Title: Executive Functioning and Autism Spectrum Disorder Behaviors in School-Age Children with Down Syndrome

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Introduction: Executive functioning (EF) is an umbrella term to describe self-regulatory cognitive abilities related to working memory, inhibition, planning, and shifting. EF has important implications for adaptive functioning, social interactions, and academics, thus impacting the ability to function in everyday life. Previous research indicates that individuals with Down syndrome (DS) have a unique profile of EF, with relative impairments in working memory, monitoring, planning and organization, and shifting, and relative strengths in emotional control and organization of materials (Loveall et al., 2017; Daunhauer et al., 2014; Lee et al., 2011). An important next step in examining the EF profile in DS is to identify behavioral correlates of EF, such as the presence of autism spectrum disorder (ASD)-like behaviors. About 7-18% of individuals with DS have comorbid ASD (DiGuiseppi et al., 2010), and increased ASD-like behaviors have been noted in youth with DS compared to the general population (Channell et al., 2015). The presence of ASD behaviors impacts adaptive functioning (Channell et al., under review) and may also impact EF, leading to more impairments in these skills (Happé et al., 2006). In the present study, we explore the associations of EF across the two core domains of ASD behaviors (social communication and interaction; restricted interests and repetitive behaviors). Understanding the nature of the relationship between EF and ASD-related behaviors in DS has important implications for treatment and intervention for this population.

Method: Participants were 39 children with DS, ages 6 to 11 years (M = 8.48, SD = 1.59; 66.7% female). Parents completed the Social Communication Questionnaire–Lifetime (Rutter et al., 2003) as an exclusionary criterion for the larger study. Five children (12.5%) screened above the SCQ cutoff score (>15) for ASD risk but were included in our sample to examine the full range of ASD-related behaviors in DS as they relate to EF. As part of a larger battery, parents also completed the Behavior Rating Inventory of Executive Function, 2nd edition (BRIEF-2; Gioia, Isquith, Guy, & Kenworthy, 2015) and the Social Responsiveness Scale, 2nd edition (SRS-2; Constantino & Gruber, 2012). The BRIEF-2 has the following domains: Behavior Regulation Index (BRI), which includes the subscales Inhibit and Self-Monitor, Emotion Regulation Index (ERI), which includes the subscales Shift and Emotional Control, and Cognitive Regulation Index (CRI), which includes the subscales Initiate, Working Memory, Plan/Organize, Task-Monitor and Organization of Materials. The BRIEF-2 also yields a Global Executive Composite (GEC) of overall EF. The GEC and all indexes yield standard scores normed for age and sex, with higher scores indicating more impaired EF. The SRS-2 yields a composite T-score (standard score normed for age and sex) that includes two domains: Social Communication and Interaction (sub scales of Social Awareness, Social Cognition, Social Communication, and Social Motivation) and Restricted Interests and Repetitive Behavior (RRB). Higher scores indicate more ASD symptomatology. Child participants were administered the Leiter International Performance Scale, 3rd edition (Leiter-3; Roid & Miller, 2013) to measure nonverbal cognition (Nonverbal IQ: M = 59.23, SD = 9.59, Range = 36-75).

Results: Controlling for nonverbal IQ, Pearson’s r partial correlations were conducted to examine the association between EF and ASD-like behaviors. Overall EF (BRIEF-2 GEC) was significantly associated with SRS-2 Total Scores (r = .37, p = .03) such that children with higher levels of impairment in EF also exhibited higher levels of ASD-like behaviors. Next, we examined the association between the domains of EF from the BRIEF-2 and the domains ASD-like behaviors from the SRS-2. The BRIEF-2 GEC was positively associated with SRS-2 RRB T-scores (r = .46, p = .007). Further, although not statistically significant, a positive trend was observed between the BRIEF-2 GEC and SRS-2 Social Communication & Interaction T-scores (r = .28, p = .09). SRS-2 Total T-scores were significantly positively related to the BRIEF-2 Behavior Regulation Index (r = .42, p = .01) and Emotion Regulation Index (r = .34, p = .04). SRS-2 RRB T-scores were also significantly positively correlated with the BRIEF-2 Behavior Regulation Index (r = .43, p = .01) and Emotion Regulation Index (r = .52, p = .001). Finally, significantly positive correlations were observed between SRS-2 Social Communication & Interaction T-scores and the BRIEF-2 Behavior Regulation Index (r = .36, p = .03).

Discussion: Results indicate that children with DS who have more EF difficulties also have higher levels of ASD-related behaviors. Specifically, children with DS who have more difficulties in EF domains of emotion regulation and behavior regulation present with more ASD-related behaviors overall and within the two core domains (i.e., RRBs; social communication and interaction). Previous research indicates that children with DS tend to have relative strengths in emotion control, but weaknesses in shifting. The Emotion Regulation Index combines both these domains of EF. Thus, the presence of more ASD-related behaviors may lead to more problems with emotional control, specifically, in DS, although additional research is needed to support this hypothesis. Additionally, the presence of ASD-related behavior may lead to more difficulties with behavior regulation, which involves both self-monitoring—a relative weakness—and inhibition. Although the research on inhibition in DS is mixed (some report strengths...
while others weakness; Loveall et al., 2017), inhibition may be more difficult for those with more ASD-related behaviors. Caution should be taken when interpreting these preliminary correlational findings, as they do not indicate directionality or causality. Implications for adaptive functioning, social interactions, and academics will be discussed.

References/Citations: