

Investigating the literacy, language and memory skills of children with Down's syndrome

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This paper presents the first phase of a longitudinal study following 24 children with Down's syndrome who are receiving their education in mainstream primary schools. The literacy, numeracy, language and memory skills of the children with Down's syndrome were compared to 2 groups of children selected from their classmates. The comparison groups were a group of typically developing children who were average readers in the classes and a group of children who were matched to the children with Down's syndrome for reading age.

The baseline data revealed that the children with Down's syndrome had uneven cognitive profiles with relatively advanced reading skills compared to their other cognitive skills. The group of ordinary children who were matched to the children with Down's syndrome on reading ability, attained significantly higher scores than the children with Down's syndrome on all assessments other than reading. However, the reading matched group who were generally of below average reading ability for their age, were also significantly delayed relative to the average readers on measures of language, number and memory. As a group the average readers were average or above average on all measures.

A cross-sectional analysis which divided the children with Down's syndrome into 3 groups according to age and school year group indicates steady progress in all skills as the children move through primary school.

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Introduction

Published literature concerning reading skills in children with Down's syndrome is extremely limited and consists mainly of anecdotal evidence and single case studies (see Buckley et al, in press). One reason for the limited amount of information on the reading abilities of children with Down's syndrome is that until recently the majority of them have not had the opportunity to learn to read. Until the last five years, the majority of children with Down's syndrome in the United Kingdom, were educated in special schools for children with severe learning difficulties. Children with Down's syndrome were not introduced to literacy teaching at the usual age of 4 or 5 because it was assumed that most of them were not able to learn to read. However, over the past five years increasing numbers of children with Down's syndrome have been included in mainstream primary schools and educated alongside their peers. In 1994 there were approximately 40 children with Down's syndrome attending their local mainstream school in the county of Hampshire (Bird and Buckley, 1994). This number includes children in both primary and secondary schools. Almost all the primary age children in the local district were in integrated mainstream placements and had access to literacy teaching from beginning of school.

Frith's developmental model of reading describes the way in which literacy skills change as the typical child learns to read and write (Frith, 1985). Most children will at first recognise words by sight only. They will then go on to an alphabetic stage when words can be sounded out letter by letter and then on to an orthographic stage of morpheme recognition. The building of a child's sight vocabulary will depend on his or her visual discrimination and visual memory skills as the printed words are stored visually. The alphabetic stage involves learning letter to sound rules so that when the child is faced with an unfamiliar word he or she can sound it out to identify the printed word from its spoken form. Seymour has proposed a set of operational characteristics which can be used to identify whether children are using the logographic or alphabetic strategy when reading, (e.g. Seymour, 1993). The characteristics studied by Seymour include the types of errors the children make when trying to read words and the times it takes to read words in milliseconds.

Many children with Down's syndrome are able to establish a sight vocabulary even from as young as two to three years of age (Bird and Buckley, 1994). Very few studies have focused on the use of the phonological route to reading in children with Down's syndrome. However to be able to make use of phonological recoding the child must be able to hear all of the sounds in words. If the hearing loss and auditory short term memory difficulties that are often associated with having Down's syndrome are taken into consideration, it would seem likely that they would find this strategy more difficult than the direct visual route (Buckley et al 1995).

Buckley has also suggested that children with Down's syndrome may be logographic readers after observing that the children were not translating print to speech in order to retrieve the meaning of a word, but were going straight from the visual form of the word to its meaning (Buckley, 1985). Buckley goes on to suggest that the reading and language skills of children with Down's syndrome may rely on right hemisphere processes in the brain, whereas in the majority of the population these functions are handled by the left hemisphere. The language processing abilities of the right

hemisphere are more limited than those of the left and one of its limitations is that it is not able to use sound to print (grapheme to phoneme) coding.

Research on reading development in typically developing children suggests a reciprocal relationship between reading progress and other cognitive skills such as working memory development and phonological awareness, (Ellis and Large, 1988, Gathercole and Baddeley, 1993). Tests of phonological awareness aim to measure a person's ability to make judgements about or manipulate the sound structure of words. Bradley and Bryant (1983) asserted that an overt knowledge of how spoken words can be analysed into their constituent sounds play a causal role in the development of reading ability. However recent studies (Cossu, Rossini and Marshall, 1993, Evans, 1994) have shown that many children with Down's syndrome have acquired reading skills despite their inability to perform phonological awareness tasks.

Cossu, Rossini and Marshall (1993) investigated the phonological skills of 10 Italian children with Down's syndrome who ranged in age from 8 to 15 years and who could read at about the same level as ordinary 7 year old children. However the children with Down's syndrome failed the phonological awareness tasks passed by the reading age matched children. Thus Cossu et al suggest that phonological awareness tasks may not embody those skills which are crucial to reading.

Evans (1994) describes a study of phonological skills in six children with Down's syndrome who were participating in a larger study of literacy development. The results indicated that some logographic reading ability had developed, while alphabetic and phonological skills were largely absent. The lack of alphabetic processing was indexed by an inability to read or spell non-words, although all the children had some knowledge of the sounds of individual letters of the alphabet. The results supported those of Cossu et al in that the children with Down's syndrome were unable to perform competently in tasks which required phonological skills.

Buckley et al (in press), also point out that the phonological route to reading is only of any real use if the word that is being sounded out is in the child's vocabulary. Children will often use phonological recoding and the context given by other words in the sentence to help them guess a word that will fit that sentence. However children with Down's syndrome often have less language knowledge both in terms of their vocabulary and their knowledge of grammar and syntax than other children with the same level of reading ability. Therefore it would seem likely that children with Down's syndrome may not be able to make as much use of context or phonological recoding as other children.

Ellis and Large (1988) also found reciprocal interactions between reading development and other cognitive skills in typically developing children. By looking at the cognitive skills that were associated with reading at several time samples, Ellis and Large were able to investigate developmental changes in reading ability. 40 children were tested annually on 44 variables. From the analyses the authors concluded that the nature of reading skills changes rapidly in the first three years of acquisition. For example the correlations between various short-term memory abilities and reading skill indicate that in the early stages of reading

acquisition it is the visual STM tasks that predict later reading ability not the auditory ones. Thus it seems that early reading builds on visual STM skills. Although reading and auditory STM are associated in these early stages, they seem to be developing in unison and with mutual benefit. From 6 to 7 years it is auditory rather than visual STM that is more highly associated with reading skill and it is now reading that is a better predictor of the auditory STM skills than auditory STM is of later reading skill. Hence Ellis and Large's conclusion that it is "the acquisition of reading skill which underpins the developmental changes in strategies and skills used in STM tasks."

In 1993 the author embarked upon a longitudinal research project which has only been made possible because of the recent changes in educational provision for children with Down's syndrome in the local area. The opportunity for this research project has arisen because almost all of the primary aged children with Down's syndrome in the local district are now in mainstream placements. For the first time it has become possible to study the literacy development of a representative sample of children with Down's syndrome who have all had access to literacy teaching. The main aims of this study are:

- 1) to chart the literacy, language and memory skills of 24 children with Down's syndrome comparing their progress with their mainstream classmates.
- 2) to investigate the interrelationships between literacy, language and memory skills.
- 3) to look at the cognitive strategies the children are using to read.

This paper will present the results of the first phase of the longitudinal study. It will focus on the results of a battery of standardised assessments which were administered to three groups of children (children with Down's syndrome, average readers, and reading age matches) in order to obtain baseline measures. The profiles of cognitive abilities in the three groups will be discussed.

Method

Participants

A total of 97 children participated in the study. The children were drawn from 18 schools in Hampshire, 5 schools in West Sussex and 1 school on the Isle of Wight.

The research strategy used, was to identify the children with Down's syndrome first and then to select 2 control groups, (i) children matched for reading age, and (ii) average readers from the same classes.

The sample was restricted to the primary school age range and to schools within a seventy mile radius of Portsmouth. A letter was sent to 25 mainstream Primary schools in Hampshire, West Sussex and the Isle of Wight that had included a child with Down's syndrome, inviting them to take part in the research project. All of the schools that were contacted agreed to take part. A sample of 20 schools was established in the spring of 1994. Another 4 schools joined the research project in September 1994.

Three groups of children were assessed:

Children with Down's syndrome: This group consisted of 24 children with Down's syndrome, 10 girls and 14 boys, mean age 8 years 2 months, range 4 years, 11 months to 12 years, 7 months.

Average readers: The second group of children were described as average readers in their class. The teacher of each child with Down's syndrome was asked to select 2 children who she considered to be average readers in the class. The group of average readers comprised 42 children, 21 girls and 21 boys. Their mean age was 7 years, 3 months, range 4 years, 7 months to 10 years, 5 months.

Reading age matched: The third group of readers were children without Down's syndrome who were matched to the children with Down's syndrome on reading ability, using the British Ability Scales Word Reading subtest (Elliot, 1993). This group comprised 31 children, 12 girls and 19 boys. Their mean age was 7 years, 1 month, range 4 years, 8 months to 9 years, 10 months. If it was not possible to find a reading match from within the same class as the child with Down's syndrome, a match was found from another class within the same school.

Materials and procedure

The children were assessed on standardised measures of reading, spelling, short term memory and number, using subtests of the British Ability Scales (BAS) and Kaufman Assessment Battery for Children (K-ABC) and on language measures, the Test for the Reception Of Grammar (TROG) and the British Picture Vocabulary Scale (BPVS). The children were assessed individually at school during the summer term, 1993. The assessments were typically completed in 2 sessions lasting 30 - 40 minutes each.

Results

A series of one-way analyses of variance (ANOVA) were performed on the assessment data raw scores, followed by the Student Newman-Keuls post hoc test. Table 1 shows the mean raw scores attained by the three groups of children.

Memory

Significant differences were found between all 3 reading groups on the British Ability Scales immediate visual recall task, ($F(2,90) = 18.40, p < .00$), and on the delayed visual memory task, ($F(2,81) = 19.20, p < .00$). Similarly all three groups differed significantly in terms of auditory short term memory as measured by the British Ability Scales recall of digits test, ($F(2,91) = 52.27, p < .00$). Thus on all 3 memory assessments the average readers achieved significantly higher scores than the group of reading matched children, who in turn achieved significantly higher scores than the children with Down's syndrome.

Reading

Analysis of variance revealed a significant effect of reading group on the British Ability Scales reading test, ($F(2,93) = 14.48, p < .00$). As the reading matches for the children with Down's syndrome were selected using the British Ability Scales word reading test it was expected that the mean raw scores of these two groups would not be significantly differ-

ent and this was the case. Post hoc comparisons using the Student Newman-Keuls test revealed that the mean scores for both the children with Down's syndrome and the reading matches were significantly lower than the mean raw score attained by the average readers at the 0.05 level. The mean scores attained by the children with Down's syndrome and the reading matches were not significantly different.

Likewise there was a significant effect of reading group on both the Kaufman single word reading ($F(2,92) = 16.01, p < .00$) and on the reading comprehension, ($F(2,89) = 15.82, p < .00$). Post hoc comparisons revealed that children with Down's syndrome and the reading matches did not differ significantly on the two measures of reading taken from the Kaufman Assessment Battery for Children. However, the mean scores for both the children with Down's syndrome and the reading matches were significantly lower than the mean scores attained by the average readers in both tests.

Spelling

There was a significant effect of reading group on spelling, ($F(2,83) = 16.62, p < .00$). Post hoc comparisons revealed that all three groups differed significantly on the British Ability Scales spelling test with the average readers achieving the highest scores followed by the reading matches and then the children with Down's syndrome.

Number

There was a significant effect of reading group on number, ($F(2,89) = 60.53, p < .000$). Post hoc comparisons revealed that all 3 groups differed significantly on the British Ability Scales basic number test with the average readers achieving the highest scores followed by the reading matches and then the children with Down's syndrome.

Language

There was a significant effect of reading group on both the TROG ($F(2,91) = 65.85, p < .00$) and BPVS ($F(2,85) = 25.26, p < .00$). Post hoc comparisons revealed that all 3 groups differed significantly in their understanding of grammar as measured by Test for Reception Of Grammar, and in their knowledge of vocabulary as measured by the British Picture Vocabulary Scale. Thus on both language assessments the average readers achieved significantly higher scores than the group of reading matched children, who in turn achieved significantly higher scores than the children with Down's syndrome.

In summary, on each of the subtests measuring reading ability, the children with Down's syndrome did not differ significantly from the reading match children. However both of these groups differed from the average readers who were scoring significantly higher. The pattern was different but equally consistent for skills other than reading. On measures of memory, language, and number, the average readers scored significantly higher than the matched readers who in turn scored significantly higher than the children with Down's syndrome. This highlights the fact that although the ordinary children in group 3 were matched to the children with Down's syndrome on reading ability, they were not matched on any of the other abilities that were assessed.

In Table 2 the mean raw scores have been converted into age equivalent scores. The children with Down's syndrome were often in classes with children one year younger than themselves. As a result the children with Down's syndrome

Table 1 - Mean Raw Scores Attained by the Three Reading Groups.

ASSESSMENT		MEAN RAW SCORES								
		DOWN'S SYNDROME 1			AVERAGE READERS 2			READING MATCH 3		
		MEAN	STD DEV	N	MEAN	STD DEV	N	MEAN	STD DEV	N
AGE		97.75	19.84	24	87.43	16.89	42	85.00	18.58	31
BAS	Immediate visual recall	3.77	2.20	22	7.98	2.57	42	6.59	2.99	29
BAS	delayed visual recall	1.52	1.97	21	5.77	3.05	35	4.04	1.99	28
BAS	recall of digits	6.70	3.28	23	17.90	4.18	42	15.41	5.04	29
BAS	number skills	9.74	5.66	23	36.02	10.10	41	27.25	10.00	28
BAS	word reading	16.91	18.35	23	41.26	26.25	42	17.29	16.86	31
BAS	spelling	1.91	3.01	22	7.76	4.55	38	4.31	3.54	26
K-ABC	reading-decoding	11.96	8.41	23	21.68	7.27	41	13.81	7.04	31
K-ABC	reading-understanding	1.08	2.36	24	7.32	6.56	38	1.97	3.61	30
TROG	understanding of grammar	5.63	2.53	24	15.07	2.81	41	11.90	4.11	29
BPVS	understanding vocabulary	9.74	2.85	23	17.00	4.21	39	14.04	4.16	26

Table 2. The cognitive profiles of children with Down's syndrome compared to other children selected from their mainstream classmates.

			British Ability Scales			Raw Score	BPVS	TROG
Group	N	mean CA	reading age	spelling age	number age	digit recall	vocabulary age	grammar age
Down's syndrome	24	8y 2m	6y 3m	6y 4m	4y 1m	6.7	4y 5m	4y 3m
Average readers	42	7y 3m	7y 3m	7y 6m	7y 3m	17.9	7y 9m	8y 0m
Reading matched	31	7y 1m	6y 4m	6y 9m	6y 4m	15.4	6y 3m	5y 9m

are significantly older than both the average readers who were selected from the same class and the reading matches ($F(2,94) = 3.68, p < .029$). Post hoc comparisons revealed that the average readers and the reading matches did not differ significantly in age.

All of the children with Down's syndrome were learning to read but there was a wide range of abilities with reading ages ranging from 5 years to 8 years 5 months. Although the children with Down's syndrome are matched to slower readers on reading measures, they fall significantly behind the slower readers on the measures of language, memory and number.

The children with Down's syndrome were divided into 3 groups on the basis of their school year. Group 1 were 8 of the youngest children who were either in reception or year

1 classes. The next group consisted of 9 children who were in year 2 and year 3 classes of infant schools. The oldest age group consisted of 5 junior school children who were in year 3 to year 5 classes. Table 3 shows the assessment data for each of these 3 groups. This cross-sectional data indicates steady progress in these skills as the children move through the infant and junior classes.

Discussion

The present study has established three groups of children who will be assessed longitudinally. The children can be described as 1) children with Down's syndrome, 2) average readers and 3) slower readers.

It is interesting to note that although the children with Down's syndrome were matched to the slower readers in terms of

reading ability, they fall significantly behind them on measures of language, memory and number skill. In other words, the children with Down's syndrome appear to have advanced reading ability compared to their other cognitive abilities. The typically developing children who were selected by their teachers as being average readers in their class, showed even and age appropriate cognitive profiles across all measures. The children who were selected by their teachers as being "slower readers" and who were reading at approximately the same level as the child with Down's syndrome, showed more even cognitive profiles than the children with Down's syndrome. However the slower readers were significantly delayed relative to the average readers on all measures, with mean age equivalent scores approximately one year behind the mean chronological age of the group.

Within the group of children with Down's syndrome there was a wide range of ability in reading with some children yet to score on the standardised measures and others who have attained significant reading ability and reading ages of 8 years 5 months. It is expected that the individual rates of progress made in reading over the next 2 years will vary dramatically. A cross-sectional analysis which divided the group of 24 children into 3 groups according to age and school year group, indicates steady progress in all the assessment measures as the children move up through the primary school years. Longitudinal data is needed to confirm this indication and this data will be available in due course.

Future research

The assessment data that has been described will form the baseline data for a longitudinal study which will monitor the children's reading progress in relation to other cognitive abilities. The research design will be similar to other longitudinal studies which select samples of children who are tested and re-tested at further intervals, and then explore the changing predictors and beneficiaries of reading as reading abilities develop, (Ellis and Large, 1988; Gathercole and Baddeley, in press, cited in Gathercole and Baddeley, 1993).

As well as exploring whether learning to read improves other cognitive abilities such as the working memory and language skills of children with Down's syndrome, this research project will look at the strategies the children are using to read. The main enquiry is whether the children with Down's syndrome are using the same strategies to read as the typically developing children as well as the manner in which these strategies develop or fail to develop. The study will investigate the extent to which the children have established, a) a logographic process which recognises words on a visual basis, and, b) an alphabetic process which applies letter to sound knowledge in the decoding on unfamiliar items. A main focus of interest will be the stages of reading

Table 3. The cognitive profiles of the children with Down's syndrome divided into 3 groups on the basis of age and school year.

Children with Down's syndrome	Group 1 N=8	Group 2 N=9	Group 3 N=5
Mean chronological age	6yrs 8m	8yrs 3m	9yrs 7m
BRITISH ABILITY SCALES			
Number	6.00 (3y 8m)	8.78 (3y 11m)	16.20 (4y 11m)
Reading	5.25 (5y 5 m)	14.44 (6y 2m)	38.60 (7y 2m)
Spelling	0.75 (6y 1m)	1.00 (6y 1m)	5.50 (7y 2m)
Recall of digits	5.13	5.89	10.60
Immediate visual recall	2.63	4.13	4.8
Delayed visual recall	0.38	2.5	1.75
LANGUAGE ASSESSMENTS			
BPVS - vocabulary	8.25 (3y 7m)	9.75 (4y 5m)	12.00 (5y 4m)
TROG - grammar	3.75 (<4y0m)	6.33 (4y 3m)	7.80 (5y 0m)
KAUFMAN ASSESSMENT BATTERY			
Reading/decoding	6.00 (5y 3m)	12.00 (6y 3m)	20.60 (7y 6m)
Understanding	0.00 (6y 3m)	0.56 (6y 6m)	4.20 (7y 0m)

development and the ages of the children when the transition from logographic to alphabetic strategy use begins. An experimental investigative technique will be used to compare the strategies used by children with Down's syndrome and the 2 control groups which were established for the longitudinal study.

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