# Short-term memory deficits and Down's syndrome: A comparative study


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**This study provides an evaluation of the short-term memory performance of children with Down's syndrome (DS) and children with intellectual disability of other etiologies (ID/OE) on the Stanford-Binet 4th Edition (SB4). Results revealed a significant difference between the two groups for short term memory scores on the SB4, indicating that on short-term memory tasks children with Down's syndrome function at a significantly lower level, than a group of intellectually disabled peers with other etiologies. Differences between visual and auditory short-term memory sub-scores for the two groups also were identified, with significantly lower scores for auditory short-term memory for the group with Down's syndrome. Finally it was established that while the SB4 appears to be a suitable instrument for the identification of intellectual disability, the test is limited in its range of short-term memory subtests for young children with Down's syndrome.**



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## Young children with Down's syndrome

Intellectual disability has traditionally been used as the generic term for intellectual functioning one or more standard deviations below the mean for the general population, when measured on a standardised intelligence scale (and supported by evidence of deficits in adaptive functioning). Researchers and professionals working with persons with intellectual disabilities frequently have acted as if they had a single disorder, with similar cognitive functioning for all persons identified as having an intellectual disability (Detterman, 1987). Studies seeking specific knowledge of this population have tended to use groups of non-disabled individuals as their comparison samples (McDade and Adler, 1980; Marcell and Armstrong, 1982; Stratford and Metcalf, 1982). This practice is, however, problematic. Children without intellectual disability may have distinctly different family, social and educational experiences than children with intellectual disability, and these differences in experience may be reflected in the children's intellectual functioning.

Many studies of persons with Down's syndrome have compared them with children in the general population (McDade and Adler, 1980; Marcell and Armstrong, 1982). It is suggested that the choice of a comparison group of children with intellectual disabilities of other etiologies appears more appropriate, as individuals within this group are more likely to have similar background experiences, and therefore represent a more appropriate comparison group. Burack, Hodapp and Zigler, (1988) argue strongly for differentiating individuals with intellectual disability by etiology. They suggest that to ignore etiological factors will adversely affect research, by not fully acknowledging the diversity of individuals with intellectual disability. Burack et al. suggest that:

> *there are over 200 identified etiologies of organic intellectual disability and it would be simplistic to believe that the differences between them are insignificant (p.766).*

Information processing and memory differences across groups of persons with intellectual disabilities represent an important area for investigation. It is characteristic of persons with intellectual disabilities to have deficits in information processing, particularly in the area of short-term memory (Bilovsky and Share, 1965; Das, 1985; McDade and Adler, 1980, Marcell and Armstrong, 1982; Stratford 1985; Varnhagen, Das and Varnhagen, 1987). These studies indicate that persons with Down's syndrome experience particular problems in auditory and visual processing and memory. Studies of short-term memory have established that, when compared with children without intellectual disabilities, children with intellectual disabilities, particularly those who have Down's syndrome, perform marginally better in the visual than in the auditory mode of learning (Buckley, 1985; Varnhagen, Das and Varnhagen, 1987; Marcell, 1987; Marcell and Weeks, 1988).

The identification of a short-term memory deficit in children with Down's syndrome is dependent on the availability of suitable assessment instrument capable of discerning the short-term memory functioning for this group. The Stanford-Binet Intelligence Scale 4th Edition (SB4) enables assessment of short-term memory functioning in the auditory and visual modes (Thorndike, Sattler and Hagen, 1986). It provides a range of scores, from composite (IQ) to area standard

age scores (SAS) and subtest scores. The short-term memory area score is derived from four sub-test scores, of which two (digit recall and memory for sentences) assess auditory memory functioning, and two (bead memory and memory for objects) assess visual memory functioning. In theory, this facility makes the test particularly appropriate for use with persons with intellectual disability. The SB4 also has a suitably low entry age of 2 years. In sum these factors appear to make the SB4 a useful instrument for examining possible differences among sub-groups of children with intellectual disabilities.

The validity of the SB4 for use with children and adolescents with intellectual disability is reported in a number of small sample studies (Bower, 1993; Bower and Hayes, 1993 (in press); Lukens, 1988). These studies have concluded that a reasonable level of internal validity exists between global, area standard age and subtest scores.

## Method

The participants in this study were children with intellectual disability. 13 children had Down's syndrome (DS) and 13 children were non-Down's syndrome intellectually disabled (ID/OE), without specific etiologies. The two groups were matched on the following variables: chronological age, IQ, gender and socio-economic status. The sample of 26 intellectually disabled children was representative of the intellectually disabled population between 5 and 18 years in the geographic area in which it was conducted, and represented 24.5% of the total population of intellectually disabled students in an urban school district in North Queensland, Australia (N=106). All participants had been previously tested, and their intellectual ability level was obtained from existing school guidance records. The mean IQ value was 44.33 (SD=5.64) for the DS group and 48.25 (SD=8.84) for the ID/OE group. The mean MA in months was 55.15 (SD=14.00) for the DS group and 63.07 (SD=14.67) for the ID/OE group. There was no significant difference in IQ level between the two groups.

## Procedures

Administration of the SB-4 was according to the guidelines recommended by Delaney and Hopkins (1987) for the testing of special populations. Entry levels for subtests were determined by using an estimated functional level, rather than the chronological age. The reason for choosing specific entry levels for individual participants was to eliminate boredom, frustration or anxiety, by requiring the child to complete tasks either too easy or too difficult, and therefore reducing the motivation level of the participant. Each individual's functioning level was therefore carefully considered. This was particularly the case for adolescent participants who had functional mental ages between 5 and 6 years, but chronological ages of 14 to 15 years.

The minimum number of subtests administered was 5, for ages 5 years to 6 years 10 months, and the maximum number was 11 for ages 7 years 4 months to 15 years 11 months. For the two youngest children in the study only 5 subtests were administered because of their low developmental level. For 23 of the remaining 24 children the 6 subtests which are recommended in the SB4 Technical Manual as "general purpose battery" were administered. These are vocabulary, comprehension, pattern analysis, quantitative, bead memory and memory for sentences. One child received only five subtests because she did not respond to the quantitative subtest. Depending on the participants' age and individual ability level, from one to five additional subtests were administered.

## Results

This study explored the usefulness of this instrument for the investigation of differences between two intellectually disabled groups (DS and ID/OE), with a specific focus on short-term memory ability. The results were collated and analysed using the SPSS-X Statistical Analysis Package (SPSS Inc. 1986). Means, standard deviations and t-tests were calculated for differences between the DS and IE/OE groups, on area standard age scores (Area SAS) and 4 short-term memory (STM) subtest scores.

Results from the SB4 scores indicate that children and adolescents with intellectual disabilities obtain lower scores for short-term memory area standard age scores (STM Area SAS) when compared with Verbal, Abstract/Visual and Quantitative Area SAS's. These preliminary findings suggest that this instrument usefully identifies short-term memory functioning as a particular area of deficit for children and adolescents with intellectual disabilities.

The results further suggest that within the intellectually disabled population the test can differentiate between the performance of children with Down's syndrome and children with intellectual disabilities of other etiology in the area of short-term memory functioning. While the ID/OE group scored consistently higher on all 4 STM subtests than did the DS group, significant differences were obtained for two auditory STM subtests, memory for sentences ($t$= -2.96 p.<.05) and memory for digits ($t$= -3.44 p.<.01)

The analysis of STM subtests administered to participants in this study reveals no significant differences between mean scores of the visual and auditory STM subtests of the SB4. It is suggested, however, that the limited number of participants who responded to the subtests memory for digits (N-8) and memory for objects (N=9) may have contributed to the non-significance of these results.

## Discussion

The overall results of this study clearly support the previously reported finding that individuals with Down's syndrome have a specific deficit in the area of short-term memory functioning (Bilovsky and Share, 1965; Das, 1985; Lukens, 1988; Marcell and Armstrong, 1982; McDade and Adler, 1980; Stratford, 1985). The SB4 appears to have the capacity to identify the short-term memory deficit for all children with intellectual disabilities, as well as to differentiate between different subgroups of children and adolescents with intellectual disability. A relatively small number of studies (Marcell, 1987; Marcell and Weeks, 1988; Marcell, Croen, and Sewell, 1990; Stratford and Metcalf, 1982; Varnhagen, Das and Varnhagen, 1987;) have examined performance differences between two groups of intellectually disabled children and adolescents, Down's syndrome and those who have intellectual disabilities of other etiologies.

Our findings suggest that, not only do test results from the SB4 confirm these differences between the two groups for intellectual functioning across all area SAS's, but more importantly the results of this study indicate that the SB4 has

*Table 1. Means (M) Standard Deviations (SD) and t-test Results for Area SAS and STM Subtest Scores on the SB-4 for all Participants and DS and ID/OE*

| SB-4 | Whole Group N = 26 | | DS N = 13 | | ID/OE N = 13 | | |
|---|---|---|---|---|---|---|---|
| | M | SD | M | SD | M | SD | t |
| AREAS SAS | | | | | | | |
| Verbal Reasoning | 57.59 | 9.82 | 56.69 | 6.26 | 58.69 | 12.95 | -0.50 |
| Abstract Visual Reasoning | 52.53 | 9.86 | 51.92 | 9.26 | 53.15 | 11.14 | -0.31 |
| Quantitative Reasoning | 54.95 | 10.54 | 51.81 | 9.61 | 57.83 | 11.39 | -1.36 |
| Short-term Memory | 46.24 | 10.01 | 40.91 | 7.32 | 51.15 | 10.25 | -2.85** |
| STM Subtest | | | | | | | |
| Bead Memory | 25.54 | 6.16 | 23.25 | 5.97 | 27.83 | 5.98 | -1.88 |
| Memory for Sentences | 26.16 | 5.25 | 23.33 | 2.99 | 28.26 | 5.83 | -2.96* |
| Memory for Digits | 31.37 | 3.93 | 27.66 | 0.57 | 33.60 | 3.78 | -3.44** |
| Memory for Objects | 36.33 | 4.32 | 35.00 | 0.00 | 37.00 | 5.65 | -0.59 |

* $p<.05$
** $p<.01$

value in the identification of short-term memory problems in children with intellectual disability.

The SB4 assesses both, auditory and visual short-term memory, each with two subtests. The division of the short-term memory area scores into auditory - and visual short-term memory scores is of specific use for the two groups of intellectually disabled children and adolescents discussed in this study. While this is a definite strength of the SB4, the four short-term memory subtests, however, require different test entry ages, and two subtests, memory for digits and memory for objects are of limited use for most young children with intellectual disabilities. Only the subtests bead memory and memory for sentences can be used with confidence for most intellectually disabled children and adolescents.

In considering the well documented difficulties persons with intellectual disability experience with short-term memory functioning, and the long standing reputation the Stanford-Binet Scale has earned for use with this population, it is regrettable that the instrument does not provide for a wider application of its short-term memory subtests. In summary it may be stated that the SB4 is a useful, but not flawless instrument for use with this population.

The preliminary findings of this study add further evidence that persons with Down's syndrome experience specific problems in the area of auditory short-term memory and are therefore among the most language handicapped of the intellectually disabled population (Marcell and Armstrong, 1982; Marcell, 1987; Marcell and Weeks, 1988; Marcell, Croen and Sewell, 1990; Varnhagen and Varnhagen, 1987). It is not surprising that the widely accepted practice has arisen of utilising the visual short-term memory skills in the teaching of reading of children and adolescents with Down syndrome (Buckley, 1985; Buckley, Emslie, Haslegrave and Le Prevost,1986; Duffen, 1974; 1976; 1979). The findings of this study however, do not explore the association between intellectual and organic auditory impairment of persons with Down syndrome, and further research examining the relationship between auditory short-term memory deficit and physical causes of auditory problems is suggested.

This study has some practical implications for children, adolescents and adults with Down's syndrome and has emphasised that children with Down's syndrome have educational needs related to their specific difficulties they experience in the area of short-term memory processing, and consequently in receptive and expressive language development. These findings are of importance for parents, educators, therapists and researchers who are concerned with the life-long development of persons with Down's syndrome.

In the past researchers have identified specific short-term memory deficits such as lexical storage and retrieval (Marcell and Armstrong, 1982), auditory sequential processing (Snart, O'Grady and Das, 1982) and the articulatory loop (Varnhagen, Das and Varnhagen, 1987), which is instrumental in the short-term maintenance of phonological information during memory access and processing (p. 403). The next logical step for research is to determine effective modes of intervention in these areas of short-term memory functioning, in an attempt to assist people with Down's syndrome in their language development throughout the lifespan.

While the limitations of this study are acknowledged, particularly related to the small sample size of the two groups, our results clearly lend further support to the previous finding that there are specific differences between DS and ID/OE children and adolescents' short-term memory ability (Varnhagen, Das and Varnhagen, 1987). Further studies using the SB4

with a larger sample of DS and ID/OE participants with a mental age of 4-5 years are indicated in order to obtain more reliable results for the short-term memory subtests. Given a larger sample, the differences between visual and auditory short-term memory scores for the DS and ID/OE groups should emerge, allowing for more in-depth analysis of these areas of functioning of two separate groups within the intellectually disabled population. The SB4 however, is used essentially as an instrument for the identification of intellectual ability, and test results in the area of short-term memory processing should be used as initial indicators for further, more in depth, investigation of individual performance in this specific area of intellectual functioning.

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