
Developing the speech and language skills of teenagers with Down's syndrome

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This paper reports on the outcomes of a project designed to evaluate the effectiveness of language teaching for teenagers. The aim was to improve the structure of the language used by teenagers with Down's syndrome. Twelve teenagers took part in the study, which involved them in a variety of experimental and practical teaching activities over the period of a year. All the teenagers benefited from the intervention, though there were large individual differences in how much and why they benefited. Teaching which capitalised on the visual perceptual and visual memory strengths of these teenagers, by making use of reading, was the most effective. A key reason for delay in language development appears to be limited auditory short-term memory span.

Acknowledgement

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Introduction

Teenage Language

The author's own study of teenage development was the starting point for this project (Buckley and Sacks, 1987). Information on all aspects of the development of 90 teenagers, born between 1967 and 1974, was collected from parents and teachers, including an assessment of their speech and language skills.

Three of the teenagers, one girl and two boys, had no speech at all. For the 87 with speech, parents were asked about the length of utterance their children usually used. While 70% of all the girls and the older boys (over 14 years) regularly used utterances of five words or more, only half the younger boys did so. Conversely, 18% of the younger girls and 33% of the younger boys were limited to communicating in three word utterances or less, and 10% of the older children were equally limited.

The teenager's short utterances showed a lack of use of basic grammatical and syntactical structures but were adequate for making themselves understood by those who knew them as only 10% of the teenagers were described by their parents as often unintelligible. However, their intelligibility when attempting to communicate with strangers was not so good. Less than half the girls and less than a fifth of the boys were able to be understood when they talked to people in shops, in restaurants or on the bus.

These young people were reaching the end of their schooling and would soon be moving towards adult life. Their ability to achieve any degree of meaningful independence in the community was clearly going to be severely compromised by the poor intelligibility of their speech. The problems were usually twofold - limited grammar and syntax resulting in "telegraphic" utterances and poor articulation or phonology.

A number of other studies have produced similar findings. Bray and Woolnough (1988) video-recorded 12 teenagers in three conversational situations, with an adult, with peers at school and with the family at home. Nearly 50% of the sampled utterances consisted of single words. MLU (mean length of utterance) ranged from 0 to 3.62 (as one boy was non-verbal). Two of the teenagers were able to produce up to 9 word sentences showing more complexity at times. Intelligibility was rated by speech therapists who had no experience of children with Down's syndrome. Only 2 of the teenagers were rated as mostly intelligible. Intelligibility was very dependent upon the listener's knowledge of context and all were perceived as having difficulty in transmitting their message in the verbal medium.

The authors noted that sadly, those teenagers using more words in a sequence were often at a disadvantage, as intelligibility decreased with increasing complexity of syntax partly because the more able teenagers were more likely to initiate and elaborate conversations so the listener had no starting cues to context from an earlier speaker. They also comment on the range of speech production problems shown by the group.

Fowler (1990) provides a detailed review of research into the language development of children and adolescents with Down's syndrome, confirming the conclusions of the above studies - that most teenagers have immature language skills

and that their vocabulary skills are better than their grammatical and syntactical skills.

Description without explanation

However, almost all of the research to date is descriptive, reporting on the language skills achieved, with no information on the children's past difficulties, experience or interventions. Very few studies explore any of the possible reasons for the typical language delays and difficulties except in hypothetical discussion. Few published studies which report on the language skills of teenagers or adults contain any information on their hearing status either at the time of the study or during early childhood. Very few explore the links between language complexity and speech production difficulties.

Taking up the last point, Bray and Woolnough's study suggests that children with very poor production skills may have learned that they are more likely to be understood if they only use one or two word utterances, so this style of speech may not reflect their actual ability to produce complex utterances. In addition, the speech production difficulties of such children may well change the language behaviour of the adults who talk to them and result in a tendency to ask closed questions, repeat, clarify and complete sentences for the children. Such adult strategies, while useful in making the communications successful in the short term, may hold back the development of longer utterances for the children, as has been shown in the case of hearing impaired children (Wood et al., 1987). There are many other possible reasons for delays in language learning, some of which Fowler discusses but further research is needed to evaluate their actual role, if any.

Is remediation possible?

There are very few intervention studies, designed to see how much improvement can be gained from teaching and most of these are single case studies. Many authors seem to believe that the problems are not remediable as they may reflect biological or cognitive limits imposed by the chromosome disorder. However there are a host of other influences on language learning that could be explored, most with remedial implications; the effect of impaired hearing and of poor auditory short-term memory function for example (see Broadley and MacDonald, in this issue).

A number of studies show that the children have better acquisition of vocabulary than grammatical and syntactical knowledge. It could be suggested that auditory short term memory limits would have a greater effect on learning the rules of grammar and syntax than on learning lexical items - as in order to process sentences for meaning, the child needs to hold a number of words in auditory short-term store.

Intervention programmes for teenagers, if successful, would at least rule out the possibility of a critical period for language learning ending at about 7 years, or a "syntactic ceiling" as Fowler suggests (1990). Intervention could be aimed at improving the speech production skills of teenagers and at improving their comprehension and production of more complex grammar and syntax.

The research reported here addresses the latter issue.

The study

The present study was designed to investigate the delayed mastery of grammar and syntax in the speech of some of the

teenagers who took part in the 1987 study, addressing three questions.

- 1) Would intensive teaching improve both their comprehension and production skills, resulting in longer and more grammatically correct speech?
- 2) Would the teaching produce a faster rate of progress than might have occurred naturally in a year without specific intervention?
- 3) Would a teaching method which used reading to support the learning be more effective than one which relied on copying a spoken model only?

The students

Year 1. All the teenagers in our local district between the ages of 12 and 15 were invited to participate and completed two standardised assessments of language comprehension, The British Picture Vocabulary Test (BPVT) and the Test for Reception of Grammar (TROG), at the beginning of the school year. They then continued with their usual school curriculum for the year. They all attended special schools for children with severe learning difficulties.

Year 2. The teenagers were reassessed at the beginning of the next school year on the BPVT and the TROG. Twelve teenagers were selected to take part in the training study in order to make six matched pairs, matched as closely as possible for sex, age and comprehension of grammar on the basis of their scores on the TROG in Year 2. One of each pair was then assigned to each of the two training groups, I and II. (see Table 1). None of the 12 had a hearing loss greater than 15dB at this time. Accurate information on their hearing status in early childhood was not available.

At this point, the teenagers completed two more standardised assessments, the Coloured Progressive Matrices as a measure of their non-verbal cognitive ability and the Neale Analysis of Reading Ability to assess their reading skills (see Table 1). Their ability to read the words to be used in the training programme was also assessed by presenting them as a random list of the words to be read.

In order to assess their speech production skills they were tape-recorded completing a test of Imitated Production using the sentences from the TROG (see Fig 3 - page 67) and in conversations with the author (to be reported in a future article). Once the assessments were completed all the teenagers started on the training programme which continued throughout the school year.

Year 3. The teenagers were reassessed at the start of the next school year on all the assessments that they had completed at the start of year 2.

The training

The main training programme was designed to enable the effectiveness of two teaching methods to be compared, one using reading to support the learning (SR method) and the other not (S method), across a number of different grammatical and syntactical sentence structures. The design allowed individual differences to be investigated in case some students gained more from one method and others gained more from the other. So for each sentence structure taught, one group received (S) training and the other group received (SR) training, with the method alternating for each group on each new sentence structure as illustrated in Table 2.

The materials

Materials were designed to teach grammar which could be assessed using the TROG. All the teenagers passed the TROG blocks A to F on comprehension assessment so the teaching began with block G, personal pronouns and the grammatical and syntactical structures as illustrated in Table 2 were taught in complete sentence form over the course of the school year.

For each structure, twelve different sentence examples were used during the training. Teaching cards were prepared with a picture to illustrate each sentence example. The same sentences and pictures were used for both the training methods, speech only (S) and speech plus reading (SR), but for the SR method the sentences were written under the pictures.

The Procedure

The training procedure was designed to ensure the two methods would be comparable, with the amount of teaching and practice the same. For each sentence, there were three teaching trials and one test trial as follows:

1. Imitated production - teacher says the sentence and then student attempts to reproduce the sentence correctly while they look at the picture (S) or picture plus sentence (SR) prompt.
2. Imitated production - exactly as the first trial.
3. Spontaneous production - student attempts the sentence while looking at the picture (S), or picture plus sentence (SR) without a model from the teacher.
4. Spontaneous production - student attempts the sentence while looking at the picture only in both methods as Trial 4 was used to assess the student's ability to generate the spoken sentence without any spoken or written prompts.

At the start of the study the intention was to continue with training sessions in this way until the student mastered the sentence structure completely. However this proved impossible as it quickly became apparent that some students were never able to repeat the whole sentence correctly after the teacher in the speech only, (S) method, so would never reach the criterion set.

At this point, a few weeks into the training, the digit spans of all the teenagers were assessed as it appeared that some were being adversely affected by limited auditory short term

	CA	TRO	BPV	Matrice	Neale Readin	Word Readin	Digit Span
1 Brenda	187	51	49	60	-	5	2
2 Nora	180	69	71	84	92.3	41	3
3 Chrissie	172	63	70	96	84	20	3
4 Miles	191	57	60	96	56.7	19	3
5 Gary	190	63	83	93	-	-	2
6 Robert	160	66	39	90	-	7	2
Group 1 Mean	180	61.5	62	86.5	38.8	15.3	2.5
1 Mary	174	51	61	93	-	-	2
2 Glenda	175	66	88	72	87.3	33	3
3 Jane	169	66	83	96	79	17	4
4 Steven	190	54	53	48	79.6	16	3
5 Mark	188	63	66	96	-	-	3
6 Daniel	167	60	81	84	86.3	30	3
Group 2 Mean	177.	60	72	81.5	55.4	16	3
Total Sample Mean	178.	60.75	67	84	47.1	15.6	2.75

Table 1. Students' age-equivalent scores (in months) on the pre-training assessments (Year 2) and their digit-spans tested one month later.

Sentence Type	Group 1	Group 2
Personal/plural pronouns	S	SR
Prepositions	SR	S
Comparatives	S	SR
Passives	SR	S
Post modified subject	S	SR
X but not Y	SR	S

Table 2. Design of training programme showing training method for the groups on each sentence type.

S = speech only method

SR = speech and reading method

memory spans. This was indeed the case as can be seen from Table 1 where these scores are included. The teenagers with digit spans of 2 were the ones having the greatest difficulty with the speech only, (S) method. All the students were finding the speech plus reading, (SR) method easier, even those who were non-readers at the outset, much to the surprise of the author.

Generalisation

Since the overall aim of the project was to try and produce lasting improvements in the teenagers everyday speech skills, the strict training procedure was continued for the introduction of each new structure and data tape-recorded for the 4 training trials for each of the twelve sentences. After that all the students moved on to training materials with the written sentences and then to making books using examples of the structures to describe events and activities which they could participate in during the school day. The students were photographed acting out examples for the sentences using a Polaroid instant camera which they found great fun. They glued the photographs in their own books and wrote or copied the sentences underneath.

Results

Comparing training methods

The results achieved using the two training methods are illustrated in Figure 1 which shows the mean percentage of words produced correctly by each group on the test trials for each sentence structure. The graphs show that the teenagers made more progress with the reading (SR) method on every structure.

Reading gain

The difference between the two methods was statistically significant for 3 of the 6 structures. Group 1 found the (S) method more difficult than group 2. The overall performance of group 2 was enhanced by learning to use the articles, auxiliaries and some prepositions while learning the first sentence structure with the (SR) method and transferring this learning to the test of the sentences.

Individual differences

While all the students learned more with the (SR) method there were large individual differences in the extent to which they benefited, as can be seen in Figure 2. The gain in performance was measured by subtracting the mean % correct score on the test trials for the three sentence structures learned in the (S) method from the mean % correct score on the test trials (Trial 4) for the three sentence structures learned in the (SR) method.

The two teenagers who showed the greatest gains from the (SR) method, Brenda and Robert, were almost non-readers at the start and both had digit spans of 2. Neither was able to score on the standardised reading assessment though they both were able to read a few of the words used in the sentences correctly during the pre-training assessments (see Table 1). The other two teenagers with digit spans of 2, Mary and Gary, showed only small gains from the (SR) method, perhaps because they had no sight vocabulary at all at the outset and so made little use of the written words. The only other student with no sight vocabulary at the start, Mark, did show a 2% gain overall from the (SR) method. Jane, who showed very little

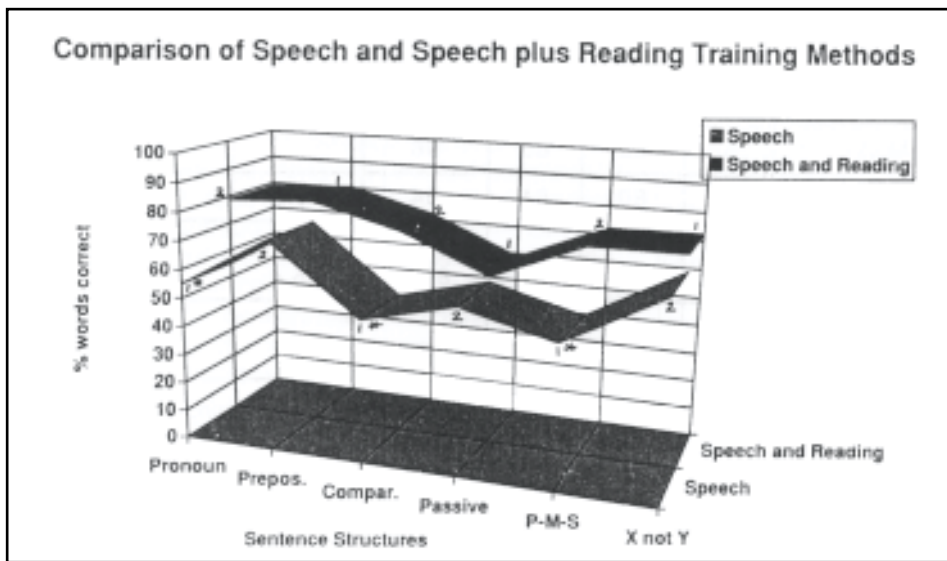


Figure 1

* indicates significant differences between methods ($p < 0.05$) Wilcoxon Matched Pairs Test

1 = Group 1

2 = Group 2

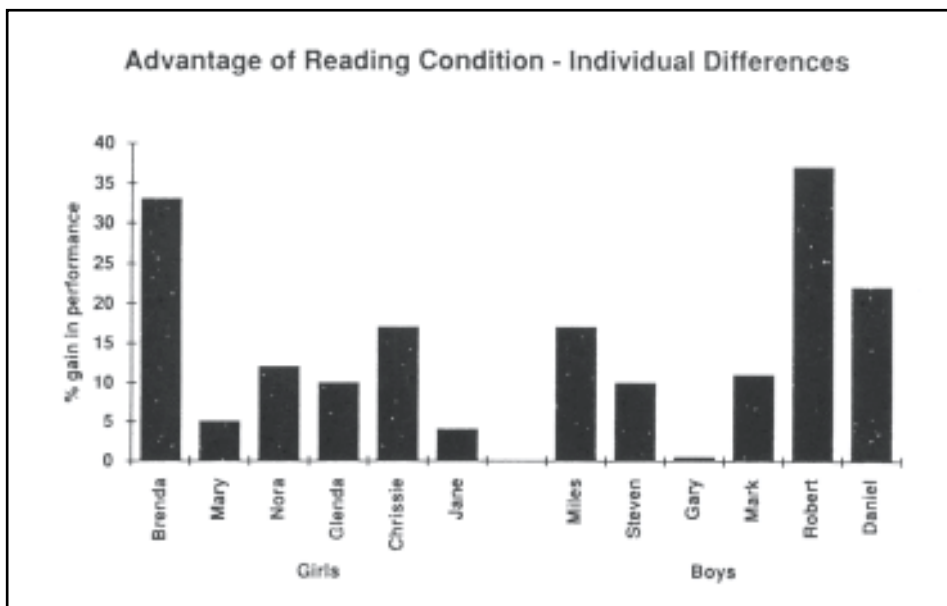


Figure 2

benefit, had a digit span of 4 and was able to do very well with either method.

Imitated production

The teenagers were assessed for their ability to imitate production of all the sentences used in the TROG at the start of years 2 and 3, pre and post training. The imitated production was tape recorded each year after the students had completed the TROG in the standardised way as a test of comprehension of grammar. By the end of year 3 all students had been benefitting from a variety of teaching activities using reading as described above.

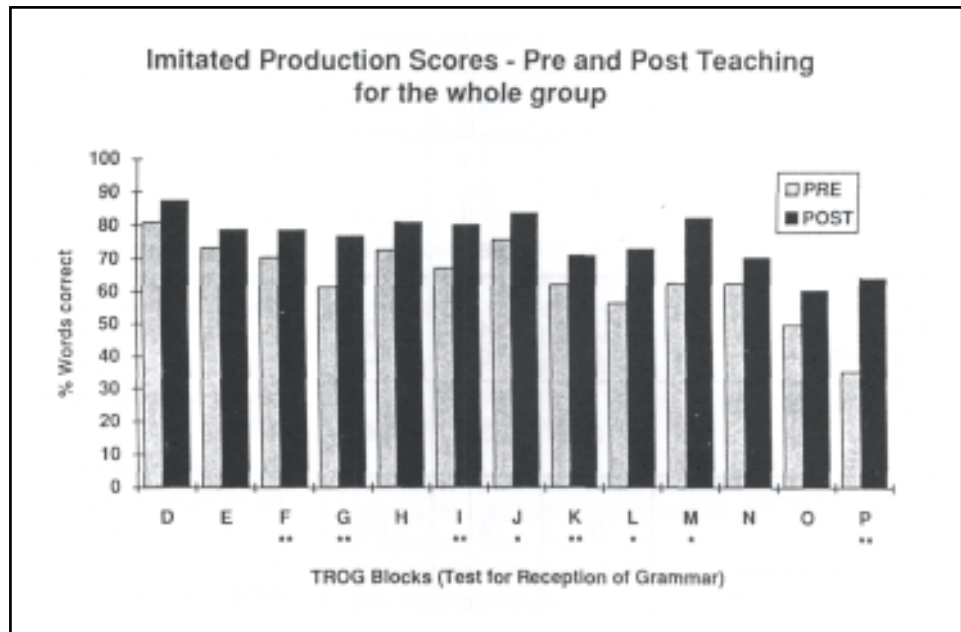


Figure 3

Specific effects on production

Figure 3 illustrates the mean scores for the whole group of twelve teenagers on each sentence structure of the TROG. While production ability has improved for every sentence structure, the gains are less than 10% for 7 of the 13 structures. However, of the 7 structures specifically trained during the year, blocks G, I, M, P, K, L, N, and O (see Table 3) 5 show gains of more than 10% and 2 gains of more than 20%. The pre- and post-training conversation samples are still being analysed.

Individual differences

Figure 4 illustrates the improvements in imitated production scores made by

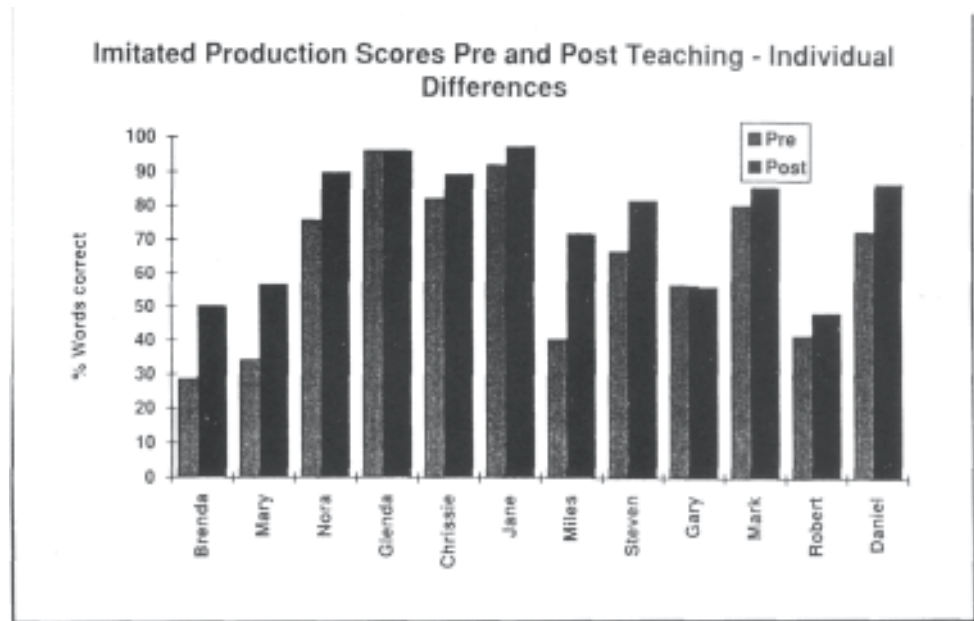


Figure 4

individual students and shows considerable variation. The 3 students who made gains of 20% or more, Brenda, Mary and Miles, had the lowest pretraining scores. The four with the highest pretraining scores, Glenda, Jane, Chrissie and Mark, show only small gains if any. With pretraining performance 80 to 90 % correct these four were able to imitate almost correctly sentences that they failed to comprehend correctly at the start of Year 2.

Specific effects on comprehension

The student's scores on the TROG at each assessment illustrate that the training did improve their comprehension of grammar. Table 3 (page 68) shows the number of students passing the comprehension tasks each year for the structures

trained in year 2.

To pass the block the student must pass on all 4 examples. The figures in brackets indicate the number of students who passed 3 out of 4. Note the number of students who were able to reliably comprehend comparative absolute and reversible passive sentences after being specifically taught.

Table 4 (page 68) illustrates the gains in BPVT and TROG scores during the baseline year and the training year. From the BPVT scores it can be seen that the mean gain of almost six months in vocabulary comprehension was the same for both years. However the improvement in comprehension of

TROG Comprehension Scores for the structures taught			
	Year 1	Year 2	Year 3
Personal Pronouns G They/Them I He/Him She/Her	4	8	12
Prepositions M In/On P Above/Below	2 0	4 0	10 4 (+2)
Comparative Absolute K	2	3	8 (+3)
Reversible Passive L	0	0	8 (+2)
Post-modified Subject N	1	1	1 (+6)
X but not Y O	0	0	1 (+6)
Figure in bracket is number of children passing 3 out of 4 sentences for that block			

Table 3. Number of children passing the block at each test point.

	BPVT		TROG	
	Yr 1-2	Yr 2-3	Yr 1-2	Yr 2-3
Girls	4.8	3.2	3.0	18.0
Boys	6.5	8.0	5.5	11.0
All	5.7	5.6	4.25	14.5
Mean gains expressed in months - based on test age norms				

Table 4. Mean improvements in vocabulary and comprehension age (in months) over two years.

	Year 1	Year 2	Year 3
Girls	- 6.7	- 9.3	+ 6.66
Boys	- 0.8	- 3.2	+ 1.16
All	- 3.75	- 6.25	+ 3.92
Minus sign indicates TROG age is lagging behind BPVT age			

Table 5. Difference between BPVT and TROG ages (in months) each year.

grammar in the second year as indicated from the TROG scores shows a very significant training effect.

Table 5 illustrates the mean difference in age scores obtained on the BPVT and TROG at each assessment point. In year 1 and year 2, grammar age lags behind vocabulary age and the gap is growing, but in year 3 after specific teaching, grammar age is now in advance of vocabulary age. (The difference between the scores for the boys and the girls in years 1 and 2 in this table are largely due to one individual, Robert, who had grammar scores way ahead of vocabulary scores on each occasion due to unusually poor vocabulary scores).

Why does reading enhance performance?

All the students found the training materials with the written sentences easier to learn from, even though they were not taught the sight vocabulary before the training started. The words that were not in their sight vocabulary were learned during the sentence training.

The words that the students were omitting from the sentences in spontaneous production before training began - and in the (S) speech only training - were the articles, auxiliaries and prepositions. For example, "man sitting chair" or "they ride horse" were typical responses for "the man is sitting on the chair" or "they are riding on the horse" at the beginning of year 2.

The sight vocabulary which the students needed to learn so that the (SR) materials could prompt correct production of the sentences was repetitive across many of the sentences - particularly the articles and auxiliaries - so easy to learn as the training progressed.

The benefit of the reading method could be explained in two ways:

1. that it provided a visual clue to each word that was stored in visual memory and used to help recall,
2. that in the (SR) method, the students production on the 3 training trials was much nearer to 100% accuracy because they quickly learned to read the sentences. In the (S) method, the accuracy of repetition on the training trials was much less for most of the students.

To try to establish the role of visual memory, a further sentence structure (plurals) was taught using a "shadowing" procedure. The student repeated the sentence with the teacher - shadowing each word. This enabled 100% accurate practise for the training trials in both methods. One group used the (S) materials, the other the (SR) materials. The mean % of words correct in the test trials for the two methods with shadowing were (S) 58.4% (for group 1) and (SR) 75.8% (for group 2). This difference is significant ($p < .05$ Wilcoxon Matched Pairs) and these figures are very similar to those for the two methods across all the sentence structures as can be seen in Fig 1. Shadowing had no effect on performance, suggesting the gain in the (SR) method is due to visual memory - the student is storing the visual image of the word and using this to aid recall.

This explanation is consistent with other evidence reviewed by Poeschel (1988) showing visual perception and visual memory are less impaired than auditory processing and auditory memory in children with Down's syndrome.

Why the individual differences?

Several factors may be affecting the large individual differences in progress illustrated in the results including auditory short-term memory span, motivation, previous experience of failure, reading ability, age and speech production difficulties.

Auditory short-term memory span would seem to be a significant variable. The two students who showed the greatest benefit of the (SR) method during the training sessions, Brenda and Robert (see fig 2), each had digit spans of 2. The student who showed the least benefit of the (SR) method, Jane, had a digit span of 4. She could manage near perfect production in both training methods.

Brenda and Robert experienced the (S) training first, and found it extremely difficult and not enjoyable, once the novelty of being audio-taped had worn off. Brenda became increasingly uncooperative in the sessions but when she moved to a new sentence structure and the (SR) materials the effect was dramatic from the first trials. She realised at once that the words were a clue which would help her succeed though no attention was drawn to them by the teacher. Her face "lit-up" and she put her finger on the words. Her whole attitude to the teaching changed from being difficult and unmotivated to being enthusiastic and interested. She had no reading ability as measured by the Neale test at the start of the training year. She was the last child the author expected to benefit from the reading.

Brenda found the digit span testing aversive - as she seemed to realise she was having great difficulty. When it came to the final "shadowing" experiment, she was in the group to use the (S) materials and flatly refused to participate, insisting on the (SR) materials which she knew must exist so her results were left out of the analysis. Her teachers reported that her success on the language programme produced a noticeable change in her motivation to learn in the classroom.

Robert was enjoying the individual attention the teaching gave him and tried to please in the (S) method despite finding it hard. He too showed surprising enthusiasm for the (SR) method - though also a non-reader - and his attitude and progress in the classroom improved. Robert lived in a children's home which may explain his low vocabulary score. He may have received less individual attention in the care setting than the other students who lived at home with their families.

The other two students with digit spans of 2, Gary and Mary, did not show the same gain from the (SR) method. They had different problems and personalities. Gary disliked school and expected to fail at everything. He had failed to learn to read and reading was aversive to him. He treated the sessions as an escape from the classroom and enjoyed hearing himself on tape, especially if he was allowed to be a pop-star during breaks from the teaching, but his concentration on the training was poor. He made no real effort to learn the sentences, this was typical of his attitude to learning at the time.

Mary was a very timid, quiet, withdrawn student who suffered from severe arthritis and could only move with difficulty. She hardly talked at all during the day - and then only in a faint whisper. Much patient encouragement was required to persuade her to speak loud enough to even be recorded.

She rarely used more than single word utterances to communicate. Despite these difficulties, she did make some progress and showed a gain in comprehension age of 12 months on the TROG at the end of the intervention year, as did Brenda. Robert and Gary each showed 6 months gain on the TROG at the end of the year.

Reading ability

Of the six students with the most reading ability at the outset, Nora, Chrissie, Glenda, Jane, Stephen and Daniel, only two showed gains of over 15% on the (SR) method. These two, Chrissie and Daniel had speech production problems and poor intelligibility at the outset. It is possible that the reading method increased their confidence as both were more intelligible when reading.

Daniel's production benefited considerably from reading, as he had a severe stutter when speaking spontaneously which disappeared when he was reading. During the year, the students kept 'conversation' diaries in which they wrote their news at school and at home, to share with family and school friends. Daniel enjoyed keeping this diary, as he had found difficulty in sharing his news with the others in the usual morning news session in the class because of his stutter. Once he began to write the news down he could tell his friends fluently by reading it aloud to them. This had a noticeable positive effect on his self-confidence and self-esteem. Daniel gained 24 months on the TROG comprehension test in the training year compared to 9 months in the previous year.

While these six more able readers did not make such large gains in production ability over the year - at least as reflected in their imitated production or training scores - they did make significant gains in comprehension of grammar and syntax. Their mean gain in TROG comprehension score for year 2 was 20.5 months compared to a mean gain of 14.5 months for all twelve students. At the beginning of the year their mean TROG score was 63 months and their mean BPVT score 74.3 months compared to total group means of 60.75 and 67 months respectively. Their vocabulary age is significantly higher than that of the non-readers at the start of year 2, but not their comprehension of grammar age. Perhaps their reading ability has given them an advantage in exposing them to a wider range of vocabulary than is encountered in everyday speech.

However, their vocabulary ability alone does not explain their TROG comprehension gain as the three students with the lowest vocabulary scores, Brenda, Stephen and Robert with a mean BPVT age of 47 months, showed a mean gain during year 2 of 11 months on the TROG and the two highest scorers on the BPVT, Glenda and Gary, with scores of 88 and 83 months respectively, only gained 6 months each on the TROG in year 2 and ended the year with BPVT scores 21 months and 10 months ahead of their TROG scores. No other students had such a large vocabulary advantage at the end of year 2. Nora and Miles were still 7 and 6 months ahead respectively on vocabulary age and Stephen just 1 month ahead. The 7 other students had TROG scores ahead of their BPVT scores after training by 1 - 29 months (mean difference for the 7 was 13.1 months).

So, it seems to be reading ability rather than vocabulary knowledge that is the key to the large comprehension gains made by the six best readers, but they needed the specific

teaching of grammatical and syntactical structures as well as the reading ability, as in the baseline year their mean TROG gain was 4 months (compared to a total group mean 4.25). In the baseline year their BPVT gain was 6.2 months and in the training year 6.3 months. At the end of the training, the six readers had a mean TROG score of 83.5 months and a mean BPVT score of 80.6 months - so their grammar and vocabulary comprehension skills are now approximately equal and equivalent to those of the average 7 year old. The mean age of the six readers was 175.5 months and their mean score on the Matrices was 83.5 months at the start of year 2 so they were not older or more able in the non-verbal cognitive domain than the remaining six students.

Conclusions

The intervention was effective

The large gain in comprehension of grammar and syntax over the training year compared to the baseline year, for the whole group, shows the teaching was effective and the students were capable of significantly increasing their understanding of language structure at this age. Their mean on the TROG after the training was 75.25 months or 6yrs 3mths, (range 63 - 108 months, 5yrs 3 mth - 9 yrs).

No evidence of 'ceilings'

These results suggest that two of Fowler's hypotheses for delayed language development in teenagers with Down's syndrome in her 1990 review are incorrect.

These students, aged 13yrs 3mths to 15yrs 9mths at the start of the training year, were able to improve considerably therefore providing no support for her 'critical period' hypothesis which predicts little progress after 7 years of age. The progress the students made in learning complex sentences also questions the likelihood of a 'syntactic ceiling'.

Chapman et al. (1992) reported findings which support those of the present study. They collected narrative and conversational samples from 49 children with Down's syndrome aged 5 to 20 years and compared them with those of normally developing children matched for mental age and socio-economic status. The narrative samples produced longer MLU (mean length of utterance) output from the children. They found no evidence of 'critical period' as MLU's continued to increase right through the teenage years. They also found complex sentences with more than one clause in the language of the teenagers with Down's syndrome refuting the view that there is a 'syntactic ceiling' arresting development at the simple sentence level. They did find evidence of difficulties with grammatical morphology and noted that all the words the young people with Down's syndrome omitted were from closed class grammatical categories. These findings are entirely consistent with those of the present study.

What produced the gains?

If teaching can produce improvements, what has been causing delay? The scores for the non-verbal cognitive ability of the students in this study at the start of year 2 showed that their language skills were lagging some 18 months behind this measure of cognitive ability as many other authors have reported. This suggests that language learning is being delayed by factors over and above any cognitive delay.

The importance of memory

This study suggests that one important influence may be poor auditory short-term memory span. Most children learn language from listening. Poor auditory short-term memory skills may have a particularly detrimental effect on learning the rules for the structure of the language and less effect on vocabulary acquisition.

The links between language skill and auditory short-term memory are complex, and likely to lead to a vicious circle without intervention. Poor progress with speech may itself be preventing memory strategies such as 'rehearsal' from developing.

Reading

The benefit of being able to read may be because reading can overcome the memory limit. Print can be perused for as long as is necessary to work out the meaning conveyed by a sentence that is too long to hold in a limited auditory memory store. In English and in most languages, the structure of the written form is the same as the spoken form, so that what is learned from reading can be transferred to speech. All children learn new vocabulary and new structures as they become skilled readers and read more and more widely. They then use this knowledge in their speech (see Garton and Pratt (1992) for further discussion of the inter-active relationship between speaking and reading for all children).

There is also the possibility that multi-sensory input is helping these young people. Words in print become tangible and can be handled, moved to illustrate syntactical rules, morpheme changes can be seen - maybe this type of multi-sensory reinforcement is needed by children with Down's syndrome. It has been shown to help other children with learning difficulties (see Hulme, 1987).

Reading may help comprehension in these ways and it may also improve production. The students who can read can practise speaking longer, more complex and grammatically correct sentence structures when they read them than they can generate spontaneously in their speech. Limited speech production over the years - in terms of total quantity, length and complexity of utterances - means that most teenagers with Down's syndrome have had much less practise at talking than normally developing children. This lack of practice alone could account for some of their speech production difficulties - as for all children speech intelligibility improves with practise in their early years.

Many children with Down's syndrome are now learning to read in early childhood and have reading ages equivalent or ahead of their chronological age. Further research is needed to ascertain the effect of this reading skill on their language skills.

Language environment

In the U.K. the majority of these reading youngsters are being educated in mainstream schools. The mainstream classroom will provide a much more stimulating language environment - so reading ability will not be the only influence on their language development.

The author's impression, based on teachers' reports and school visits, is that these mainstreamed readers are making extremely good progress and have speech and language

skills at 8/9 years, way ahead of the teenagers who took part in this study. A sample of mainstreamed pupils will be studied in detail in the next school year.

The students in this research project were in school with other students with equal or greater language impairments. Their social lives were extremely restricted (see Buckley and Sacks, 1987). Most of their time was spent in the company of school friends in school and family out of school. They had very little opportunity to communicate outside this circle in order to learn how to do better.

Their early hearing status was largely unknown and they did not have the opportunity to benefit from sign teaching.

Implications for the future

In the author's view, the interventions which will produce the greatest gains in language development for children with Down's syndrome are:

- 1) *continuous awareness of and treatment for hearing loss,*
- 2) *appropriate remedial language teaching including signing from the first year of life,*
- 3) *normal language experience throughout life by being educated in mainstream classrooms and included in the ordinary social world,*
- 4) *teaching which takes account of auditory short-term memory limitations,*
- 5) *learning to read and to write, beginning in the preschool years.*

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The Development of Language and Reading Skills in Children with Down's Syndrome 2nd edition

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