**Title**: Executive function and literacy skills in early school-aged autistic children with limited spoken language

**Authors**: Yanru Chen1, Shamili Satheesan1, Alyssa Daniels1, Gabriella Russo1, & Helen Tager-Flusberg1

**Introduction**: Executive function refers to a complex set of skills regulating behavioral, emotional, and cognitive processes and responses that are important for achieving goals and solving problems. Previous research has identified executive function to be closely associated with concurrent and longitudinal academic performance, including literacy achievement, in neurotypical children (e.g., Blair & Razza, 2007; McClelland et al., 2007). Within the limited studies on autistic children, emotion control was significantly correlated with literacy learning during preschool (Chen & Jahromi, 2024), and working memory was significantly associated with reading performance between Grades 3 and 8 (Bullen et al., 2022). However, little is known about whether executive function is associated with emergent literacy skills during early school years (K to Grade 3) in autistic children, particularly those with limited spoken language who are more likely to experience learning difficulties. The goal of this study was to examine the concurrent association between executive function and literacy skills, represented by directly measured letter knowledge and parent-reported written communication, in autistic children with limited spoken language and to investigate whether this association was mediated by other empirically selected variables, such as receptive language and levels of autism characteristics.

**Methods**: A total of 52 autistic children with limited spoken language between the ages of 5 and 8 were included in this study (*M*age=7.10, *SD*=1.01). Autism diagnosis was confirmed by meeting the cut-off on the Social Communication Questionnaire (SCQ). All participants had limited spoken language and an expressive language age-equivalent score of 24 months or lower on the Vineland Adaptive Behavior Scale Third Edition (VABS-3). Parents completed the VABS Comprehensive Interview for adaptive behavior, including expressive, receptive, and written communication, the BRIEF-2 for executive function problems in everyday settings, the SCQ for levels of autism characteristics, and a questionnaire regarding their child’s experience of interacting with letters and numbers. Participants’ letter knowledge was probed by an experimental behavioral task administered over Zoom, during which they were asked to touch on the screen the alphabet letter corresponding to the examiner’s verbal prompt between the target letter and a non-targeted letter. A total of four alphabet letters (i.e., B, F, M, T) were tested, with 8 trials for each letter. To control for chance performance, a participant was considered to have acquired knowledge of a letter if they correctly identified it at least 6 out of 8 times.

**Results**: On average, the participants had significantly lower written communication skills (*M*=6.57, *SD*=3.53, ranging from 1 to 14) compared to the norm (v-scale score of 15), as reported by parents on the VABS, *t*(48)=-16.72, *p*<.001. Based on the BRIEF-2, participants’ executive function problems were 1 to 2 standard deviations above the norm across all domains. Specifically, on average, the participants demonstrated mildly elevated difficulties in *Planning*, *Task-Monitor*, and *Organization* (T scores between 60-64), potentially clinically elevated difficulties in *Inhibit*, *Emotion Control*, *Initiate* (T scores between 65-69), and clinically significant difficulties in *Self-Monitor*, *Shift,* and *Working Memory* (T scores above 70).

 Written communication on the VABS was positively correlated with the overall level of executive function on the BRIEF (reversed), *r*(49) =-.29, *p*=.04, particularly two subscales of the Behavioral Regulation Index (reversed), including Inhibit, *r*(49)=-.43, *p*=.002, and Self-Monitor, *r*(49)=-.32, *p*=.027, and two subscales of the Cognitive Regulation Index (reversed), including Task-Monitor, *r*(49)=-.34, *p*=.018, and Organization, *r*(49) =-.35, *p*=.013, but not with any domain in the Emotion Regulation Index. The association between executive function skills and written communication was not mediated by any other study variables.

Written communication was also positively correlated with receptive communication, *r*(49)=.52, *p*<.001, and expressive communication, *r*(49)=.35, *p* =.015, on the VABS, as well as reading frequency reported by parents, *r*(38)=.42, *p*=.009. A mediation model using a bootstrap sample of 5000 showed that receptive communication fully mediated the association between reading frequency and written communication (a-path reading frequency-receptive communication, B=1.15, *p*=.014; b-path receptive communication-written communication, B=.66, *p*=.002; c-path total effect, B=1.35, *p*=.013; c’-path direct effect, B=.59, *p*=.22). Letter knowledge was not associated with any domains of executive function but was positively associated with written communication on the VABS, *r*(36)=.53, *p*=.001, and reading frequency, *r*(29)=.48, *p*=.009.

**Discussion:** This study highlights the important role of behavioral and cognitive aspects of executive function in written communication skills, including pre-reading and emergent reading and writing skills, in autistic children with limited spoken language during early school years. While emotion regulation supports autistic children’s literacy learning in dynamic early childhood classrooms through a stable emotional state that allows for frequent interactions, behavioral (i.e., inhibit and self-monitor) and cognitive (i.e., task-monitor and organization) executive function skills emerge to be more important in response to the higher demands of literacy learning when autistic children enter school. The reading and writing process requires sustained focus, error detection, task planning, and organization, such that executive function skills involved in these behavioral and cognitive regulation processes have a direct impact on written communication (but not on the lower level of recognizing letters). Inhibitory control helps autistic children stay on task despite distractions during reading and writing. Self-monitoring enables autistic children to observe and evaluate their behavior during reading or writing tasks and helps them learn from experience. Task-monitoring helps autistic children avoid careless errors and assess task performance to ensure the attainment of goals, while organization skills help them keep workspace and materials orderly, both of which are important for effective reading and writing.

In addition, we found that reading frequency was related to written communication in autistic children with limited spoken language through receptive communication, the ability to understand and process language. Those who were better at understanding the content of the book were more likely to benefit from frequent reading and thereby acquired better written communication skills. This finding highlights the key role of receptive language in order for frequent reading to improve written communication skills in autistic children with limited spoken language.

**References:**

Blair, C., & Razza, R. P. (2007). Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in kindergarten. *Child development*, *78*(2), 647–663. <https://doi.org/10.1111/j.1467-8624.2007.01019.x>

Bullen, J. C., Zajic, M. C., McIntyre, N., Solari, E., & Mundy, P. (2022). Patterns of math and reading achievement in children and adolescents with autism spectrum disorder. *Research in Autism Spectrum Disorders*, 92, 101933. <https://doi.org/10.1016/j.rasd.2022.101933>

Chen, Y., & Jahromi, L. B. (2024). Self-Regulation and Academic Learning in Preschoolers with Autism Spectrum Disorder: Links to School Engagement and Levels of Autism Characteristics. *Journal of autism and developmental disorders*, 10.1007/s10803-024-06288-4. Advance online publication. <https://doi.org/10.1007/s10803-024-06288-4>

McClelland, M. M., Cameron, C. E., Connor, C. M., Farris, C. L., Jewkes, A. M., & Morrison, F. J. (2007). Links between behavioral regulation and preschoolers' literacy, vocabulary, and math skills. *Developmental psychology*, *43*(4), 947–959. <https://doi.org/10.1037/0012-1649.43.4.947>

1Boston University