehearsal strategies not only improves overall rates of recall but also had some differential effect on the short term retention of sign and word labels. The success of the rehearsal training procedure in promoting use of rehearsal is reflected in subjects' significantly higher amounts of overt rehearsal under longer delay conditions in the main test, a difference which was not found in the pre-test.

Hulme and Mackenzie (1992) conducted a rehearsal training experiment with 24 adolescents (aged between 13 and 18 years) with severe learning difficulties. Memory spans for digits and acoustically similar and dissimilar words were assessed before and after rehearsal training. Changes produced by rehearsal training were compared with the performance of two control groups. An untrained, repeatedly tested, control group was used to check whether any improvements were specific to rehearsal training and not simply attributable to repeated testing. An unseen control group was tested at the beginning and end of the experiment, and this provided a true baseline against which to compare any changes seen in the rehearsal trained and repeatedly tested groups.

The subjects were trained to use an overt cumulative rehearsal strategy, based upon the method developed by Brown, Campione and Murphy (1974). The training consisted of one daily session of 10 minutes for 10 days. Materials for the rehearsal training were randomly constructed lists of similar and dissimilar words of increasing lengths. The subject repeated successively longer sequences as each individual word is spoken by the experimenter (E-hand, S-hand; E-fish, S-hand, fish; E-clock, S-hand, fish, clock). After training the data did show improvement for the rehearsal trained group.

### Organisation training

Herriot and Cox (1971) allocated 24 children with Down's syndrome and 24 children with learning difficulties (mean age 12 years) to different groups of material. Clustering was found in the recall of categorically related items, and subjective organisation in the recall of unrelated ones. These memory strategies (clustering and subjective organisation) improved their ability to recall information.

### Developing cognitive skills

Research on teaching cognitive skills to children with Down's syndrome has shown that greater improvements are made when small teaching steps are taken. Morss (1984) measured performance for children with Down's syndrome in object

permanence tasks and found greater performance improvements if the targets were taught by a series of small steps. Research has shown that adults and children with Down's syndrome are poor at sequential processing (Marcell and Armstrong, 1982), their rehearsal mechanisms may be defective (Mackenzie and Hulme, 1987); there may be impairments in storing information as a result of inadequate language skills (Rohr and Burr, 1978) and they have difficulties with auditory processing (McDade and Adler, 1980).

Since it is assumed that a better understanding of cognitive processes may lead to more appropriate educational planning, this study was designed to investigate visual and auditory memory processes in children with Down's syndrome. Some of the issues that have arisen from the previous studies are addressed here. An important issue is that most memory training studies have been conducted on adolescents. It is possible that greater gains could be achieved with younger children. This study includes children from 4 years old.

Another factor is that previous studies have included short training periods of up to 10 days, while the present study attempts to teach children over a longer-time span. Others have been solely conducted by an experimenter, while this study includes parents and teachers who have attended workshops to learn how to teach the memory skills to the child they are working with.

### Aims and objectives

The overall objectives of the research are to evaluate the effects of two specific types of intervention of training in short term memory skills for children with Down's syndrome, and to compare this data with previous research.

#### Phase 1 - The initial assessments

A wide and varied range of tests were selected to achieve a global view of short term memory skills in children with Down's syndrome. Different modalities of presentation of the test-stimulus material and response were used to investigate the effects of modality on their short term memory ability. The base-line of each child's performance was used to assess where they should start the training programme in Phase 2.

#### Phase 2 - The training programme

The aim of the programmes was to teach children with Down's syndrome the steps that should be taken to help improve their memory span. The programmes (rehearsal and organisation) are designed to teach the use of strategies not spontaneously used, or used in a very limited way. The objectives are to:

1. *Teach basic cognitive skills underpinning memory processes,*
2. *Help the pupil to generalise these skills and use them in everyday contexts,*
3. *Enhance the pupil's self esteem. By making the pupil more aware of using these skills to remember things better, his/her self-confidence and self-esteem should improve for other learning activities where memory is important,*
4. *To assess the effectiveness of the training programmes, and the maintenance, transfer and generalisation of these skills over time.*

## Method

### Subjects

Subjects were recruited from two geographical areas through a variety of local contacts. All subjects are based at home and attended day school, either a school for children with severe learning difficulties (SLD), moderate learning difficulties (MLD) or their local mainstream school. Parents who consented to their child taking part in the study filled in a questionnaire which asked questions about the child's health, hearing and vision. The children's teachers filled in a record sheet describing the child's school work and performance and scores on the Derbyshire language scheme.

### Procedure for administering the assessments - Phase 1 and Phase 3

Each child was seen individually in a quiet room at school, and assessed on a battery of tests. The child sat at a table next to the experimenter. The tests were administered in a random order. The full testing took between 3 and 4 hours. The children were tested several times depending on their concentration. This varied between 4 to 6 visits. These tests were carried out during October and November 1991.

### Materials used for initial assessments

A number of standardised tests were used; the British Picture Vocabulary Test (Dunn et al, 1982); Test for the Reception of Grammar, (Bishop, 1983); Coloured Progressive Matrices (Raven, 1962); McCarthy Scales of Children's Abilities (1972); British Ability Scale (BAS) (Elliott et al, 1978). To match the children for cognitive ability, four subtests from the British Ability Scale (BAS) were used and scored in the standardised way (see Table 1).

### Rehearsal measures

Rehearsal measures used were picture memory, verbal memory (both McCarthy) and the visual recognition test (BAS). In the picture memory task the subject was shown six items on a page which the experimenter named and asked the child to name. The page was covered and the child recalled the pictures. For the verbal memory test the child was required to repeat words and sentences after the experimenter. In the visual recognition test one page was shown to the child and then they were required to find the same pictures on a subsequent array of pictures on the next page.

### Memory Tests

These were constructed to test memory under a variety of conditions. The child was first shown all the cards used to check whether they understood the words used for the tests. For the word length test (1,2 and 3 syllables) each assessment of word span involved the presentation of lists of increasing length. The materials used for this test were one syllable words (dog, pig, car, bus, book, cup), two syllable words (tractor, rocket, table, clock, apple) and three syllable words (elephant, kangaroo, magazine, newspaper).

These words were used in three conditions: auditory, visual and probe. For the auditory condition, the experimenter said the words and the subject recalled them. For the visual condition, the experimenter placed the cards one by one, in front of the child and then turned them over asking the child to recall them. In the probe condition, the child was shown the cards by the same procedure as the visual one, but then

the experimenter asked the child to point to a named item while the cards were face down. Three trials for each list length were made, and the subject had to pass all three trials to score on that length of list. A response was only scored correct if all the items were recalled in the correct order. To score the above conditions, a series would begin by the experimenter starting with a one word list, if the subject could recall the item, a two-word list was taken and so on. Word span was taken to be the longest list that the subject could recall correctly at each condition.

Other performance measures included sentence memory (presented aurally and visually), and memory for sounds, (order and probe). and a rhyme judgement task using an oddity test (based on Bradley and Bryant, 1983).

### Organisation measures

A naming test was constructed in which subjects were asked to give the category or group name in eight examples. The children were shown the pictures and each item on the page was named, they were then asked if they knew one name for all of the pictures. One correct score was given for each category correctly named. An oddity task was constructed where subjects were shown sets of pictures in which three were from the same category and one was not (e.g. trousers, shirt, coat and car). They were asked to point to the one that did not belong to the set. One point was given to each correct point. The McCarthy fluency test was administered and scored according to the test instructions.

### Matching Groups

The subjects were organised into matched groups according to age and cognitive ability on the basis of their scores on four subscales of the BAS: Naming, Comprehension, Auditory Digits and Visual Recognition. The two groups were then compared on the battery of assessments, using a series of independent 't' tests. There were no significant differences between the two groups. The means and the standard deviations of the raw scores of the BPVT are shown in Table 1.

Tests used	Exp group n=25		Control group n=26	
CA (chron. age)	100.28	(33.28)	113.62	(34.64)
BPVT	7.8	(4.02)	8.46	(2.53)
Naming*	11.40	(4.16)	11.08	(2.77)
Comprehension*	17.28	(6.11)	20.5	(4.74)
Auditory digits*	4.96	(4.38)	4.62	(2.35)
Visual recognition*	3.28	(2.61)	3.38	(1.74)

\* Taken from the British Ability Scale (raw scores used to assess cognitive abilities and match groups).

Table 1. Mean performance of the experimental and control groups on the standardised tests.

### Materials, design and general outline of the training programmes.

The design of the study is shown in Table 2. The teaching programmes ran for six weeks with each child receiving two twenty minute sessions each week. Activities were carefully sequenced to enable the pupil to reinforce and build on basic skills, resources and strategies. Each pupil progressed at their own speed throughout the programme. The two

strategies taught were rehearsal and organisation. The rehearsal programme taught the children to use a rehearsal strategy by a cumulative rehearsal technique. The organisation programme taught categorisation and grouping as an aid to memory. The categorisation process employed normal children's ability to learn to categorise, a progression through basic categorisation and conceptual categorisation. An instruction manual and score sheets specifically designed for these programmes accompanied each task.

<b>AUTUMN 1991</b> <b>PHASE 1</b> initial assessments	<b>SPRING 1992</b> <b>PHASE 2</b>	<b>SUMMER 1992</b>	<b>JULY 1992</b> <b>PHASE 3</b> final assessments
EXPERIMENTAL TRAINING		TRAINING	
group 1 (n=11) group 2 (n=14)	REH ORG	ORG REH	
CONTROL (n=26)	CONTROL	CONTROL	

Table 2. Experimental design and plan of investigation.

**The experimental training phase - January 1992 to July 1992**

Initially parents and schools were approached and asked if they would be interested in carrying out the work with the child. A keyworker was identified who could assume the responsibility to carry out the full training programme. This was a parent, a teacher or an non-teaching assistant (NTA). Two special schools were selected where the experimenter trained half the children. The children were systematically allocated to one of two groups: either the rehearsal or organisation. One group completed the rehearsal programme first, while the other completed the organisation programme first. The allocation ensured that children of equivalent age and ability were in each group.

The keyworkers attended three training workshops which explained and demonstrated the teaching programmes to them. A training manual explaining the rationale of the memory training and the procedure was given to each keyworker. The programme was monitored and the score sheets checked to ensure that the work was completed with the pupil. The subjects were all assessed between October and November 1991, again in April 1992 and again in July 1992. Within each of these two groups approximately half were trained by the experimenter (n=14) and the others trained by keyworkers (n=11). The following term the two groups were crossed over. The rehearsal group changed over to receive organisation training, while the organisation group changed over to the rehearsal programme.

**Results**

**1. Comparisons of the control and trained children**

There were no significant differences on the initial memory tests between the experimental and control groups at the start of the study. However, after completion of the training phase there were overall differences between the two groups of subjects, showing that the group that had received the training programmes had improved significantly in several

areas. The tables below show the mean improvements for the 3 groups (1 - rehearsal-organisation; 2 - organisation-rehearsal and 3 - control) on each of the measures with mean improvements and standard deviations. A series of independent one way analyses of variance were carried out to test the differences in improvement between the three groups. These were then followed by multiple comparison tests to determine which groups differed from each other. Significant differences at the 0.50 level are shown, with reference to whether groups 1 and 2 were significantly different from group 3 or if group 2 was significantly different from group 3. The tests were conducted on the difference scores between the end and the beginning of the training phase. Positive numbers indicate an improvement in raw scores. The mean and standard deviations for the groups are shown in the tables below.

**Rehearsal training**

Standardised memory tests:

Groups	Visual recognition (BAS)	Picture memory (McCarthy)	Verbal memory (McCarthy)
1. reh-org	4.27 (2.28) <sup>1</sup>	2.72 (1.19) <sup>1</sup>	4.00 (4.98)
2. org-reh	5.28 (2.19)	2.57 (1.08)	5.21 (2.88) <sup>2</sup>
3. control	-1.08 (2.24)	0.42 (1.39)	0.730 (4.48)

1 - groups 1 & 2 significantly different from group 3  
2 - group 2 significantly different from group 3

Table 3. Means and standard deviations of the raw score changes for the experimental and control groups.

As can be seen in Table 3, the two training groups show improvements on all three tests. For the visual recognition measure 4.27 more test items were recalled for the reh-org group and 5.28 for the org-reh group. The second group received the rehearsal training last and have a slightly higher score. The control group did not improve. For the picture memory test both groups improved by remembering on average 2 more test items, while the control group improved very little. The verbal memory test shows the same type of improvement as the visual memory test, with both groups showing significant improvements and the group which received the rehearsal training last having the largest improvement.

**Word span differences**

Word span was taken to be the longest list that the child could recall correctly in each condition. Performance under each condition was assessed with one, two or three syllable words.

	auditory		visual		probe	
<b>One syllable</b>						
1. reh-org	0.73 (0.65)	2.18 (1.07) <sup>1</sup>	1.63 (1.81)			
2. org-reh	0.71 (0.61)	2.5 (1.16)	1.85 (0.86)			
3. control	-0.038 (0.53)	0.15 (0.54)	-0.11 (0.99)			
<b>Two syllable</b>						
1. reh-org	0.36 (0.50)	1.81 (0.75) <sup>1</sup>	1.63 (1.12)			
2. org-reh	0.70 (0.61) <sup>2</sup>	2.14 (0.86)	1.71 (0.72)			
3. control	0.19 (0.49)	0.07 (0.62)	0.00 (0.97)			
<b>Three syllable</b>						
1. reh-org	0.63 (0.50)	1.36 (0.92) <sup>1</sup>	1.54 (1.21) <sup>1</sup>			
2. org-reh	0.71 (0.61) <sup>2</sup>	2.0 (1.11)	1.88 (0.95)			
3. control	0.19 (0.49)	0.11 (0.43)	0.11 (0.71)			

1 - groups 1 & 2 significantly different from group 3  
2 - group 2 significantly different from group 3

Table 4. Word span changes for different word lengths (1, 2 and 3 syllables).

The most impressive improvements for these tests are for the visual recall and probe conditions, which show significant improvements for both groups. The org-reh group consistently show greater improvements than the group receiving the rehearsal training first. In the auditory condition the training only appears to be effective for longer words and only for the group who received the rehearsal training last.

**Organisation tasks**

Group	Categorisation naming		Categorisation oddity		Fluency task
1. reh-org	3.18	(2.9) <sup>1</sup>	3.27	(2.6) <sup>1</sup>	8.64 (6.5) <sup>1</sup>
2. org-reh	2.71	(1.9)	3.14	(1.5)	7.86 (7.1)
3. control	0.38	(1.6)	-0.38	(1.7)	1.27 (5.2)

1 - groups 1 & 2 significantly different from group 3  
2 - group 2 significantly different from group 3

Table 5. Means and standard deviations of the raw score changes in organisation memory tasks

The trained groups are both significantly different from the control group for each measure. For each test the group that received the organisation training last scored slightly higher than did the group who received it first.

**2. Initial training programme**

A subset of the initial battery of tests was administered to the children in the experimental group in April 1992, between the administration of the two training programmes. This allowed analysis of each programme independently. A series of independent 't' tests were carried out to compare the effects of each type of training. Means and standard deviations of the difference scores are shown below.

Groups	Visual recognition (BAS)	Picture memory (McCarthy)	Verbal memory (McCarthy)
1. rehearsal (n=11)	3.81 (3.28)	1.90 (1.04)	5.27 (2.90)
2. organisation (n=14)	1.71 (2.33)	1.57 (1.50)	3.21 (3.28)

**The standardised memory tests**

Table 6. Means and standard deviations for the raw score improvement on the standard memory measures after initial training

The group which received the rehearsal training improved the most, but none of the differences between the groups was significant.

**Word span differences**

The group receiving the rehearsal training is significantly different from the organisation group in the visual presentation condition. For the probe condition there is a significant difference for 1 syllable words, while the 2 and 3 syllable words are nearly significant at the 0.7 level. The auditory condition again is not significant, although the scores are slightly higher for the rehearsal groups in the 2 and 3 syllable conditions.

	auditory	visual	probe
<b>One syllable</b>			
1. rehearsal	0.73 (0.90)	3.18 (1.77) <sup>1</sup>	2.45 (1.57) <sup>1</sup>
2. organisation	0.78 (0.89)	1.57 (0.85)	1.21 (0.89)
<b>Two syllable</b>			
1. rehearsal	1.18 (1.83)	3.18 (1.99) <sup>1</sup>	2.45 (1.75)
2. organisation	0.64 (0.63)	1.42 (1.09)	1.35 (1.15)
<b>Three syllable</b>			
1. rehearsal	1.27 (2.05)	2.18 (1.65) <sup>1</sup>	2.36 (1.12)
2. organisation	0.714(0.61)	0.85 (1.09)	1.35 (1.49)

1 - group 1 significantly different from group 2 (p<0.05)

Table 7. Means and standard deviations for the raw score improvements on the word span measures.

**The organisation measures**

Groups	Categorisation naming	Categorisation oddity task	Fluency (McCarthy)
1. rehearsal (n=11)	0.63 (1.20)	1.09 (3.08)	8.09 (6.58)
2. organisation (n=14)	3.14 <sup>1</sup> (1.70)	3.42 (2.82)	7.50 (6.84)

1 - group 2 significantly different from group 1 (p<0.05)

Table 8. Means and standard deviations for the raw score improvements on the organisation measures

The categorisation naming task showed significant improvements for the organisation trained group, with the oddity task almost significant at the .06 level. There is little difference between the two groups on the fluency task, showing perhaps that both types of training can help children to talk and name more items for category groups.

It is clear from the above pattern of results that each training programme had an effect on only those measures that reflected the processes addressed by that training. The rehearsal programme improved the scores for the rehearsal group, with little or no change in organisational performance. Conversely the organisation training improved the performance measures but left the rehearsal measures largely unchanged.

**Discussion**

The results show that training rehearsal and organisation skills does help children with Down's syndrome to remember information. This effect is demonstrated across a wide range of different types of test materials and memory tasks. The data show the immediate effects of training as all the children were reassessed within two weeks of completing the training programmes. The children are being followed up as part of a longer term study which will allow analysis of the extent to which these improvements are maintained over time.

For both conditions the most impressive improvements in recall performance are for visually presented material. This confirms past research showing that processing in the auditory modality for short-term memory does appear to be significantly poorer for children with Down's syndrome (Marcell and Armstrong, 1982). It validates the fact that auditory memory is poor for children with Down's syndrome. Initially they were poorer on auditory memory and even after a six-week training period auditory memory does not improve as significantly as in the visual modality.

The results demonstrate the importance of teaching memory skills for children with Down's syndrome. This has implications for the priorities of teaching children with a short term memory deficit and argues the case for concentrated work on memory skills in the classroom.

The design framework of using keyworkers to teach half of the children meant that a substantially larger number of children could be included in the memory training programme. Previous work has been with fewer numbers of children. For example, In Bowler's (1991) study he had only eight children, Hulme and Mackenzie (1992) had sixteen children in the experimental groups and Farb and Throne (1972) had one child. Here 25 children received the training. This framework has not been used in the past, and has been successful as the keyworkers knew the children well and had an added interest in their development.

The other major difference between this and previous research was in terms of the frequency and duration of the training sessions. The training period used was substantially longer than previous research. Mackenzie and Hulme (1992) had 10 days training. This could indicate that children with Down's syndrome need longer periods of time to consolidate techniques and strategies learned.

The training programme was also systematic with small attainable steps. Morse (1984) has pointed to the benefits of small teaching steps for children with Down's syndrome. Several of the keyworkers commented that they felt the programme was useful because it broke down the attainment targets giving the child a sense of achievement. The work was also fun and several of the children enjoyed the routine of doing it twice a week and learned when to ask to do the "memory books".

Teaching material adapted for children with special needs often does not target the children's capabilities and progress at the required speed. Ceilings may be reached too quickly, and the child is unable to do the work which can lead to frustration and loss of interest. Teaching programmes often do not progress through small enough steps to reach the targets with attainable teaching goals. Perhaps one of the reasons of the effectiveness of this programme was these aims as well as reinforcement were incorporated into it.

It is also clear that training programmes had specific effects on the targeted processes rather than some generalised intervention. The rehearsal programme specifically effected the rehearsal indicators and the organisation programme the organisation ones.

Significant gains were also made in some of the language measures. However since the investigation was not designed to assess improvements of this type so the present analysis cannot show whether these gains are entirely attributable to memory gains or influenced by other factors operating at the time of training (e.g. reading instruction, speech therapy and specific language teaching).

These results have implications for current models of short-term memory and development. The most influential theory at the moment, the Working Memory model (Baddeley and Hitch, 1974) views short term memory relying on rehearsal processes that are dependent on acoustic or articulatory coding. However, the results here show that even in this

group of children with Down's syndrome who have some difficulty with articulation, rehearsal skills improve with specific training. Secondly this effect is more pronounced for visually presented material. This has implications for the hypothesised coding processes of the 'articulatory loop'.

This research fills an identified gap in teaching short-term memory skills to young children with Down's syndrome. It has shown to be very successful across a wide age range (5 to 14 years), showing the importance of starting intervention as young as possible.

## Further research

This research has raised several questions. First, can this effect of training memory be replicated with other groups, or was this simply a one-off situation? The training has been replicated twice since this initial testing. The first replication was with a group of "new" children who became part of the programme simply as a group trained by the keyworkers. The second replication was with part of the control group. The data from these groups is currently being analysed. Initial inspection of the data shows the main improvement trends have been replicated.

Another question asked is whether these training effects are maintained over any length of time. Further analysis is now being completed on how these memory skills are maintained. A final question raised is whether these skills can be generalised and transferred to other tasks. A new test was carried out to analyse the extent to which the strategies gained are generalised to new materials and situations. Again this is currently being analysed. The programmes are also being adapted to pre-school children and it is intended to assess the effects on a younger age-group.

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## The Educational Needs of Children with Down's Syndrome

An education resource package for schools educating children with Down's syndrome,

by Gillian Bird and Sue Buckley

The Sarah Duffen Centre, University of Portsmouth

Available Autumn 1993

The package will describe the specific processing and learning difficulties experienced by children with Down's syndrome and how best to help them develop through their education. Accessing the curriculum, methods of teaching and choice of materials will be discussed, with practical examples and case studies.

Content will reflect current research and knowledge, and provide teachers with up to date information about the specific educational needs of children with Down's syndrome.

Recommended for teachers in mainstream and special schools; management issues for both are addressed.

Further details to follow. The publication will be available from The Sarah Duffen Centre, Belmont St, Southsea PO5 1NA .

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