Title: Mathematical Abilities of 9-Year-Old Children with Williams Syndrome

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Introduction: Little is known about the mathematical abilities of children with Williams syndrome (WS). It has been suggested that people with WS have particular difficulty with math and that their math abilities are more limited than their reading abilities (Howlin et al., 1998; Pagon et al., 1987). Results from these studies are difficult to interpret because age equivalent or grade equivalent scores were reported rather than standard scores (SSs). In addition, sample sizes were relatively small and the age ranges were very broad. The aim of the present study was to investigate the profile of mathematics achievement and the predictors of mathematical abilities in a relatively large sample of children with WS in a very narrow age range.

Method: Participants were 63 9-year-olds (M = 9.34, SD = .27, range: 9.01 – 9.89; 31 girls) with genetically-confirmed classic-length WS deletions. The children completed the Verbal, Nonverbal Reasoning (NVR), Spatial, and Working Memory (WM) clusters of the Differential Ability Scales-II (DAS-II; Elliott, 2007). They also completed the Wechsler Individual Achievement Test-III (WIAT-III; Wechsler, 2009) Numerical Operations (measuring written math calculation skills) and Math Problem Solving (measuring time, money, sequencing, graph interpretation, and word problem solution abilities) subtests. The Mathematics Composite also was computed. For the general population, all measures have a mean SS of 100 (SD = 15).

Results: Mean SS was 64.38 (SD = 15.64, range: 40 – 107) for Numerical Operations, 57.44 (SD = 14.05, range: 40 – 96) for Math Problem Solving, and 60.76 (SD = 13.82, range: 40 – 102) for Mathematics Composite. Numerical Operations SS was significantly higher than Math Problem Solving SS (p < .001). At the individual level a 12-point difference in SSs is considered significant. Fifty-one of the 63 children earned a high enough SS to allow for comparisons to be made between subtests. Of these children, 16 (31%) earned a significantly higher SS on Numerical Operations than on Math Problem Solving, one (2%) earned a significantly higher SS on Math Problem Solving, and 34 (67%) did not evidence a significant difference between subtest SSs.

All correlations between DAS-II cluster SSs and WIAT-III math SSs were significant (r ranging from .49 – .77, ps < .01). To determine the predictors of these measures of math abilities, three multiple regression analyses were performed. Predictors were DAS-II Verbal SS, NVR SS, Spatial SS, and WM SS. The models explained a large amount of the variance for all three measures: Numerical Operations SS, R² = .66, F (4, 58) = 27.89, p < .001; Math Problem Solving SS, R² = .75, F (4, 58) = 43.62, p < .001; and Mathematics Composite SS, R² = .77, F (4, 58) = 48.24, p < .001. For each of the three models, NVR SS (p ≤ .021) and WM SS (p < .001) were the significant predictors.

In order to compare mathematical abilities to reading abilities, paired t-tests were performed. Mean SS was 73.29 (SD = 12.36) for the WIAT-III Basic Reading composite (Word Reading and Pseudoword Decoding subtests) and 68.02 (SD = 17.96) for the Reading Comprehension subtest. Each of the three mathematics SSs was significantly lower than both of the reading SSs (ps ≤ .012). In addition, comparisons between DAS-II GCA (similar to IQ, M = 64.70, SD = 11.45) and the mathematics SSs indicated that both Math Problem Solving SS (p < .001) and Mathematics Composite (p < .001) were significantly lower than GCA. Numerical Operations SS did not significantly differ from GCA (p = .820). Comparisons with the DAS-II Spatial SS (M = 55.33, SD = 13.62) indicated that Numerical Operations SS (p < .001) and Mathematics Composite (p = .003) were significantly higher than Spatial SS. However, Math Problem Solving SS did not differ significantly from Spatial SS (p = .392).

Discussion: The mathematical abilities of 9-year-old children with WS were highly heterogeneous; performance ranged from very low to average relative to CA-peers, with SDs similar to the general population. A very large proportion of the variance in mathematical abilities was explained by Verbal SS, NVR SS, Spatial SS, and WM SS. The finding that NVR and WM abilities contributed significant amounts of unique variance to individual differences in the mathematical abilities of children with WS parallels previous findings for typically developing children. At the group level, the mathematical abilities of children with WS were significantly weaker than their reading abilities, and calculation skills were significantly stronger than problem solving skills. Theoretical and practical implications will be discussed.

References/Citations: