Reading before talking: Learning about mental abilities from children with Down syndrome

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Abstract - *My aim in this lecture is to give you an overview of the research that my colleagues and I have been conducting for the past sixteen years. Our aim has been to understand the reasons for the delayed cognitive development of children with Down syndrome in order to be able to develop optimally effective remedial and educational strategies for them. Our programme of research has been continuous, with findings from one study leading to the next. Some of our most interesting findings were identified by chance, not because we always knew how to ask the right questions, and I hope to be able to convey how interesting and rewarding the work has been. I will illustrate how we have gained a greater understanding of the specific learning difficulties of children with Down syndrome and, in doing so, learned about the dynamic and interactive way in which mental abilities such as speaking, reading and remembering develop.*

Keywords - *Down Syndrome, Reading, Language, Cognition, Memory*

Introduction

My aim in this lecture is to give you an overview of the research that my colleagues and I have been conducting for the past sixteen years. Our aim has been to understand the reasons for the delayed cognitive development of children with Down syndrome in order to be able to develop optimally effective remedial and educational strategies for them. Our programme of research has been continuous, with findings from one study leading to the next. Some of our most interesting findings were identified by chance, not because we always knew how to ask the right questions, and I hope to be able to convey how interesting and rewarding the work has been. I will illustrate how we have gained a greater understanding of the specific learning difficulties of children with Down syndrome and, in doing so, learned about the dynamic and interactive way in which mental abilities such as speaking, reading and remembering develop. I will also argue that our findings may have significance for children with other disabilities such as deafness or autism.

The work is and has always been a team effort, not only with my colleagues in the University whose work I will acknowledge as I report on the studies, but also with the parents and the children that we study. Indeed, the work was started by a parent.

Background

I began investigating the mental abilities of children with Down syndrome in Portsmouth in 1980 after receiving a letter from a father. Leslie Duffen, describing how he had discovered that his daughter Sarah could begin to learn to read at the age of three years. Sarah was born with Down syndrome. At three, she was just beginning to imitate and to use single words in her speech. Leslie taught Sarah to read on flashcards the words that he wanted her to be able to use in her speech and he observed that she began to use the words she had learned from the printed form at a faster rate than those she only experienced in the spoken form.

When Leslie wrote to me in 1979, Sarah was twelve years old. She had good speech, was reading and writing at her age level and being educated in a local comprehensive school. She had received all but one year of her education in mainstream schools and was considered to be exceptionally able for a child with Down syndrome. Leslie felt sure that her exceptional progress had been the result of teaching her to read early and that other children might be helped in the same way.

I found Leslie's letter surprising and intriguing. His experience with Sarah suggested that *pre- school children with Down syndrome could learn to read and that reading might be a "way-in" to spoken language for these children*. In 1979 children with Down syndrome were not thought capable of learning to read at all by most professionals [1] and there was very little research into the reasons for their spoken language difficulties, even though these were well documented at that time [2]. Children with Down syndrome were expected to be late to talk, moving slowly from single words to two word utterances by five or six years of age. Very few progressed beyond "keyword" or telegraphic speech, even as adults, rarely using more than the simplest early grammar that typically developing children are using by three to four years of age. As Sarah had exceeded these expectations, we certainly thought that Leslie's observations warranted further investigation.

With a grant from the national Down Syndrome Association we were able to appoint a teacher and set up a research study to begin to investigate these hypotheses. We followed the developmental progress of fifteen children, of between two to four years, for three years while they received a regular home-teaching programme from us.

Joanna, the first child that we tried teaching to read in 1980, learned thirty words in a month at two years and six months of age. (We have this recorded on video-tape for the sceptical!) It was immediately clear that Leslie's observations with Sarah might well apply to other children with Down syndrome and the Joseph Rowntree Foundation agreed to fund our work for a further year, with the condition that we make a video and begin to disseminate our work to teachers and parents, which we did. [3,4]

Insights gained from our first study

Reading progress and reading strategies

In the 1980 research project, we recorded the children's progress with their reading and while initially we were most surprised by the speed and accuracy of their performance (as clearly illustrated on the video record of Joanna mentioned above), we were even more surprised by some of the errors we began to see.

We expected the children to make visual errors i.e. to confuse words which look similar such as *hair* and *rain* or *this* and *shoe*. These are the sorts of errors seen in the early performance of all

beginning readers taught in this "look and say" way and we found them in our children's performance.

We did not anticipate the other consistent type of error that we observed when the children were reading single words, the semantic error. Here the word the child says has the same meaning as the one they are looking at but has no visual similarity. For example, the child looks at the printed word *shut* and says *closed* or looks at *harbour* and says *ship*. These semantic errors excited us at the time for two reasons.

Firstly, they suggested that the children were definitely decoding the print for meaning and not just "barking at print" in a meaningless way as some of our critics were suggesting. They were reading single words on flashcards so had no available clues to meaning such as might be provided by pictures or the rest of a sentence. They must have decoded the printed word for meaning and then thought of word which was linked by meaning to the target word on the card.

Secondly, the errors demonstrated that the brain could go straight from print to meaning, without changing the visual image of the word to its spoken form first and then accessing the meaning. In 1982, reading theorists were still arguing about whether the developing brain could actually do this as semantic errors had only been observed in the reading of brain damaged adults described as "deep dyslexics". [5,6] Our children were demonstrating that it could and our videotapes caused quite a lot of excitement at the time. The first published examples of non-disabled children producing semantic errors when learning to read were reported in 1986. [7]

Signing

In 1982, signing was just beginning to be introduced to the younger children in special schools in the UK and some of the children we were working with learned sign at school, after we had taught them to read. We noticed two interesting effects of learning sign.

Firstly, that some of our children were able to sign the correct responses to flashcards without any extra teaching. We felt this was another clear illustration that they were not simply "barking at print" but were reading the print for meaning and able to replace the spoken response we had taught them with a sign entirely on their own initiative.

Secondly, that for some of the children signs were an easier and faster response mode than speech. They would look at a flashcard and appear to be concentrating on producing the correct spoken response, meanwhile their hands were already making a correct sign. This additional time needed to produce speech suggested to us that the children might have some sort of specific production delay with speech. Even when they knew what they wanted to say, they had difficulty in saying it.

This was one of the fist clues we had to indicate that not all the language delay typical of children with Down syndrome could be blamed on general cognitive delay. In fact the way in which the children substituted similar meaning words and signed when reading encouraged us to feel that they were more intelligent and had more understanding of language that they were being given credit for.

Mime

When we watched the video-tapes on which we recorded the children's reading progress, we noticed that we had captured a number of sequences in which a child was trying to describe an experience or explain something to his mother for which his spoken language skills were inadequate. The child would resort to the combined use of single keywords and mime to try to convey his message. We were convinced again that the children knew what they wanted to say but could not express themselves in speech.

There are a number of possible hypotheses which could be generated to explain these observations. For example, the child may not have mastered enough vocabulary or grammar to be able to construct the sentences that were being implied by the combination of words and gesture. Alternatively, we could postulate that the child was thinking in sentences but could not execute them in speech.

Either way, we were fairly confident, from watching these sequences, that the children's understanding of their world was more advanced than their expressive language development indicated. *What was beginning to emerge was the possibility that the children's language development was being delayed by a series of specific language learning difficulties in addition to the effects of any more general learning difficulties*.

Can reading enhance speech?

Our own observations of our early readers and those of many other parents and teachers [9] who followed our methods suggested that Leslie Duffen's original hypothesis was right and that reading is a "way-in" to their first language for these reading children with Down syndrome. We collected case studies of which those of Daniel, Louise and Alistair are typical.

Daniel's progress recorded by his home-teacher illustrates the effect of the early reading on his speech development. Daniel's first spoken words were *Daddy, teddy* at fourteen months and he was using some fifty single words at two years three months. Daniel was introduced to reading at two years and four months when he had a production vocabulary of about fifty single words. He learned to read ten words in two months and these were chosen to build two word phrases for him to read at two years eight months. These were rapidly transferred to his speech, according to the observations recorded by his mother and his teacher [8]. By two years eleven months Daniel was reading six three-word phrases, which again he rapidly began to use in his speech. At three years four months he could read sixty-six flashcards and many two and three word combinations of these. The next month he was reading simple books and the words 'and' and 'a' appeared in his speech. At three years six months he was reading four word sentences and at three years eight months he could read one hundred and six words and was speaking in six word sentences. Daniel's rapid progress continued and, at eight years of age, his reading age was twelve years four months and spelling age nine years nine months on the school assessment. [10] At nine years and six months of age Daniel wrote this following a school outing:-

"When we arrived at the villa it was more like a swimming pool to me but as I got closer I saw it was a villa. I thought it was very good at first. When we got in there was a wooden building with staff in it and I thought what is this building doing in the middle of the villa. Then next to it was the ruins of a Roman villa.. I wanted to explore so we split up in our groups I was in Mrs Blacks group.

First we worked on the arch way then we moved on to the cellar then my favourite part the dining room. Then we met Stephen he was just about to go upstairs then Mrs Gilbert said if I was afraid of heights then Katie and Hannah could go upstairs with them. I did a wonderful picture of a Roman farm. Then we had lunch and then me and Stephen went to choose a postcard but it was to busy and Stephen had to go and finish his pictures. I bought a postcard of a Roman Castle I loved it very much so I paid for it. Then it was time to go back to school The other coach went off without us but we followed it and got back to school and we found a short cut."

Daniel finds handwriting difficult and is still printing. He prefers to use a word-processor for writing and wrote the above story on his computer. He reads punctuation correctly but leaves much of it out when writing. He is being educated in a mainstream school and is average in his class for all subjects. His mastery of grammar exceeds that predicted to be achievable by persons with Down syndrome even in 1990. [11]

Louise was introduced to reading at three years two months when she learned to read her family names, 'Mummy', 'Daddy', 'Stephen' and 'Louise' by playing matching games. Two months later, she learned 'car', 'book', 'shoe', 'teddy', 'ball' and 'dolly'. At three years seven months 'walking', 'sleeping' and 'drinking' were added and she read two word phrases such as 'Louise walking', 'Mummy sleeping'. Louise's mother and speech and language therapist worked together, making simple books and a dictionary of pictures into which Louise had to slot the words into the right pages. At four years four months she could read thirty-five single words on flashcards and some two word sentences. She could also pick out known words in storybooks. Two months later, she could read more than sixty words and short phrases, in games, in fill sentences and in books. She was also able to memorise and say whole sentences that she had previously read. At eight years eight months Louise had a reading accuracy age of seven years four months and reading comprehension age of six years eight months on the Neale Reading Test. She was progressing well with both reading and writing, forming capitals as well as lower case letters in joined handwriting.

Alistair learned to read ill the same way as Daniel and Louise. At ten years eight months he had a reading accuracy age of seven years eleven months and comprehension age of six years nine months on the Neale. At nine years he wrote the following in cursive script:-

Christmas story I am the shepherd

one very cold night I was looking after my sheep. My friends told me about a special baby that had just been born. Some of the shepherds were fast asleep. I woke them up and told them about the baby. A angel said you must go to Bethlehem and find the baby. He will be wrapped in a warm cloth and lying in a manger. I found the baby Jesus and it made me feel very happy. [10]

While case studies such as these are valuable, they do not provide definitive evidence of the effect of reading on speech development as these children are at a stage when improvement in speech and language would be expected and, perhaps these particular children were going to be the "brighter" ones anyway. In the mid-eighties, it was not possible to establish a longitudinal study of a group of children with Down syndrome large enough to represent the typical range of learning difficulty, in order to study the effect of literacy teaching, as most of the special schools that the children went to did not teach them to read. We had to wait until 1993 to

set up such a study [11], and I will describe that study later. Meanwhile, we tried other ways of collecting the evidence.

In 1984, I took our tapes of Joanna and her friends to Professor Max Coltheart at Birkbeck College in the University of London as he was an expert on reading at the time and he suggested that we would have really convincing evidence that spoken language could be taught through reading if we could teach grammar to teenagers with Down syndrome who at that time were considered to have passed the critical period for grammar learning. So, I set up such a study in 1985. [13]

Teaching grammar to teenagers

The study was designed to improve the comprehension and production of grammar for a group of twelve teenagers. Teaching which used print to support the learning was more effective over six different sentence structures than speech and picture only teaching. All the teenagers did better in the reading condition, but there were large individual differences. The teenagers who gained the most were those with little or no reading ability at the start of the study and considered to be the "least able" by the schools. At the end of the training year, the teenagers demonstrated a significant gain in comprehension of grammar compared to a previous baseline year of no intervention beyond ordinary school practice and a significant increase in the length of the utterances that they used in everyday conversation. Individual differences in the size of the gains were linked to differences in auditory short term memory function and in speech production difficulties. [12,13]

As I was teaching the teenagers, I realised that some had such limited auditory short-term memory spans that they could not copy a six or seven word sentence if they only heard it spoken, even though they could produce the "keyword" version of tile sentence from a picture prompt without a model. For example one teenager, Rebecca, could look at the picture of a boy sitting on a chair and say "He sit chair", but she could not repeat "He is sitting on the chair" immediately after I had said it while we still looked at the picture. She, like several other teenagers in the group had digit spans of only two (digit span is the measure of how many digits a person can recall immediately after hearing them spoken at the rate of one per minute.) [14] Rebecca was fifteen years old and a non-disabled teenager of her age would have a digit-span. of six to seven digits. My group of teenagers with Down syndrome had spans of two to four digits. Work published by Charles Hulme and Susie Mackenzie of York University in 1987 confirmed that the auditory short-term memory spans of my teenagers were typical of teenager's with Down syndrome. [15]

My training study had demonstrated that reading could be used to teach grammar and improve the conversational skills of teenagers with Down syndrome. It has also drawn our attention to poor auditory short-term memory as another possible reason for their difficulty with learning grammar in the way most children do, that is by simply listening to the language around them.

Memory studies

1n 1990, with one of our colleagues in the Psychology Department, Dr. John McDonald, we set up a memory training study with a graduate student, Irene Broadley, and investigated the effectiveness of two types of memory training programmes [17,18]. Both programmes proved effective in increasing the children's short-term memory spans and the gains were sustained

for the first year after training when compared with an untrained control group but did not last over a three year period for all the children [19]. In addition, the children who had increased their memory spans also showed a significant gain in their understanding of grammar, supporting our view that limited memory span would restrict access to grammar. However, we could not be certain that the language gains were due only to the memory gains as those who had made most progress were in mainstream schools and learning to read.

When Dr. Glynis Laws assessed a subset of fourteen children from this study in 1995, she found that we had some longitudinal evidence of the beneficial effect of reading on the children's cognitive development. Those children who had learned to read since they were first assessed for the memory study in 1991 had significantly better language and memory scores in 1995 than those who had not learned to read, even though there had been no significant differences between the groups on these measures in 199l. Unfortunately, Glynis noted that all but one of the readers were in main stream schools, while the non-readers were in special schools so the positive effect of being in a more normal language environment in the mainstream schools could not be ruled out. She then looked at the cognitive scores of readers and non-readers in the special schools at the start of the study in 1991 and the readers had exactly the same advantage on their language and memory measures, despite being in poor language environments, so it looks as though reading is the important variable in the longitudinal study [20]. The results of a longitudinal study of mainstreamed children which we set up in 1993 with another graduate student, Angela Byrne, will give us better data on this issue.

Current studies

Angela is following the progress of twenty-four children with Down syndrome and comparing their progress with a group of their mainstream classmates who are matched with them on reading age, as well as classmates who are average readers for their age. Since 1990, the majority of children with Down syndrome in our local area have been able to attend their local mainstream schools with special needs support so we are now able to study representative groups of children all in the same social environment. This mainstreaming programme has been largely due to the work of my colleague Gillian Bird [1O]. Gillian has been working with me since 1983, contributing to the research programme and providing the professional support to the schools. Without her practical work in the schools and with parents, we would not have this group of readers with Down syndrome to study.

Angela's study is charting the reading, writing and spelling progress of all the children, looking at the cognitive strategies they are using to read and the links between reading, language and memory skills. The children's ages ranged from five to twelve years at the start of the data collection in 1994. All the children with Down syndrome are learning to read and their reading ages ranged from five years to eight years five months. The typically developing children identified by their teachers as average readers for their age demonstrate age- appropriate cognitive profiles over all the measures, whereas the slower readers for their age in the same classes turn out to be significantly delayed relative to the average readers on all these measures. The children with Down syndrome, while matched with the slower readers on the reading measures, are significantly behind them on the number, language

and memory measures. In other words, the children with Down syndrome show advanced reading ability compared to all their other cognitive skills at this time.

One year later, the children with Down syndrome do not differ significantly from the slow readers in reading progress, in other words both groups have made similar progress. However, Angela has been assessing their reading strategies. Research on children's reading development which indicates that all children go from a logographic stage (when words are recognised by 'sight' only) to an alphabetic stage (when words can be 'sounded out' letter by letter) and then to an orthographic stage [12]. At the end of the first year of her study Angela has shown that the children with Down syndrome are not progressing to an alphabetic strategy as fast as the slow readers despite keeping up with them on reading performance. They are still relying on logographic or visual strategies.

To be good at alphabetic or phonological recoding, a child must be able to hear all the sounds in the words and given the hearing loss and auditory processing problems that children with Down syndrome often have [22,23] they are likely to be less able to use this route with ease than their typically developing peers. Our case studies to date suggest that despite these very real additional difficulties experienced by the child with Down syndrome compared to typically developing children, they do slowly progress to being able to use phonological recoding for reading and spelling. Research on the links between typically developing children's reading progress and other aspects of cognitive development suggest reciprocal interactions. The more language knowledge and the better the phonological awareness and working memory skills children bring to the task of reading, the faster they will learn to read in the first year of reading instruction. In the second year, reading success appears to develop working memory and phonological awareness skills. [25] Being able to read opens up access to knowledge and the biggest vocabulary explosion for children is between the ages of about seven and sixteen, when children are typically learning on average three thousand words every year. [26] Reading and writing also teach children correct grammar. [27] So, the benefits of reading that we are seeing for our children with Down Syndrome are those that would be predicted from research with non-disabled children.

Children with other disabilities

We believe that other children with language learning difficulties might also benefit from reading instruction in the way we have demonstrated for children with Down syndrome. With another graduate student, Michele Appleton, we have begun to study the influence of early reading on the progress of deaf pre-school children, comparing their progress with twenty children with Down syndrome and twenty non-disabled children. After one year, the children with Down syndrome and the non-disabled children are progressing at the same rate, some children in each group have established sight vocabularies of sixty to seventy words and some only a few words, with no significant differences between them. However the deaf children are finding the task more difficult, with little success so far, though we would not wish to draw any conclusions as to the reasons for this at present. It is well-known that severely and profoundly deaf children have great difficulty with literacy and that less than half leave school able to read, so that this is an important area for future research. [28,29,30]

We plan to extend our work to autistic children in the next year, as studies in America suggest that they also can be taught language

through reading but that they learn language differently from most children, by learning language in chunks via echolalia, and make more and different use of visual imagery. [31,32]

In conclusion

We now know that the speech and language delay of children with Down syndrome is not just due to some global mental impairment as was assumed in 1980. Put another way, it was thought that their language reflected their ability to understand the world and that little improvement could be expected as their ability was fixed by their genes [1]. We would argue that the reverse is true; that children's understanding of the world is heavily dependent on their ability to learn their native language. Every word a child learns draws his or her attention to some aspect of the world or the people in it. The size of a child's vocabulary reflects the extent of their knowledge and in addition, language becomes a tool for thinking, reasoning and remembering. Any child with a language delay will therefore be at risk for delay in all areas of cognitive or mental development.

I would like to end with a parent's view as this is how the whole project began.

"I started to teach Emma to read after hearing you talk in Bristol seven years ago. She was then two years and four months of age. Emma is now nine years old and an able and avid reader. She attends our large local mainstream primary school and holds her own well in the second year junior class. She seems to develop in leaps and bounds. Being able to read has done so much for her. [33]

It helped her speech. For example when she began to read at age two, she spoke understandably but imperfectly as she left out the definite and indefinite articles, prepositions etc. The change came when she was able to sentence build in flashcards. Today her speech is mature and her teacher commented at the last parents evening that the extent of her vocabulary and her turn of phrase would leave many in the class standing.

It helped in the way other children regarded Emma and not least her own self-esteem. They knew and she knew that in reading she was amongst the best in the class. This apparently less able child wasn't so less able after all!

Emma is now an independent reader and books give her so much. She wakes early and reads for at least one hour every morning. She makes her own choice of book but everything she reads fulfils her - she chuckles when reading 'The Twits' and cries over 'Heidi'. These are her two favourite books at the moment and she reads them over and over again. Equally however she will read poems and her atlas, history book, nature book etc. from which she teaches herself. She loves her Bible. She is very proud when her five year old sister carries the newspaper to her and asks "What time is ..... on the television?" She is always able to tell her and I feel Sarah, who I feel senses rather then knows Emma's differences, is thrilled with the sense of her big sister having the 'big sister' image for once."

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