**Title:** An Examination of the Memory Profile of Children with Down syndrome: Evidence for Impaired Short-Term, Long-Term, And Working Memory Impairments and Relations to Intellectual and Adaptive Functioning

**Authors:** Mary Godfrey¹, Moshe Maiman¹, Taralee Hamner², Manisha Udhnani², Megan Perez³, Rebecca LaQuaglia¹
Nancy Raitano Lee⁴

¹Department of Psychology, Drexel University,
²Department of Public Health Sciences, Drexel University

**Introduction:** Down Syndrome (DS) is associated with global cognitive impairments, deficits in adaptive functioning, and specific explicit memory difficulties that exceed overall cognitive functioning (Carr, 2012; Pennington, Moon, Edgin, Stedron, & Nadel, 2003). We recently completed a systematic review of the literature examining memory across the lifespan (Godfrey & Lee, 2018) and evaluated the degree of impairment reported relative to typically developing, mental age (MA) matched peers in the existing literature by examining effect size data. This review yielded the following: First, large mean effect sizes for long-term memory (LTM, d=.73), short-term memory (STM d=.91) and working memory (WM; d=.81; Godfrey & Lee, 2018) were found across in the literature, documenting significant impairments in these three memory domains relative to mental age expectations. Second, while many studies have examined memory impairments in adults and teens with DS, no study has comprehensively examined LTM, STM, and WM abilities in the same sample of children with DS relative to MA-matched typically developing (TD) control participants. Third, few studies have examined relations between these memory domains and the core features of intellectual disability – namely intellectual and adaptive functioning. Consequently, the current study sought to investigate the memory profile of children with DS between the ages of 6 and 17 years by examining (1) STM, LTM and WM in comparison to typically developing (TD) MA-matched peers, and 2) relations between these memory domains and both intellectual and adaptive functioning in children with DS.

**Method:** A total of 26 children with DS (age M=11.16, SD=3.5, Range=6.00-17.17; MA=5.08, SD=1.07) participated in the current study. To compare performance of the DS group to TD children, a subgroup of 22 children with DS (age M=11.37, SD=3.33) and 15 TD children (age M=5.10, SD=1.33) were matched on MA as estimated by the Kaufman Brief Intelligence Test – Second edition (KBIT-2; Kaufman & Kaufman, 1990). Participants completed the following memory assessments. STM assessments included the Wechsler Digit Span subtest, which requires repeating a series of digits increasing in length, and the Wechsler Spatial Span subtest, which involves tapping a series of locations on a grid which increase in length (Wechsler, et al., 2004). LTM tasks included the NEPSY-II Memory for Names task, which requires children to learn a series of names associated with pictures and recall these names after a delay (Korkman, Kirk, & Kemp, 2007), and a Paired Associates Learning Task (Morton-Evans & Hensley, 1978), which requires children to learn six pairs of unrelated objects and recall these pairs after a delay. WM was assessed using the Missing Scan Task (Roman, Pisoni, & Kronenberger, 2014) which requires children to recall a missing toy animal from a series of previously presented toy animals that are briefly hidden from view. Adaptive functioning was measured using the composite score of the Vineland Adaptive Behavior Scales – Second Edition (VABS-II; Sparrow, Cicchetti, & Balla, 2005) Caregiver Report Form.

**Result:** To evaluate the DS group’s memory profile, a 2x3 mixed measures ANOVA was completed, with one between-subjects factor (group) and one within-subject factor (memory domain: STM, LTM, and WM). A significant main effect for group was found (F(1,28)=4.56, p<.05), such that the DS group (M=.01, SD=.93) performed significantly worse than the MA-matched TD group (M=.35, SD=.75) overall. However, there was no group by memory domain interaction, suggesting similar levels of impairment across the three memory domains under investigation.

To evaluate relations among memory scores and intellectual functioning, a multiple linear regression was conducted with STM, LTM, WM scores as the independent variables and the IQ composite score on the KBIT as the dependent variable. The overall model was significant (R²=.55, p<.01). However, an evaluation of the individual memory domains revealed that only the STM domain (b=.06, S.E.=.02, t(21) = 2.59, p<.05) was significantly associated with IQ scores; LTM and WM were not. A second multiple linear regression was completed to examine whether each memory domain was associated with VABS-II scores. Again, the model was significant (R²=.34, p<.05). Similar to the findings for IQ, STM (b=39.56, S.E.=15.36, t(19) = 2.58, p<.05) was significantly associated with the VABS-II scores, but LTM and WM were not.

**Discussion:** The current study provides a comprehensive analysis of the memory profile of children with DS in comparison to their TD peers, including examining associations between memory and other aspects of functioning. The results indicated that all three domains of memory were impaired relative to MA expectations without evidence for a particular memory domain being more impaired than others. Additionally, our results revealed that STM was associated with IQ and adaptive functioning. These findings highlight the significance of STM impairments in DS, as STM relates to both daily living skills and overall cognitive
functioning. Moreover, research suggests that STM impairments in DS are evident from early in development (Naess, Lervag, Lyster, & Hulme, 2015). Consequently, STM interventions, such as memory training and pharmaceutical trials, should begin in early childhood for this population. Furthermore, future research should longitudinally examine whether STM is predictive of IQ or adaptive functioning, as improvements in STM through intervention could possibly improve intellectual functioning and daily living skills as well.

References/Citations: