The Journal of Child Psychology and Psychiatry

Journal of Child Psychology and Psychiatry 67:2 (2026), pp 225–237 doi:10.1111/jcpp.70038

Executive function predicts academic and social skills in autistic kindergartners based on a multimodal approach

Boin Choi,[1,2] Haeun Lee,[3] Laura Kuhn,[4] Jeongjin Kim,[5] Seok-Jun Hong,[6] Adriana Di Martino,[7] Alessandro Gozzi,[8] Michael V. Lombardo,[9] Frederick J. Morrison,[10] Catherine Lord,[11] and So Hyun Kim[12]

[1]Department of Special Education, Ewha Womans University, Seoul, South Korea; [2]Mind Health Institute, Korea University, Seoul, South Korea; [3]Department of Psychology, Korea University, Seoul, South Korea; [4]Frank Porter Graham Child Development Institute, University of North Carolina, Chapel Hill, NC, USA; [5]Center for Neuroscience, Brain Science Institute, Korea Institute of Science and Technology, Seoul, South Korea; [6]Department of Biomedical Engineering at Sungkyunkwan University, Seoul, South Korea; [7]Child Mind Institute, Autism Center, New York, NY, USA; [8]Functional Neuroimaging Laboratory, Istituto Italiano di Tecnologia, Center for Neuroscience and Cognitive Systems, Rovereto, Italy; [9]Laboratory for Autism and Neurodevelopmental Disorders, Istituto Italiano di Tecnologia, Center for Neuroscience and Cognitive Systems, Rovereto, Italy; [10]Department of Psychology, University of Michigan, Ann Arbor, MI, USA; [11]Semel Institute for Neuroscience and Human Behavior, University of California, Los Angeles, California, USA; [12]School of Psychology, Korea University, Seoul, South Korea

Background: Executive functions (EF) are cognitive processes that underlie goal-directed abilities and behaviors which have been found to be variable in autistic children. While EFs are well-established predictors of academic and social outcomes in neurotypical children, it is unclear if these same associations are true for children with autism spectrum disorder (ASD). This study examined the relation between EF and academic and social skills in cognitively able, verbal kindergarteners with ASD, while using a multimeasurement approach to EF skills. **Methods:** Participants included 67 autistic children aged 4–6 years longitudinally followed from kindergarten entry to exit. Children's EF was measured using a multimodal assessment approach with a computerized EF battery, behavioral observation, and parent report. Academic achievement and social skills were evaluated through a standardized assessment and parent report, respectively. Multiple regression models were conducted to explore the associations of EF with academic and social outcomes, while controlling for key demographic factors (e.g. age, sex, nonverbal IQ). **Results:** EF, measured through the computerized battery, was significantly associated with math achievement when controlling for age, sex, and nonverbal IQ, both concurrently and longitudinally. EF difficulties, as reported by parents, were closely linked to current and later parent-reported peer play challenges. **Conclusions:** These findings indicate that EF may be critical foundational skills for school success in young autistic children at school transition. Therefore, targeted EF interventions could be a powerful way to optimize academic and social development in autistic kindergarteners. The results also highlight the importance of a multimeasurement approach to EF assessment, as it provides a more comprehensive understanding of the broader impact of EF on key developmental outcomes in ASD.
Keywords: Autism spectrum disorder; executive function; academic achievement; social skills.

Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental condition characterized by difficulties in social communication and restricted and repetitive behaviors/interests (American Psychiatric Association, 2013, 2022). In addition to the diagnostic criteria, many autistic individuals experience challenges in executive function (EF), a set of higher-order cognitive processes that underlie goal-directed abilities and behaviors (Lezak, Howieson, Bigler, & Tranel, 2012). This aligns with the longstanding executive dysfunction theory of autism from the 1990s, which suggests that deficits in EF are a common feature of ASD and underlie many of its behavioral characteristics (Hill, 2004; Pennington & Ozonoff, 1996). Supporting this, extensive research reports significant EF difficulties across the lifespan of autistic individuals (Demetriou et al., 2018; Happé, Booth, Charlton, & Hughes, 2006). For example, a meta-analysis synthesizing findings from 235 studies indicated substantial overall impairments in multiple EF domains, such as working memory, attention shifting, and inhibition, among autistic individuals compared with neurotypical peers (Demetriou et al., 2018).

EF deficits emerge in childhood and persist into adulthood, even among cognitively able autistic adults (Dijkhuis, de Sonneville, Ziermans, Staal, & Swaab, 2020; Rosenthal, Wallace, & Lawson, 2013; Wallace et al., 2016; Xie, Sun, Yang, & Guo, 2020). EF difficulties are also pervasive across environments, including school and home (Tschida & Yerys, 2022). This early emergence and pervasiveness of EF deficits highlight the need to study EF development, particularly during the transition to

Conflict of interest statement: No conflicts declared.

© 2025 The Author(s). *Journal of Child Psychology and Psychiatry* published by John Wiley & Sons Ltd on behalf of Association for Child and Adolescent Mental Health.
This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

formal schooling—a critical period for social, emotional, and academic growth (Lloyd, Irwin, & Hertzman, 2009; Marsh, Spagnol, Grove, & Eapen, 2017). The preschool to elementary years represent a key window for EF growth in neurotypical children (Anderson & Reidy, 2012; Reilly, Downer, & Grimm, 2022), with EF skills being essential for success in school settings. EF is also crucial for developmental milestones, such as joint attention and theory of mind (Dawson et al., 2002; Pellicano, 2010) and is strongly linked to personal autonomy in adulthood (Cribb, Kenny, & Pellicano, 2019; Fossum, Øie, Orm, Andersen, & Skogli, 2024). These studies therefore collectively underscore the significance of promoting strong EF skills beginning in childhood to enhance outcomes throughout the lifespan of autistic individuals. However, most prior research has relied on cross-sectional designs, limiting insight into developmental directionality between EF and academic skills. To address this gap, the present study uses a longitudinal design to track EF development across the critical transition from preschool to formal schooling.

Another limitation of prior work is the variability of EF measurement methods. Some studies have evaluated EF skills using computerized tasks (e.g. EF Touch; Willoughby, Blair, Wirth, & Greenberg, 2010) and behavioral observations (e.g. Head-Toes-Knees-Shoulders [HTKS]; Kenny et al., 2023), while others have used informant measures such as the Behavior Rating Inventory of Executive Function (BRIEF-II; Gioia, Isquith, Guy, & Kenworthy, 2015) to ecologically assess daily EF difficulties (Tschida & Yerys, 2022; Wallace et al., 2016). Different measurement approaches complement each other and bring additive value in assessment contexts (Pino Muñoz & Arán Filippetti, 2021; Toplak, West, & Stanovich, 2013). Computerized tasks provide precise data in controlled settings but may lack ecological validity (Willoughby, Blair, Wirth, & Greenberg, 2012). Behavioral observations allow clinicians and researchers to judge EF performance in more naturalistic, social settings. Informant-reported measures add a critical perspective on the individual's day-to-day EF across multiple contexts (Kenworthy, Yerys, Gutermuth Anthony, & Wallace, 2008).

Studies have reported low correlations and discrepancies between task-based and everyday EF assessments (Kenworthy et al., 2008; Pino Muñoz & Arán Filippetti, 2021) and suggested that these measures evaluate different underlying mental constructs of EF (Camerota, Willoughby, Kuhn, & Blair, 2018; Toplak et al., 2013). However, most individual studies tend to measure EF using one or the other approach, thereby failing to capture a more comprehensive picture of EF across different contexts. As many studies with autistic children do not always incorporate multiple assessment tools to measure the various aspects of EF within one study (Kuhn, Willoughby, Blair, & McKinnon, 2017), the results from this methodological constraint may obscure the full extent of EF variability observed in autistic children. Notably, performance-based tasks may reveal greater heterogeneity in EF profiles, while parent-report measures tend to show more consistent difficulties (Demetriou et al., 2018). Incorporating diverse, multimethod approaches could offer a more holistic view of EF and yield deeper insights into its associations with functional outcomes such as academic and social skills.

Executive function and academic achievement

Although EF impairments in ASD have been extensively studied (Demetriou et al., 2018; Hill, 2004), its specific relation to academic achievement in autistic individuals has received less attention. This may be partly due to past assumptions that most autistic individuals had cognitive impairments, leading studies to predominantly focus on intellectual abilities and language skills as key predictors of functional outcomes; however, these factors explain only a small portion of the variance in later outcomes (Duncan et al., 2007; Eaves & Ho, 1997; Happé et al., 2006; Mayes, Calhoun, Bixler, & Zimmerman, 2009). Recent studies consistently indicate that 60%–90% of the ASD population have average to above-average cognitive skills (Baio, 2018; Department of Education, 2016), highlighting the importance of identifying additional early neurobehavioral predictors of academic outcomes, such as EF, in young autistic children. In neurotypical children, components of EF skills are known to predict academic success (Cameron et al., 2012; Spiegel, Goodrich, Morris, Osborne, & Lonigan, 2021; Willoughby, Piper, Oyanga, & Merseth King, 2019, Willoughby, Wylie, & Little, 2019). For example, working memory (the ability to hold information over short periods) is essential for following multistep instructions, while attentional shifting (the ability to switch between tasks) and inhibitory control (the ability to suppress inappropriate behaviors) are critical for maintaining focus and resisting distractions during learning (Blair & Raver, 2015; Raver, Smith-Donald, Hayes, & Jones, 2005).

Despite the well-documented link between EF and academic achievement in neurotypical populations, this connection is less explored in ASD. Existing research highlights links between EF and academic outcomes, such as attentional switching and math performance in autistic children aged 7–12 years (May, Rinehart, Wilding, & Cornish, 2013), as well as associations between inhibitory control and school readiness (Pellicano et al., 2017) and between EF and math progress in autistic preschoolers (Chen & Jahromi, 2024). Neural correlates of EF have also been tied to reading and math skills in autistic kindergartners (Buzzell, Thomas, Choi, & Kim, 2022;

© 2025 The Author(s). *Journal of Child Psychology and Psychiatry* published by John Wiley & Sons Ltd on behalf of Association for Child and Adolescent Mental Health.

14697610, 2026, 2, Downloaded from https://acamh.onlinelibrary.wiley.com/doi/10.1111/jcpp.70038 by Ewha Womans University Library, Wiley Online Library on [20/05/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Kim, Buzzell, & Faja, 2020). Longitudinal studies further demonstrate that EF skills predict later math achievement in autistic children (St John, Dawson, & Estes, 2018) and academic progress in autistic adults (Dijkhuis et al., 2020). However, many studies lack a comprehensive EF measurement approach, highlighting a gap in the literature that warrants further investigation. Further, most have focused on older children, leaving a gap in understanding EF's role in academic achievement among younger autistic populations, particularly during school transition.

Executive function and social skills

Autistic individuals experience challenges in social communication and interaction, which are often compounded by EF difficulties. For example, deficits in working memory can hinder autistic individuals' ability to follow conversations or maintain social exchanges (Akbar, Loomis, & Paul, 2013; Kuijper, Hartman, Bogaerds-Hazenberg, & Hendriks, 2017). Difficulties with attention shifting can also make it challenging to adjust behavior to different social contexts, potentially leading to inappropriate or rigid responses. Moreover, individuals with poor inhibitory control may find it difficult to suppress maladaptive social behaviors or irrelevant information, which can disrupt the flow of communication. In fact, Greco, Choi, Michel, and Faja (2023) found greater inhibitory control difficulties in autistic children were linked to less fluent narrative production during social interactions, demonstrating how EF deficits can negatively impact social engagement.

Several studies have explored the link between EF and social skills in autistic individuals, but the findings have been mixed. For instance, Landa and Goldberg (2005) found no significant association between neuropsychological assessments of EF and social skills. By contrast, Kenworthy et al. (2009) reported that certain aspects of EF, such as semantic fluency and auditory divided attention, are significantly related to social symptoms in ASD. More recently, Berard, Loutzenhiser, Sevigny, and Alfano (2017) found EF was associated with parent-reported social competence in autistic boys aged 8–13 years. Similarly, Baez, Dajani, and Voorhies (2020) reported autistic children with impaired EF faced greater social challenges. Additionally, metacognitive challenges were associated with increased playground isolation and reduced peer engagement in elementary-aged children with ASD (Freeman, Locke, Rotheram-Fuller, & Mandell, 2017) and lower overall social functioning in autistic children and adolescents (Torske, Nærland, Øie, Stenberg, & Andreassen, 2018). Longitudinal research by Faja et al. (2016) further demonstrated that EF abilities during preschool predicted play skills at age 6 in autistic children. These mixed findings underscore the need for more research to better understand the link between EF and social skills.

In summary, while EF is a well-established predictor of academic and social outcomes in neurotypical children, its role in ASD remains less clear. Given the variability in EF among autistic individuals (Craig et al., 2016; Hill, 2004), a multimeasurement approach is essential to fully capture EF skills and their impact on academic and social skills. Understanding these relations could shed light on the variability in functional outcomes within ASD. Thus, this study aimed to address the following research questions: (1) Do EF skills relate to current and future reading and math achievement in autistic kindergarteners? (2) Are EF skills associated with current and later social skills in autistic kindergarteners?

Methods

Participants

Participants were 67 autistic children aged 4–6 years at enrollment. Children were recruited from the clinic at the Center for Autism and the Developing Brain, as well as from the urban and suburban communities of New York. Inclusion criteria were as follows: (1) a previous clinical diagnosis of ASD confirmed using the Autism Diagnostic Observation Schedule-2 (ADOS-2; Lord, Rutter, DiLavore, Risi, & Gotham, 2012) and other sources of information; (2) no intellectual disability based on the DSM-5 criterion (APA, 2013; APA, 2022); (3) flexible use of complex sentences (i.e. language appropriate for ADOS-2 Module 3); and (4) English as primary language. The mean full-scale IQ of children was 102.55 (SD = 12.07, range = 75–132), with a mean verbal IQ of 99.63 (SD = 15.55, range = 70–138) and a mean nonverbal IQ of 105.03 (SD = 12.07, range = 68–135). All assessments and diagnostic confirmation were done by trained research staff and a licensed clinical psychologist with extensive experience working with autistic children. Participant characteristics are detailed in Table 1.

Procedure and measures

All parents provided written informed consent for their child's participation, and protocols and procedures were approved by the Institutional Review Board at [institution name masked]. At kindergarten entry, children were administered diagnostic and cognitive assessments in the lab to determine study eligibility. Children's EF skills, academic achievement, and social behaviors were measured at kindergarten entry and exit.

Diagnostic and cognitive assessments at kindergarten entry. ADOS-2 (Lord et al., 2012): Research-reliable examiners administered the ADOS-2 under the supervision of a licensed clinical psychologist. The ADOS-2 provides an overall Calibrated Severity Score (CSS), enabling comparison across different modules while minimizing the influence of developmental factors such as IQ and language level (Hus & Lord, 2014). All children had CSS scores within the ASD classification on the diagnostic algorithm (M = 8.28; SD = 1.94; Gotham, Pickles, & Lord, 2009).

Differential Ability Scales II (DAS-II; Elliott, 2007): To measure cognitive functioning, the DAS-II was administered. The DAS-II is a standardized, norm-referenced

© 2025 The Author(s). *Journal of Child Psychology and Psychiatry* published by John Wiley & Sons Ltd on behalf of Association for Child and Adolescent Mental Health.

14697610, 2026, 2, Downloaded from https://acamh.onlinelibrary.wiley.com/doi/10.1111/jcpp.70038 by Ewha Womans University Library, Wiley Online Library on [20/05/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Table 1 Descriptive statistics for demographic information, EF measures, academic achievement, and social skills at kindergarten entry and kindergarten exit

	Kindergarten entry (N = 67)	Kindergarten exit (N = 64)
Demographic information		
Age (in months)	63.0 (5.0)	72.3 (4.4)
	54–79	65–87
Percent male	73.1%	79.7%
Race		
Percent White	53.8%	57.1%
Percent Black/African-American	7.7%	6.3%
Percent Asian/Pacific Islander	4.6%	6.3%
Percent biracial	23.1%	19.0%
Percent other	10.8%	11.1%
Percent non-Hispanic	69.0%	70.2%
Percent college degree of mothers	87.7%	90.3%
Educational placement		
General education	8.9%	15.3%
General education with pullout	13.3%	10.2%
Inclusion	53.3%	52.5%
Special education	24.4%	22.0%
EF measures		
EF Touch composite	0.01 (0.70)	0.00 (0.72)
	−1.29 to 1.67	−1.60 to 1.36
	N = 51	N = 63
Spatial conflict arrows (raw score)	0.61 (0.19)	0.75 (0.17)
	0.20–0.97	0.33–1.00
	N = 52	N = 63
Pick the picture (raw score)	0.65 (0.11)	0.74 (0.11)
	0.38–0.97	0.38–0.97
	N = 52	N = 63
Something's the same (raw score)	0.71 (0.12)	0.79 (0.13)
	0.50–0.93	0.47–0.97
	N = 51	N = 63
HTKS total score (raw score)[a]	14.73 (17.74)	25.47 (21.44)
	0–54	0–58
	N = 44	N = 64
BRIEF-II global executive composite (T-score)[b]	61.97 (10.95)	63.41 (12.86)
	39–79	37–88
	N = 30	N = 27
Academic achievement		
WJ-III passage comprehension (W-score)[c]	414.79 (35.02)	441.39 (25.70)
	322–470	353–487
	N = 67	N = 64
WJ-III applied problems (W-score)[c]	425.21 (18.30)	441.78 (20.01)
	380–470	406–498
	N = 67	N = 64
Social skills		
PIPPS disruption (T-score)[d]	51.86 (10.23)	51.38 (9.29)
	29–73	33–73
	N = 66	N = 63
PIPPS disconnection (T-score)[d]	56.42 (16.27)	57.70 (13.07)
	10–73	10–73
	N = 66	N = 63
PIPPS interaction (T-score)[d]	37.02 (11.77)	39.40 (11.47)
	10–61	10–64
	N = 66	N = 63

Data are presented as means and standard deviations unless otherwise indicated. Some of the children were lost to follow-up at kindergarten exit, resulting in a sample size of 64 children at kindergarten exit. Therefore, descriptive statistics are provided separately for children at kindergarten entry and exit.
[a]Head-Toes-Knees-Shoulders.
[b]Behavior Rating Inventory of Executive Function.
[c]Woodcock-Johnson III—Tests of Achievement.
[d]Penn Interactive Peer Play Scale.

assessment that evaluates levels of functioning in verbal reasoning, nonverbal reasoning, and visual–spatial reasoning. In our analyses, nonverbal IQ (NVIQ; Standard Scores M = 100, SD = 15) served as an estimate of cognitive ability, assessed through tasks including Pattern Construction and Picture Similarities.

© 2025 The Author(s). *Journal of Child Psychology and Psychiatry* published by John Wiley & Sons Ltd on behalf of Association for Child and Adolescent Mental Health.

14697610, 2026, 2, Downloaded from https://acamh.onlinelibrary.wiley.com/doi/10.1111/jcpp.70038 by Ewha Womans University Library, Wiley Online Library on [20/05/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

EF skills at kindergarten entry and exit. EF skills were measured using three distinct, yet complementary, methods to ensure a comprehensive assessment of EF: EF Touch, HTKS, and BRIEF.

EF Touch (Willoughby et al., 2010): EF Touch is a computerized battery administered on a touchpad tablet, designed for assessing EF in children. Extensively validated in 1,292 neurotypical children 3–5 years of age, it demonstrates strong psychometric properties and has been previously used with autistic preschoolers (Kuhn et al., 2017). It includes seven tasks, three of which were used in this study: *Spatial Conflict Arrows* (inhibitory control), *Pick the Picture* (working memory), and *Something's the Same* (attention shifting) (see Appendix S1). The proportion of correct answers across all trials for each task was calculated, yielding scores between 0 and 1. Following the methodology established by the creators of EF Touch (Willoughby, Kuhn, Blair, Samek, & List, 2017; Willoughby, Piper, et al., 2019; Willoughby, Wylie, & Little, 2019), we created a *composite* EF score based on the proportion of correct answers across the tasks. This was calculated by standardizing the individual task scores ($M = 0$, $SD = 1$) and averaging the child's performance across the tasks, which were positively correlated with each other (r's = .318–.424 at kindergarten entry; r's = .213–.427 at kindergarten exit). Only children completing over 95% of total trials per task were included (77.6%), and the remainder (22.4%) were excluded (see Appendix S2 for a comparison of included and excluded participants).

HTKS (McClelland & Cameron, 2012): HTKS is a structured behavioral observation task designed to evaluate self-regulation in children aged 4–8 years. It has shown high construct and predictive validity and reliability, offering insights into children's ability to integrate multiple EF skills, including working memory for rule retention and flexibility for rules change (McClelland et al., 2014; Ponitz, McClelland, Matthews, & Morrison, 2009). In the first part of the task, children performed the opposite of what the examiner said (e.g. if instructed to 'touch your *head*', they were supposed to touch their *toes*). If the children passed this head/toes task, they moved onto the second part, during which rules involving knees and shoulders were added (e.g. touching shoulders when instructed to touch knees). In the third part, the rules were further changed (e.g. touching their head when told to touch their knees, touching shoulders when told to touch their toes). While HTKS yields performance-based scores, it involves real-time, socially embedded responses and allows researchers to evaluate how children integrate EF skills in response to verbal instructions from an adult social partner. HTKS consists of 30 items, each scored as 0 (incorrect), 1 (self-correct), or 2 (correct), yielding a total score ranging from 0 to 60, where higher scores indicate better EF.

BRIEF-II (Gioia et al., 2015): To assess children's EF difficulties in real-life settings, we utilized the BRIEF-II, a standardized[1] report measure where parents rated the frequency of their child's EF challenges (e.g. 'Resists or has trouble accepting a different way to solve a problem with schoolwork, friends, tasks, etc'.). The BRIEF-II consists of 63 items, each rated on a 3-point Likert scale (1 = *Never*, 2 = *Sometimes*, 3 = *Often*). For analyses, we used the Global Executive Composite (GEC), an overall summary score that incorporates all BRIEF-II clinical scales including behavioral, cognitive, and emotional regulation, with higher scores indicating more EF challenges.

Academic achievement at kindergarten entry and exit. Two subtests of the Woodcock-Johnson III-Tests of Achievement (WJ-III; Woodcock, McGrew, Mather, & Schrank, 2001), a norm-referenced measure of academic abilities, were used to assess children's reading and math skills: Passage Comprehension and Applied Problems. The Passage Comprehension assesses reading comprehension skills, and the Applied Problems measures the ability to use mathematical operations to solve practical problems. *W* scores from these two subtests were used for analyses. The *W* scale is a special transformation of the Rasch ability scale, providing a common, equal-interval measurement scale on which an individual's ability and the task difficulty can be represented. The *W* scale is centered on a value of 500, which approximates the average performance of children at age 10 years, 0 months.

Social skills. Social skills were measured using the Penn Interactive Peer Play Scale (PIPPS; Fantuzzo & McWayne, 2002). The PIPPS is a parent or teacher report based on a 32-item Likert scale that evaluates peer play interaction across Play Interaction (e.g. encouraging others to join play), Play Disruption (e.g. aggressive, antisocial behaviors that interfere with peer play), and Play Disconnection (e.g. withdrawn behavior and nonparticipation in play). The PIPPS has been previously validated as an outcome measure of peer connections in school-aged autistic children (Jones, Pickles, & Lord, 2017). Higher scores in Play Interaction reflect more adaptive behaviors, whereas higher scores in Play Disruption/Disconnection reflect more problematic behaviors. Standardized scores from the three domains based on parent reports were used in the current analyses.

Data analytic approach

Before conducting the main analyses, we first examined descriptive statistics for outcome measures to understand the distribution of academic achievement and social skills. Additionally, we assessed the bivariate correlations among the three EF measures to explore the relations among these key variables.

To address the first research question about the associations between EF skills and academic outcomes in autistic kindergarteners, we conducted multiple regression analyses. We identified relevant covariates by examining their correlations with academic skills, including age, sex, and nonverbal IQ, given their established relations to academic outcomes (e.g. Bölte, Duketis, Poustka, & Holtmann, 2011). In our sample, all these variables were significantly correlated with academic achievement. We also considered school placement as a potential covariate; however, it was not correlated with any of the outcomes and thus was dropped from all analyses. For regression analyses, with alpha = .05, power = .8, a sample size of 55 is required to detect an R^2 change with a medium effect size ($f^2 = .15$) while controlling for three covariates; therefore, we have sufficient power to conduct the models with our sample size of 67. For the second research question on the relation between EF skills and social skills, we applied a similar approach. Among potential covariates, only parental education level significantly related to PIPPS Disconnection scores and was included as a covariate.

For academic/social outcomes, we ran three main sets of regression models to examine: (1) concurrent associations at kindergarten entry, (2) concurrent associations at kindergarten exit, and (3) longitudinal associations between kindergarten-entry EF and -exit academic/social skills. Each EF measure (EF Touch, HTKS, BRIEF) was entered separately as the predictor in the regression models. After testing all regression models, results were interpreted only if the model remained statistically significant following a false discovery rate correction applied to account for multiple comparisons, with the threshold at $q < .05$. All analyses were performed using Stata 18.0 (StataCorp, ;2023).

© 2025 The Author(s). *Journal of Child Psychology and Psychiatry* published by John Wiley & Sons Ltd on behalf of Association for Child and Adolescent Mental Health.

14697610, 2026, 2, Downloaded from https://acamh.onlinelibrary.wiley.com/doi/10.1111/jcpp.70038 by Ewha Womans University Library, Wiley Online Library on [20/05/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

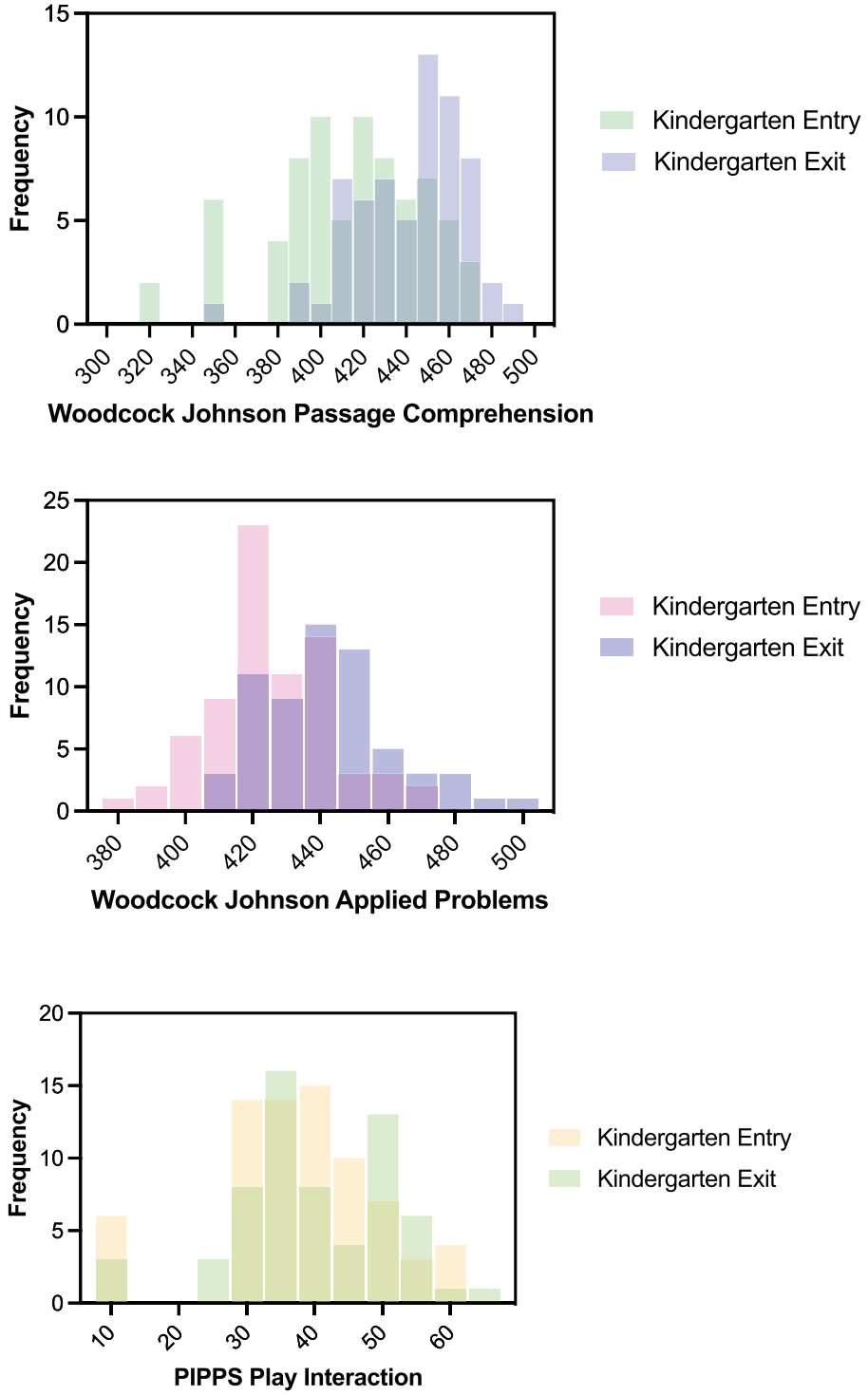


Figure 1 Individual variation in reading and math achievement (WJ-III) and social skills (PIPPS play interaction) among autistic children at kindergarten entry and kindergarten exit

Results

Descriptive statistics for academic achievement and social skills are provided in Table 1. Consistent with previous research (Jones et al., 2009; Kim et al., 2016), autistic children varied widely in their academic and social skills during kindergarten (Figure 1). At kindergarten entry, WJ-III Passage Comprehension *W* scores ranged from 322 to 470, while at kindergarten exit, these scores ranged from 353 to 487. The substantial heterogeneity was also evident in the social skills of children. For instance, some children scored as low as 10 on the PIPPS Disconnection domain, indicating less difficulty in engagement and interaction with peers during play; others scored more than two standard deviations above the mean *T*-score of 50, reflecting severe difficulty in peer interactions.

Bivariate correlations between EF Touch, HTKS, and BRIEF scores are summarized in Figure 2. At

© 2025 The Author(s). *Journal of Child Psychology and Psychiatry* published by John Wiley & Sons Ltd on behalf of Association for Child and Adolescent Mental Health.

14697610, 2026, 2, Downloaded from https://acamh.onlinelibrary.wiley.com/doi/10.1111/jcpp.70038 by Ewha Womans University Library, Wiley Online Library on [20/05/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License



Figure 2 Bivariate correlations among EF Touch, HTKS, and BRIEF scores at kindergarten entry and kindergarten exit. The black outlines indicate the correlations with significance ($p < .05$)

kindergarten entry, higher HTKS scores (more advanced skills) were significantly correlated with lower BRIEF scores (less impairment; $r = -.413$, $p = .023$). In contrast, EF Touch was not significantly correlated with BRIEF scores; however, the moderate magnitude of the correlation ($r = -.38$) suggests a modest relation that may not have reached statistical significance, partly due to the relatively small sample size. By the end of kindergarten, HTKS was no longer correlated with the BRIEF, while EF Touch scores were significantly correlated with HTKS ($r = .539$, $p < .001$). EF Touch, HTKS, and BRIEF scores at kindergarten entry were significantly positively correlated with their respective scores at kindergarten exit, indicating stability over time.

Associations between EF and academic achievement

As expected, age, sex, and NVIQ were significantly associated with reading and math. As shown in Table 2, based on multiple regression analyses at kindergarten entry, EF Touch was significantly positively related to current reading ($B = 16.35$, $SE = 6.51$, $p = .016$) and math ($B = 8.23$, $SE = 3.05$, $p = .010$), when controlling for age, sex, and NVIQ. At kindergarten exit, EF Touch continued to be significantly associated with current math ($B = 11.75$, $SE = 3.01$, $p < .001$), and HTKS was significantly positively associated with math ($B = 0.37$, $SE = 0.11$, $p = .002$). Longitudinal analysis revealed that EF Touch at kindergarten entry significantly predicted later math ($B = 10.67$, $SE = 4.42$, $p = .021$) at kindergarten exit, controlling for the covariates.

A sensitivity analysis on the subset of children who completed all three EF measures (entry: $n = 15$; exit: $n = 27$) was conducted to determine whether the statistical effects changed, as not all children completed all three measures. Results indicated that EF Touch remained significantly related to current reading ($B = 37.25$, $SE = 12.03$, $p = .011$) and math ($B = 16.12$, $SE = 6.29$, $p = .028$) at kindergarten entry. However, in this reduced sample, EF Touch and HTKS no longer related to current math at kindergarten exit and EF Touch at kindergarten entry no longer predicted math at kindergarten exit.

Associations between EF and social skills

As displayed in Table 3, based on multiple regression analyses at kindergarten entry, BRIEF-II was positively associated with current PIPPS Disconnection ($B = 1.08$, $SE = 0.28$, $p = .001$) and Disruption

Table 2 Associations between EF variables and academic achievement at kindergarten entry and kindergarten exit

	Kindergarten entry		Kindergarten exit	
	B (*SE*)		*B* (*SE*)	
Predictor	Passage comprehension	Applied problems	Passage comprehension	Applied problems
Entry EF touch	16.35 (6.51)*	8.23 (3.05)*	3.91 (6.03)	10.67 (4.42)*
Entry HTKS[a]	−0.16 (0.30)	0.21 (0.16)	−0.08 (0.22)	0.09 (0.18)
Entry BRIEF[b]	0.52 (0.65)	0.43 (0.34)	0.61 (0.44)	0.59 (0.36)
Exit EF touch	–	–	8.84 (4.40)*	11.75 (2.01)***
Exit HTKS	–	–	0.27 (0.16)	0.37 (0.11)**
Exit BRIEF	–	–	0.76 (0.31)	0.64 (0.33)

Data from the multiple regression models are reported as unstandardized coefficients with standard errors in parentheses. Covariates (not shown) include sex, NVIQ, and age.
[a]Head-Toes-Knees-Shoulders.
[b]Behavior Rating Inventory of Executive Function.
*$p < .05$; **$p < .01$; ***$p < .001$ based on false discovery rate (FDR) corrections.

© 2025 The Author(s). *Journal of Child Psychology and Psychiatry* published by John Wiley & Sons Ltd on behalf of Association for Child and Adolescent Mental Health.

14697610, 2026, 2, Downloaded from https://acamh.onlinelibrary.wiley.com/doi/10.1111/jcpp.70038 by Ewha Womans University Library, Wiley Online Library on [20/05/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Table 3 Associations between EF variables and social skills at kindergarten entry and kindergarten exit

	Kindergarten entry			Kindergarten exit		
	B (*SE*)			*B* (*SE*)		
Predictor	Disconnection	Disruption	Interaction	Disconnection	Disruption	Interaction
Entry EF touch	−2.45 (2.98)	−0.47 (2.30)	−2.06 (2.43)	−1.61 (3.25)	2.33 (2.03)	−0.73 (2.76)
Entry HTKS[a]	−0.27 (0.15)	0.04 (0.09)	0.15 (0.11)	−0.12 (0.12)	−0.10 (0.10)	0.10 (0.10)
Entry BRIEF[b]	1.08 (0.28)**	0.57 (0.16)**	−0.53 (0.19)**	0.78 (0.19)***	0.56 (0.15)**	−0.24 (0.14)
Exit EF touch	–	–	–	−3.54 (2.29)	0.27 (1.65)	1.28 (2.04)
Exit HTKS	–	–	–	−0.14 (0.08)	−0.01 (0.06)	0.03 (0.07)
Exit BRIEF	–	–	–	0.67 (0.14)***	0.45 (0.12)**	−0.29 (0.11)

Data from the multiple regression models are reported as unstandardized coefficients with standard errors in parentheses. A covariate (not shown) includes parent education in regression models predicting PIPPS Disconnection scores.
[a]Head-Toes-Knees-Shoulders.
[b]Behavior Rating Inventory of Executive Function.
*$p < .05$; **$p < .01$; ***$p < .001$ based on false discovery rate (FDR) corrections.

($B = 0.57$, $SE = 0.16$, $p = .001$; higher PIPPS scores indicate more impairment for these two domains). Further, BRIEF-II was negatively associated with current PIPPS Interaction scores ($B = -0.53$, $SE = 0.19$, $p = .008$; higher PIPPS scores in this domain indicate more advanced social skills). A similar pattern of results was found at kindergarten exit, such that higher BRIEF-II continued to be associated with higher Disconnection and Disruption; however, BRIEF-II no longer was associated with Interaction. These significant associations between parent-reported EF and social skills remained robust when a sensitivity analysis was conducted on the subset of children who completed all three EF measures.

Longitudinal analyses revealed that BRIEF-II at kindergarten entry was positively associated with PIPPS Disconnection ($B = 0.78$, $SE = 0.19$, $p < .001$) and Disruption ($B = 0.56$, $SE = 0.15$, $p = .001$) at kindergarten exit. However, these predictive relations became marginally significant in the reduced sample used in the sensitivity analysis. EF Touch and HTKS were not associated with any of the PIPPS domain scores concurrently and longitudinally.

Finally, given that the majority of our participants were male, we conducted exploratory analyses to examine the potential moderating effect of sex on the reported findings. Results were largely consistent with those from the full sample. When analyses were restricted to male participants only, for academic outcomes, the overall pattern of associations remained similar; however, a few findings shifted from statistically significant to marginally significant, likely reflecting reduced statistical power due to the smaller sample size. For social outcomes, all key associations remained robust.

Discussion

This longitudinal study examined the relations of EF with academic and social skills in cognitively able, verbal autistic kindergartners. Key findings indicate that EF, measured through a computerized battery, was positively associated with math performance, concurrently and longitudinally. Additionally, parent-reported EF difficulties were associated with current and later challenges in peer play interactions.

Descriptive statistics on academic achievement and social skills indicated wide variation in functional outcomes in autistic kindergarteners, similar to previous findings (Jones et al., 2009; Kim et al., 2016). Specifically, children demonstrated a broad range of skills in reading and math, as well as differences in peer play interactions at kindergarten entry and exit. This is noteworthy because even within the relatively homogenous sample of cognitively able, verbally fluent autistic kindergarteners, there was a substantial heterogeneity in these key functional outcomes during school transition. This variation indicates that, from the early stage of formal schooling, autistic children vary widely in their academic and social skills, which highlights the critical need to identify factors, such as EF, contributing to this variability.

When examining the correlations among the three EF measures, we found a negative correlation between HTKS and BRIEF at kindergarten entry, indicating that children who performed better on a behavioral observation task had fewer parent-reported EF difficulties. However, this correlation disappeared by kindergarten exit, suggesting that the consistency between the parent- and observation-based measures of EF may shift as children develop. Additionally, while EF Touch was not significantly correlated with BRIEF at kindergarten entry, the modest correlation suggests a potential association that may have been underpowered. Notably, EF Touch became significantly positively correlated with HTKS by kindergarten exit, indicating a stronger alignment between performance-based EF assessments over time. These results,

© 2025 The Author(s). *Journal of Child Psychology and Psychiatry* published by John Wiley & Sons Ltd on behalf of Association for Child and Adolescent Mental Health.

14697610, 2026, 2, Downloaded from https://acamh.onlinelibrary.wiley.com/doi/10.1111/jcpp.70038 by Ewha Womans University Library, Wiley Online Library on [20/05/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

while requiring replication in samples with wider abilities, raise the possibility that different EF measures may tap into distinct aspects of EF at varying points of time. However, these findings should be interpreted with caution, as the observed correlations were small to moderate, and only a subset of children completed all three EF measures. Therefore, the changes over time may reflect a combination of measurement variability and task-specific demands, rather than definitive developmental shifts in EF measurement.

BRIEF scores showed greater stability from kindergarten entry to exit (r = .88; Figure 2) compared with task-based EF measures (r's = .42–.52). This pattern may reflect the relatively stable nature of everyday EF in real-life settings, as perceived by parents, while task-based assessments may be more sensitive to developmental changes. Alternatively, the parent-report measures may not be precise enough to detect subtle EF improvements (i.e. change in skills) that are more readily captured by structured tasks. Future research should explore the extent to which these different measurement approaches are precise enough (i.e. sensitive) to accurately capture small developmental changes.

These differences in measurement patterns also highlight a broader issue of variability in how EF manifests across contexts and methods. This variability may arise due to differences in assessment contexts and demands, with performance-based tasks focusing on specific structured skills and behavioral ratings reflecting broader, everyday EF applications influenced by social and environmental factors. Parental biases, such as expectations and stress, may further affect ratings. Additionally, EF is a multifaceted construct involving multiple cognitive processes that may manifest differently across contexts, making it challenging for any single assessment to capture the entire scope of EF. Together, these results highlight the importance of a multimodal approach to fully capture the diverse EF skills of autistic children.

EF, assessed through a computerized battery, was significantly associated with current math achievement at kindergarten entry. Specifically, children who performed better on EF Touch achieved higher scores in math. These associations remained robust in the sensitivity analysis while controlling for key demographic factors, age, sex, and NVIQ, highlighting the robustness of EF as an indicator of academic success. Additionally, stronger EF skills at kindergarten entry longitudinally predicted better math outcomes at kindergarten exit. Moreover, HTKS performance was significantly related to current math achievement at kindergarten exit. However, this relation was not as consistent in the sensitivity analysis, suggesting that the predictive power of HTKS may be more variable across samples. In sum, our analyses support the notion that EF is positively associated with academic success, especially math, suggesting that EF skills generally contribute to better academic outcomes.

Children's EF challenges, as reported by their parents, were related to peer play difficulties, concurrently and longitudinally. Specifically, greater EF impairment was associated with higher scores in PIPPS Disconnection and Disruption, indicating that children with poorer EF skills exhibited more withdrawn and aggressive behaviors in peer settings. This pattern persisted longitudinally, showing that children with more EF difficulties at kindergarten entry exhibited more disconnected and disruptive play behaviors by kindergarten exit. Our finding aligns with those of previous research reporting relations between EF and social skills in ASD (Baez et al., 2020; Berard et al., 2017; Freeman et al., 2017; Torske et al., 2018). Faja et al. (2016) reported that EF predicted play skills over time, particularly in preschoolers with ASD who had high language abilities, but not in those who had more limited language skills. These results as a whole suggest that the association of EF with play may differ based on children's developmental levels and that EF plays a critical role in the social development of autistic children, even in the presence of advanced language skills.

Several limitations should be noted. First, this study focused on cognitively able, verbal autistic children, which limits the generalizability of the findings to those with a wider range of abilities. Although EF and its key role in academic and social success have been studied extensively in neurotypical children, the focus of the current study was not on the between-group comparisons. However, the direct comparison with matched controls or other clinical populations in future studies could elucidate the unique needs in the autistic population as well as intervention strategies that could cut across various developmental disorders. The predominantly male sample further restricts the applicability to autistic girls, given known sex differences in EF (Bölte et al., 2011), although sex was controlled for in our analyses. Additionally, although participants were identified as Hispanic or non-Hispanic, we did not collect further information on ethnicity. This limits our ability to explore within-group differences in a demographically diverse population and may obscure culturally nuanced patterns related to EF or functional outcomes. Further, a subset of participants (22.4%) was excluded due to not meeting the 95% completion threshold across all three EF Touch tasks, and these children were significantly older than those retained in the analysis. As such, our findings may not fully generalize to the broader age range of the sample. Second, this study examined general EF in relation to academic and social skills without investigating the contributions of specific EF

© 2025 The Author(s). *Journal of Child Psychology and Psychiatry* published by John Wiley & Sons Ltd on behalf of Association for Child and Adolescent Mental Health.

14697610, 2026, 2, Downloaded from https://acamh.onlinelibrary.wiley.com/doi/10.1111/jcpp.70038 by Ewha Womans University Library, Wiley Online Library on [20/05/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

components. While some view EF as a single factor before school entry (Wiebe et al., 2011; Willoughby et al., 2010), others highlight distinct but related components in preschoolers (Lerner & Lonigan, 2014). Given that these components may relate differently to academic and social skills (Spiegel et al., 2021), future research should examine the unique contributions of each EF subdomain to functional outcomes in ASD. We did not include lab-based assessments of social skills or broader indicators of school success (e.g. teacher reports), which may provide a more comprehensive analysis. Future studies should include other unmeasured factors, such as externalizing and internalizing behaviors, to explain the variability in outcomes. Finally, both the BRIEF-II and PIPPS are parent reports, which could introduce shared method variance and potentially inflate the strength of the observed associations. Similarly, the use of the performance-based EF task (EF Touch) and a direct assessment of academic skills (e.g. math) may share method characteristics—such as the structured testing context—that contribute to the observed relation. Future studies should consider the influence of method variance more explicitly, ideally incorporating multiple informants and multiassessment approaches to better disentangle true associations from measurement artifacts.

Nonetheless, our findings contribute valuable insights into the relations between EF and academic and social skills in autistic kindergarteners. Our results underscore the importance of early, comprehensive assessment of EF skills in ASD, which could help identify children at risk for academic and social difficulties, allowing for targeted interventions before substantial academic and social gaps accumulate (Spiegel et al., 2021). Targeted EF interventions have the potential to maximize school readiness and social skills for autistic children, providing them with the necessary tools to succeed in various domains of their lives. In fact, efforts have been made to implement EF interventions in school settings, including with elementary and middle school students (Kenworthy et al., 2014; Tamm et al., 2024). While these programs show considerable promise, evidence on the generalization of improvements to real-life settings and long-term effects has been less explored (Pasqualotto et al., 2021). Therefore, future work could explore ways to extend or adapt EF supports into various community settings (e.g. home, school, community centers) to enhance generalization and consistency in children's everyday executive functioning.

Conclusion

This longitudinal study provides a comprehensive examination of the relations between EF skills and academic and social outcomes in cognitively able autistic kindergarteners. EF, as measured through a computerized battery, was associated with reading and math performance at kindergarten entry and exit, while everyday EF abilities, as reported by parents, predicted day-to-day social skills. Our findings underscore the important role of EF in early academic achievement and social interactions among autistic children, who exhibit substantial variability in these functional outcomes. Enhancing EF development would be one path to fostering better cognitive, academic, and social outcomes, ultimately supporting more optimal developmental trajectories for autistic individuals.

Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article:

Appendix S1. Description of EF Touch tasks.

Appendix S2. Participant characteristics by EF Touch task completion rate.

Acknowledgements

This project was funded by the Korean Ministry of Science and ICT of the National Research Foundation of Korea (RS-2023-00209635, RS-2023-00265410, PI S. H. Kim; 2023S1A5C2A07095987; RS-2024-00439474, Co-I S. H. Kim; RS-2024-00398768, PI J. Kim, Co-Is S. Kim, S-J. Hong), Kellen Junior Faculty Award (PI: Kim), R01MH115363 to ADM, and supported by a Korea University Grant (Choi). The authors thank Nurit Benrey, Claire Klein, and Denisse Janvier for help with study conceptualization and data collection. The authors thank the children and the families who participated in the study. The authors declare that they have no conflicts of interest.

Data availability statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Ethical consideration

This study was approved by the Institutional Review Board at Weill Cornell Medicine (IRB #: 1605017244). All procedures adhered to the ethical standards outlined in the 1964 Helsinki declaration and its subsequent amendments. Written informed consent was obtained from the parents of all participants involved in the study. Approval date: June 8, 2016.

Endnote

1. The BRIEF-II is standardized for children ages 5–18. Although 17 children (25% of the sample) were 4 years old at kindergarten entry (none remained 4 years of age by exit), the BRIEF-II was

© 2025 The Author(s). *Journal of Child Psychology and Psychiatry* published by John Wiley & Sons Ltd on behalf of Association for Child and Adolescent Mental Health.

14697610, 2026, 2, Downloaded from https://acamh.onlinelibrary.wiley.com/doi/10.1111/jcpp.70038 by Ewha Womans University Library, Wiley Online Library on [20/05/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

administered to all participants to ensure consistency across time points and age groups. This approach allowed us to track changes over time using the same instrument. For these younger children, the lowest age-based norms available were applied to support appropriate score interpretation. When analyses were repeated without this subgroup of children, results remained largely consistent with a few results reaching marginal significance, partly due to a reduced sample size.

Correspondence

So Hyun Kim, School of Psychology, Korea University, 145 Anam-ro, Seongbuk-gu, Seoul 02841, South Korea; Email: sohkim@korea.ac.kr

Key points

- Executive function (EF) is linked to academic and social outcomes in neurotypical children, but its role in autistic children during school transition has been less explored.
- This longitudinal study uses a multimodal approach, integrating a computerized battery, behavioral observation, and parent report to evaluate the role of EF in the academic and social skills of autistic kindergarteners.
- Children's EF, measured through computerized tasks, was significantly associated with concurrent and future academic performance in reading and math, while EF difficulties, as reported by parents, were linked to peer play challenges.
- Targeting EF through interventions may enhance both educational and social development in autistic children. In addition, a multidimensional EF assessment offers a more comprehensive view of its effects on key developmental outcomes.

References

Akbar, M., Loomis, R., & Paul, R. (2013). The interplay of language on executive functions in children with ASD. *Research in Autism Spectrum Disorders*, *7*, 494–501.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th edn). Washington, DC: American Psychiatric Publishing.

American Psychiatric Association. (2022). *Diagnostic and statistical manual of mental disorders* (5th edn, text rev.). Washington, DC: American Psychiatric Publishing. https://doi.org/10.1176/appi.books.9780890425787

Anderson, P.J., & Reidy, N. (2012). Assessing executive function in preschoolers. *Neuropsychology Review*, *22*, 345–360.

Baez, A.C., Dajani, D.R., & Voorhies, W. (2020). Parsing heterogeneity of executive function in typically and atypically developing children: A conceptual replication and exploration of social function. *Journal of Autism and Developmental Disorders*, *50*, 707–718.

Baio, J. (2018). Prevalence of autism spectrum disorder among children aged 8 years—Autism and developmental disabilities monitoring network, 11 sites, United States, 2014. *MMWR Surveillance Summaries*, *67*, 1–23.

Berard, N., Loutzenhiser, L., Sevigny, P.R., & Alfano, D.P. (2017). Executive function, social emotional learning, and social competence in school-aged boys with autism spectrum disorder. *Canadian Journal of School Psychology*, *32*, 265–281.

Blair, C., & Raver, C.C. (2015). School readiness and self-regulation: A developmental psychobiological approach. *Annual Review of Psychology*, *66*, 711–731.

Bölte, S., Duketis, E., Poustka, F., & Holtmann, M. (2011). Sex differences in cognitive domains and their clinical correlates in higher-functioning autism spectrum disorders. *Autism: The International Journal of Research and Practice*, *15*, 497–511.

Buzzell, G.A., Thomas, H.R., Choi, Y.B., & Kim, S.H. (2022). Atypical mediofrontal theta oscillations underlying cognitive control in kindergarteners with autism Spectrum disorder. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*, *7*, 566–575.

Cameron, C.E., McClelland, M.M., Jewkes, A.M., Connor, C.M., Farris, C.L., & Morrison, F.J. (2012). Fine motor skills and executive function both contribute to kindergarten achievement. *Child Development*, *83*(4), 1229–1244.

Camerota, M., Willoughby, M.T., Kuhn, L.J., & Blair, C.B. (2018). The childhood executive functioning inventory (CHEXI): Factor structure, measurement invariance, and correlates in US preschoolers. *Child Neuropsychology: A Journal on Normal and Abnormal Development in Childhood and Adolescence*, *24*, 322–337.

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*, *55*, 1286–1301.

Craig, F., Margari, F., Legrottaglie, A.R., Palumbi, R., de Giambattista, C., & Margari, L. (2016). A review of executive function deficits in autism spectrum disorder and attention-deficit/hyperactivity disorder. *Neuropsychiatric Disease and Treatment*, *12*, 1191–1202.

Cribb, S., Kenny, L., & Pellicano, E. (2019). "I definitely feel more in control of my life": The perspectives of young autistic people and their parents on emerging adulthood. *Autism: The International Journal of Research and Practice*, *23*, 1765–1781.

Dawson, G., Munson, J., Estes, A., Osterling, J., McPartland, J., Toth, K., … & Abbott, R. (2002). Neurocognitive function and joint attention ability in young children with autism spectrum disorder versus developmental delay. *Child Development*, *73*, 345–358.

Demetriou, E.A., Lampit, A., Quintana, D.S., Naismith, S.L., Song, Y.J.C., Pye, J.E., … & Guastella, A.J. (2018). Autism spectrum disorders: A meta-analysis of executive function. *Molecular Psychiatry*, *23*, 1198–1204.

© 2025 The Author(s). *Journal of Child Psychology and Psychiatry* published by John Wiley & Sons Ltd on behalf of Association for Child and Adolescent Mental Health.

14697610, 2026, 2, Downloaded from https://acamh.onlinelibrary.wiley.com/doi/10.1111/jcpp.70038 by Ewha Womans University Library, Wiley Online Library on [20/05/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Department of Education. (2016). *Special Educational Needs in England*.
Dijkhuis, R., de Sonneville, L., Ziermans, T., Staal, W., & Swaab, H. (2020). Autism symptoms, executive functioning and academic progress in higher education students. *Journal of Autism and Developmental Disorders*, *50*, 1353–1363.
Duncan, G.J., Dowsett, C.J., Claessens, A., Magnuson, K., Huston, A.C., Klebanov, P., … & Japel, C. (2007). School readiness and later achievement. *Developmental Psychology*, *43*, 1428–1446.
Eaves, L.C., & Ho, H.H. (1997). School placement and academic achievement in children with autistic spectrum disorders. *Journal of Developmental and Physical Disabilities*, *9*, 277–291.
Elliott, C.D. (2007). *Differential ability scales–second edition (DAS-II)*. San Antonio, TX: Harcourt Assessment.
Faja, S., Dawson, G., Sullivan, K., Meltzoff, A.N., Estes, A., & Bernier, R. (2016). Executive function predicts the development of play skills for verbal preschoolers with autism spectrum disorders. *Autism Research*, *9*, 1274–1284.
Fantuzzo, J., & McWayne, C. (2002). The relationship between peer-play interactions in the family context and dimensions of school readiness for low-income preschool children. *Journal of Educational Psychology*, *94*, 79–87.
Fossum, I.N., Øie, M.G., Orm, S., Andersen, P.N., & Skogli, E.W. (2024). Longitudinal predictors of adaptive functioning in emerging adults with and without autism spectrum disorder. *Research on Child and Adolescent Psychopathology*, *53*, 137–149.
Freeman, L.M., Locke, J., Rotheram-Fuller, E., & Mandell, D. (2017). Brief report: Examining executive and social functioning in elementary-aged children with autism. *Journal of Autism and Developmental Disorders*, *47*, 1890–1895.
Gioia, G.A., Isquith, P.K., Guy, S.C., & Kenworthy, L. (2015). *BRIEF: Behavior rating inventory of executive function*. Lutz, FL: Psychological Assessment Resources.
Gotham, K., Pickles, A., & Lord, C. (2009). Standardizing ADOS scores for a measure of severity in autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *39*, 693–705.
Greco, G., Choi, B., Michel, K., & Faja, S. (2023). Here's the story: Narrative ability and executive function in autism spectrum disorder. *Research in Autism Spectrum Disorders*, *101*, 102092.
Happé, F., Booth, R., Charlton, R., & Hughes, C. (2006). Executive function deficits in autism spectrum disorders and attention-deficit/hyperactivity disorder: Examining profiles across domains and ages. *Brain and Cognition*, *61*, 25–39.
Hill, E.L. (2004). Executive dysfunction in autism. *Trends in Cognitive Sciences*, *8*, 26–32.
Hus, V., & Lord, C. (2014). The autism diagnostic observation schedule, module 4: Revised algorithm and standardized severity scores. *Journal of Autism and Developmental Disorders*, *44*, 1996–2012.
Jones, C.R.G., Happé, F., Golden, H., Marsden, A.J.S., Tregay, J., Simonoff, E., … & Charman, T. (2009). Reading and arithmetic in adolescents with autism spectrum disorders: Peaks and dips in attainment. *Neuropsychology*, *23*(6), 718–728.
Jones, R.M., Pickles, A., & Lord, C. (2017). Evaluating the quality of peer interactions in children and adolescents with autism with the Penn Interactive Peer Play Scale (PIPPS). *Molecular Autism*, *8*, 28.
Kenny, S.A., Cameron, C.E., Karing, J.T., Ahmadi, A., Braithwaite, P.N., & McClelland, M.M. (2023). A meta-analysis of the validity of the Head-Toes-Knees-Shoulders task in predicting young children's academic performance. *Frontiers in Psychology*, *14*, 1124235.
Kenworthy, L., Black, D.O., Harrison, B., Della Rosa, A., & Wallace, G.L. (2009). Are executive control functions related to autism symptoms in high-functioning children? *Child Neuropsychology*, *15*(5), 425–440.
Kenworthy, L., Anthony, L.G., Naiman, D.Q., Cannon, L., Wills, M.C., Luong-Tran, C., … & Wallace, G.L. (2014). Randomized controlled effectiveness trial of executive function intervention for children on the autism spectrum. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, *55*, 374–383.
Kenworthy, L., Yerys, B.E., Gutermuth Anthony, L., & Wallace, G.L. (2008). Understanding executive control in autism spectrum disorders in the lab and in the real world. *Neuropsychology Review*, *18*, 320–338.
Kim, S.H., Bal, V.H., & Lord, C. (2016). Longitudinal follow-up of academic achievement in children with autism from age 9 to 18. *Autism*, *21*(3), 287–300.
Kim, S.H., Buzzell, G., & Faja, S. (2020). Neural dynamics of executive function in cognitively able kindergarteners with autism spectrum disorders as predictors of concurrent academic achievement. *Autism*, *24*, 780–794.
Kuhn, L.J., Willoughby, M.T., Blair, C.B., & McKinnon, R. (2017). Examining an executive function battery for use with preschool children with disabilities. *Journal of Autism and Developmental Disorders*, *47*, 2586–2594.
Kuijper, S.J.M., Hartman, C.A., Bogaerds-Hazenberg, S.T.M., & Hendriks, P. (2017). Narrative production in children with autism spectrum disorder (ASD) and children with attention-deficit/hyperactivity disorder (ADHD): Similarities and differences. *Journal of Abnormal Psychology*, *126*, 63–75.
Landa, R.J., & Goldberg, M.C. (2005). Language, social, and executive functions in high functioning autism: A continuum of performance. *Journal of Autism and Developmental Disorders*, *35*(5), 557–573.
Lerner, M.D., & Lonigan, C.J. (2014). Executive function among preschool children: Unitary versus distinct abilities. *Journal of Psychopathology and Behavioral Assessment*, *36*, 626–639.
Lezak, M.D., Howieson, D.B., Bigler, E.D., & Tranel, D. (2012). *Neuropsychological assessment* (5th edn (pp. xxv, 1161)). New York, NY: Oxford University Press.
Lloyd, J.E.V., Irwin, L.G., & Hertzman, C. (2009). Kindergarten school readiness and fourth-grade literacy and numeracy outcomes of children with special needs: A population-based study. *Educational Psychology*, *29*, 583–602.
Lord, C., Rutter, M., DiLavore, P.C., Risi, S., & Gotham, K. (2012). *Autism diagnostic observation schedule, second edition (ADOS-2)*. Torrance, CA: Western Psychological Services.
Marsh, A., Spagnol, V., Grove, R., & Eapen, V. (2017). Transition to school for children with autism spectrum disorder: A systematic review. *World Journal of Psychiatry*, *7*, 184–196.
May, T., Rinehart, N., Wilding, J., & Cornish, K. (2013). The role of attention in the academic attainment of children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *43*, 2147–2158.
Mayes, S.D., Calhoun, S.L., Bixler, E.O., & Zimmerman, D.N. (2009). IQ and neuropsychological predictors of academic achievement. *Learning and Individual Differences*, *19*, 238–241.
McClelland, M.M., & Cameron, C.E. (2012). Self-regulation in early childhood: Improving conceptual clarity and developing ecologically valid measures. *Child Development Perspectives*, *6*, 136–142.
McClelland, M.M., Cameron, C.E., Duncan, R., Bowles, R.P., Acock, A.C., Miao, A., & Pratt, M.E. (2014). Predictors of early growth in academic achievement: The head-toes-knees-shoulders task. *Frontiers in Psychology*, *5*, 599.
Pasqualotto, A., Mazzoni, N., Bentenuto, A., Mulè, A., Benso, F., & Venuti, P. (2021). Effects of cognitive training programs on executive function in children and adolescents with

© 2025 The Author(s). *Journal of Child Psychology and Psychiatry* published by John Wiley & Sons Ltd on behalf of Association for Child and Adolescent Mental Health.

14697610, 2026, 2, Downloaded from https://acamh.onlinelibrary.wiley.com/doi/10.1111/jcpp.70038 by Ewha Womans University Library, Wiley Online Library on [20/05/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

autism spectrum disorder: A systematic review. *Brain Sciences*, *11*, 1280.
Pellicano, E. (2010). Individual differences in executive function and central coherence predict developmental changes in theory of mind in autism. *Developmental Psychology*, *46*(2), 530–544.
Pellicano, E., Kenny, L., Brede, J., Klaric, E., Lichwa, H., & McMillin, R. (2017). Executive function predicts school readiness in autistic and typical preschool children. *Cognitive Development*, *43*, 1–13.
Pennington, B.F., & Ozonoff, S. (1996). Executive functions and developmental psychopathology. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, *37*, 51–87.
Pino Muñoz, M., & Arán Filippetti, V. (2021). Confirmatory factor analysis of the BRIEF-2 parent and teacher form: Relationship to performance-based measures of executive functions and academic achievement. *Applied Neuropsychology: Child*, *10*, 219–233.
Ponitz, C.C., McClelland, M.M., Matthews, J.S., & Morrison, F.J. (2009). A structured observation of behavioral self-regulation and its contribution to kindergarten outcomes. *Developmental Psychology*, *45*, 605–619.
Raver, C.C., Smith-Donald, R., Hayes, T., & Jones, S.M. (2005). *Self-regulation across differing risk and sociocultural contexts: Preliminary findings from the Chicago school readiness project*. Atlanta, GA: Biennial Meeting of the Society for Research in Child Development.
Reilly, S.E., Downer, J.T., & Grimm, K.J. (2022). Developmental trajectories of executive functions from preschool to kindergarten. *Developmental Science*, *25*, e13236.
Rosenthal, M., Wallace, G.L., & Lawson, R. (2013). Impairments in real-world executive function increase from childhood to adolescence in autism spectrum disorders. *Neuropsychology*, *27*, 13–18.
Spiegel, J.A., Goodrich, J.M., Morris, B.M., Osborne, C.M., & Lonigan, C.J. (2021). Relations between executive functions and academic outcomes in elementary school children: A meta-analysis. *Psychological Bulletin*, *147*, 329–351.
StataCorp (2023). *Stata statistical software: Release 18*. College Station, TX: StataCorp LLC.
St John, T., Dawson, G., & Estes, A. (2018). Brief Report: Executive function as a predictor of academic achievement in school-aged children with ASD. *Journal of Autism and Developmental Disorders*, *48*, 276–283.
Tamm, L., Hamik, E., Yeung, T.S., Zoromski, A.K., Mara, C.A., & Duncan, A. (2024). Achieving Independence and mastery in school: A school-based executive function group intervention for autistic middle schoolers. *Journal of Autism and Developmental Disorders*, *54*, 4357–4368.
Toplak, M.E., West, R.F., & Stanovich, K.E. (2013). Practitioner Review: Do performance-based measures and ratings of executive function assess the same construct? *Journal of Child Psychology and Psychiatry*, *54*, 131–143.
Torske, T., Nærland, T., Øie, M.G., Stenberg, N., & Andreassen, O.A. (2018). Metacognitive aspects of executive function are highly associated with social functioning on parent-rated measures in children with autism spectrum disorder. *Frontiers in Behavioral Neuroscience*, *11*, 258.
Tschida, J.E., & Yerys, B.E. (2022). Real-world executive functioning for autistic children in school and home settings. *Autism*, *26*, 1095–1107.
Wallace, G.L., Kenworthy, L., Pugliese, C.E., Popal, H.S., White, E.I., Brodsky, E., & Martin, A. (2016). Real-world executive functions in adults with autism spectrum disorder: Profiles of impairment and associations with adaptive functioning and co-morbid anxiety and depression. *Journal of Autism and Developmental Disorders*, *46*, 1071–1083.
Wiebe, S.A., Sheffield, T., Nelson, J.M., Clark, C.A.C., Chevalier, N., & Espy, K.A. (2011). The structure of executive function in 3-year-old children. *Journal of Experimental Child Psychology*, *108*, 436–452.
Willoughby, M.T., Blair, C.B., Wirth, R.J., & Greenberg, M. (2010). The measurement of executive function at age 3 years: Psychometric properties and criterion validity of a new battery of tasks. *Psychological Assessment*, *22*, 306–317.
Willoughby, M.T., Blair, C.B., Wirth, R.J., & Greenberg, M. (2012). The measurement of executive function at age 5: Psychometric properties and relationship to academic achievement. *Psychological Assessment*, *24*, 226–239.
Willoughby, M.T., Kuhn, L.J., Blair, C.B., Samek, A., & List, J.A. (2017). The test-retest reliability of the latent construct of executive function depends on whether tasks are represented as formative or reflective indicators. *Child Neuropsychology*, *23*, 822–837.
Willoughby, M.T., Piper, B., Oyanga, A., & Merseth King, K. (2019). Measuring executive function skills in young children in Kenya: Associations with school readiness. *Developmental Science*, *22*, e12818.
Willoughby, M.T., Wylie, A.C., & Little, M.H. (2019). Testing longitudinal associations between executive function and academic achievement. *Developmental Psychology*, *55*, 767–779.
Woodcock, R.W., McGrew, K.S., Mather, N., & Schrank, F. (2001). *Woodcock-Johnson III: Tests of achievement*. Itasca, IL: Riverside Publishing.
Xie, R., Sun, X., Yang, L., & Guo, Y. (2020). Characteristic executive dysfunction for high-functioning autism sustained to adulthood. *Autism Research*, *13*, 2102–2121.

Accepted for publication: 14 May 2025

© 2025 The Author(s). *Journal of Child Psychology and Psychiatry* published by John Wiley & Sons Ltd on behalf of Association for Child and Adolescent Mental Health.

14697610, 2026, 2, Downloaded from https://acamh.onlinelibrary.wiley.com/doi/10.1111/jcpp.70038 by Ewha Womans University Library, Wiley Online Library on [20/05/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License