

Working Memory in Individuals With Down Syndrome: A Treatment Case Study

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Abstract

The great majority of people with Down Syndrome (DS) tend to be more limited in their short term memory (STM) and working memory (WM) abilities than other people. Moreover, research has found that individuals with DS experience relatively more difficulty storing and retrieving verbal information than they do with storing and retrieving visual information. Previous studies focusing on the enhancement of memory skills in DS generally used a rehearsal training strategy to investigate the possibility of increasing verbal memory span durably (Comblain, 1999; Conners, 2008). Therefore, these studies focused on the enhancement of short-term memory skills. The aim of our study was to evaluate the impact of a school-based visuo-spatial working memory training on the short-term memory and working memory skills a teenage child (A.S.) with Down's syndrome. The results showed that A.S. improved his WM and STM performance in the trained and non-trained working memory tasks proposed. These results suggest that school-based visuo-spatial memory training in a school setting could be both feasible and effective for individuals with DS.

Keywords: Down Syndrome; working memory; training.

Introduction

Working memory refers to a mental workspace, which enables a person to hold information in mind while simultaneously performing other complex cognitive tasks (Holmes & Adams, 2006). Different studies demonstrated the close link between WM abilities and a broad range of learning achievement (e.g. Alloway & Alloway, 2010).

A number of studies have examined WM processes in individuals with Down Syndrome (DS) showing that DS have a deficit in the phonological loop. The current best explanation for the deficit in phonological STM in individuals with Down Syndrome is that they have a problem that originates in storage rather than either encoding or rehearsal (Baddeley & Jarrold, 2007). In contrast, visuo-spatial skills seem to be relatively preserved (Jarrold & Baddeley 1997). Compared to TD children of the same mental age, they obtain largely equivalent scores. Talking about the central executive it seems that children with Down syndrome have difficulties with executive load WM on both verbal and visuo-spatial measures, compared to mental age matched TD children (Lanfranchi, Baddeley, Gathercole, & Vianello, 2012).

Given that the working memory system is important for spoken language learning, intervention studies designed to target the memory difficulties associated with Down Syndrome typically focus on improving verbal memory skills by training children to use rehearsal strategies. Groups

with Down syndrome have been shown to benefit from training of an overt cumulative rehearsal strategy, in which participants are required to rehearse aloud increasing amounts of material in the course of a short-term memory task (Broadley & MacDonald, 1993; Comblain, 1994; Laws, McDonald, & Buckley, 1996). Some of the studies dealing with rehearsal training used picture supports (children used visual processing to aid their memory span) and found significant improvements for visual span measures but mixed outcomes for auditory span measures (Broadley and Mac Donald, 1993; Laws et al., 1996). A third study (Comblain, 1994) phased out picture supports ending in auditory-only training and found a clear improvement in auditory memory span. Differently Conners and colleagues (2008) used a rehearsal training auditory only form beginning to end and the results showed verbal span improvements. To our knowledge, only the study of Bennet and colleagues (2013) investigated the effects of a computerized visuo-spatial WM training in DS children. Results showed improvements on trained and non-trained visuo-spatial short-term memory tasks. This improvement was sustained four months later. The aim of our study was to evaluate the efficacy of a school-based visuo-spatial working memory training on the short-term memory and working memory skills for a teenage child (A.S.) with Down's syndrome. Moreover, the possible transfer effects of the visuo-spatial training procedure on verbal WM and STM has been explored.

Method

Participants and procedure

A.S. is a teenage-boy with DS. At the time of the investigation AS was aged 15 years 11 months. Non verbal mental age assessed using the RCPM was 7 and the BPVS raw score was 96. The TD group was comprised of children selected from a mainstream primary school. To ensure that patterns of relative impairment and advantage were interpreted in relation to normal function, A.S. was matched to the TD group on the basis of non verbal intelligence assessed with Raven's Coloured Progressive Matrices.

All participants were administered pre-treatment assessments in order to evaluate WM and STM abilities. A.S. participated in ten visuo-spatial WM training sessions over a five-week period. Each session lasted approximately 40 minutes, with short breaks within the session. After the training AS was re-tested to examine whether there were training benefits.

Assesments

In order to assess WM and STM abilities we used the WM battery proposed by Lanfranchi and colleagues in 2004 (Lanfranchi, Cornoldi, & Vianello, 2004).

The *pathway recall task* was used to tap children's visuo-spatial STM capacity. In order to assess visuo-spatial WM abilities we used, the *backwards pathway recall task*, the *selective pathways task* and the *visuo-spatial dual task* and we obtained a cumulative visuo-spatial WM score by summing these scores.

The *word recall task* was used to tap children's verbal STM capacity. In order to assess verbal WM abilities we used the *backwards word recall task*, the *selective word recall task* and the *verbal dual task*, and we obtained a cumulative verbal WM score by summing these scores.

Visuo-spatial WM training

The working memory training used in this study included different tasks that were designed to enhance visuo-spatial WM abilities and was implemented for 5 weeks, twice weekly for approximately 40 minutes each. This training included activities that sought to enhance both low-control processes (i.e., passive information storage), using games of forward memory span and games that require the simple recall of paths, and activities that were designed to improve high-control processes (i.e., the ability to manipulate and store information). These activities utilized a dual task and backward recall task. For every session we proposed 2 games: one mainly focused on the enhancement of visuo-spatial STM, one mainly focused on the enhancement of visuo-spatial WM.

Results and Discussion

Performance was analysed using Crawford and Howell's (1998) modified t-test, which is designed for use with single-case studies. Performance prior and after training is reported for A.S., a teenage-boy with DS, in comparison to matched TD controls.

The results of this study showed that the trained participant improved his performance in the trained and non-trained working memory tasks proposed. A.S.'s WM and STM performance was significantly impaired compared to the control TD group prior to training. After the training his performance improved and there was no longer significant difference from the TD group. These results suggest that school-based visuo-spatial memory training in a school setting could be effective for individuals with DS.

Given the importance of WM abilities for the development of a broad range of learning achievement (e.g. Alloway & Alloway, 2010), more research is needed to investigate possible transfer effects of WM training on learning in individuals with DS and to follow up post-intervention to see if benefits of training last. Moreover, future studies should further investigate the effectiveness of such kind of working memory training with group-studies.

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