

## Improving academic performance through a school-based intervention targeting academic executive functions – a pilot study

Leanne Tamm, Sydney M. Risley, Elizabeth Hamik, Angela Combs, Lauren B. Jones, Jamie Patronick, Tat Shing Yeung, Allison K. Zoromski & Amie Duncan

To cite this article: Leanne Tamm, Sydney M. Risley, Elizabeth Hamik, Angela Combs, Lauren B. Jones, Jamie Patronick, Tat Shing Yeung, Allison K. Zoromski & Amie Duncan (2022): Improving academic performance through a school-based intervention targeting academic executive functions – a pilot study, *International Journal of Developmental Disabilities*, DOI: [10.1080/20473869.2022.2095690](https://doi.org/10.1080/20473869.2022.2095690)

To link to this article: <https://doi.org/10.1080/20473869.2022.2095690>



Published online: 11 Jul 2022.



Submit your article to this journal [↗](#)



View related articles [↗](#)



View Crossmark data [↗](#)

# Improving academic performance through a school-based intervention targeting academic executive functions – a pilot study

Leanne Tamm<sup>1,2</sup> , Sydney M. Risley<sup>3</sup> , Elizabeth Hamik<sup>1</sup> , Angela Combs<sup>4</sup> , Lauren B. Jones<sup>3</sup> , Jamie Patronick<sup>4</sup> , Tat Shing Yeung<sup>1</sup> , Allison K. Zoromski<sup>1,2</sup>  and Amie Duncan<sup>1,2</sup> 

<sup>1</sup>Department of Pediatrics, Division of Behavioral Medicine and Clinical Psychology, Cincinnati Children's Hospital Medical Center, Cincinnati, OH, USA; <sup>2</sup>University of Cincinnati College of Medicine, Cincinnati, OH, USA; <sup>3</sup>Miami University, Oxford, OH, USA; <sup>4</sup>College of Arts and Sciences, University of Cincinnati, Cincinnati, OH, USA

**Background:** Academic challenges such as losing/not turning in assignments, misplacing materials, and inefficient studying are common in middle-school students with autism spectrum disorder (ASD) without intellectual disability. Deficits in organization, planning, prioritizing, memory/materials management, and studying skills [i.e. academic executive functioning (EF) deficits] contribute to these challenges.

**Aims:** To assess the feasibility, satisfaction, and initial efficacy of the school-based version of the Achieving Independence and Mastery in School (AIMS) intervention in a proof-of-concept trial with 6 students with ASD.

**Methods:** 6 middle-schoolers with ASD without ID participated in AIMS. Parents and teachers rated academic EFs and functioning.

**Results:** Results suggest high feasibility, youth satisfaction, and improved EF skills and academic behaviors by parent and teacher report.

**Conclusions:** These promising results support further intervention development and suggest that academic EF skills are malleable in students with ASD.

**Keywords:** study skills, academic performance, executive function training, homework, school-based intervention

Individuals with an autism spectrum disorder (ASD) without an intellectual disability (ID) often struggle academically (Keen *et al.* 2016, Kim *et al.* 2018, Baixauli *et al.* 2021). This includes challenges with writing, attention, complex processing across domains (e.g., problem solving), numerical operations, listening comprehension, and reading comprehension. These academic challenges are linked to deficits in executive functioning (EF) (Ameis *et al.* 2022), which are common in ASD, such as cognitive flexibility, organization, time management, prioritization, initiation, multi-tasking, working memory, and planning deficits (Berenguer *et al.* 2018, Tschida and Yerys 2021). Due to their EF challenges, students with ASD may struggle to acquire

and manage critical academic behaviors (e.g. organizing and tracking assignments, prioritizing tasks, getting started on tasks, completing homework, studying effectively, and managing large assignments).

Interventions targeting academic EF skills, including planning, organization, time management, and study skills for students with ASD are needed (Buescher *et al.* 2014, Ameis *et al.* 2022), particularly for those in middle school. While the transition to middle school presents challenges for all students, students with ASD are at heightened risk for experiencing difficulties given their problems with EF and social competency that are potent risk factors for academic problems in the middle school environment (Ameis *et al.* 2022). Older children with ASD show greater EF problems (organization and planning) than younger children with ASD (Pugliese *et al.* 2015). These difficulties may manifest in middle

Correspondence to: L. Tamm, Center for ADHD, Cincinnati Children's Hospital Medical Center, 3333 Burnet Ave, MLC 10006, Cincinnati, OH, 45229-3039, USA. Email: leanne.tamm@cchmc.org

**Table 1. Achieving independence and mastery in school-outpatient (AIMS-O) and AIMS school-based content.**

Session	AIMS Version
	<b>Original Version of AIMS-O</b>
1	Orientation to AIMS-O and Understanding Executive Functioning
2	ABCs of Problem Solving
3	Using a Behavioral Agreement to Promote Use of AIMS-O Skills
4	Developing a Homework Organization System
5	Study Skills (study cards, summarizing, storyboards and plot diagrams)
6	Summarizing
7	Maintaining Skills and School Communication Tips
	<b>School-based Version of AIMS</b>
	<b>Module 1 - EF and Social Communication</b>
1	Overview of AIMS
2 & 3	What is executive functioning?
4 & 5	What is social communication?
	<b>Module 2 – ABCs of Problem Solving</b>
6 & 7	ABCs of Problem Solving
8	Establish Problem Solving Plan
	<b>Module 3 - Organization Systems</b>
9	Binder organization system
10	Backpack organization system
11	Locker organization system
12	Computer organization system
13	Problem Solving Plan check-in
	<b>Module 4 - Planning and Prioritization</b>
14	Keeping track of homework
15	Prioritizing homework
16	Problem Solving Plan check-in
17 & 18	Breaking down long term assignments
19	Breaking down studying for tests and quizzes
20	Problem Solving Plan check-in
	<b>Module 5 - Study Strategies</b>
21	Using effective study strategies
22	Study strategies (textbook, notes, study guide)
23 – 26	Study strategies (study cards)
27	Problem Solving Plan check-in
28	Study strategies (acronyms, acrostics, songs)
29 & 30	Study strategies (summarizing)
31 & 32	Study strategies (plot diagram and story board)
33	My study strategies and Problem Solving Plan check-in
34	<b>Final review of concepts &amp; AIMS Graduation</b>

school as difficulty following multistep directions, keeping materials organized, and being a ‘self-starter’ (Rosenthal *et al.* 2013). The transition to middle school is also a natural time for caregivers to demand increased academic independence (Kiuru *et al.* 2020). However, caregivers of youth with ASD often struggle to foster this increasing independence, in part because they may lack the knowledge and skills regarding how to facilitate this process. Unfortunately, there are currently no evidence-based interventions targeting EF skills for middle-school students with ASD (Hugh *et al.* 2021). Unstuck and On Target, a promising school-based intervention targeting behavioral/cognitive regulation for elementary school youth with ASD, does not target academic outcomes specifically or involve applying EF skills to academic tasks (Kenworthy *et al.* 2014). There are, however, multiple baseline studies providing support for specific strategies to improve organization (Dorminy *et al.* 2009), work initiation (Brown and Mirenda 2006), and on-task behaviors (Wilczynski *et al.* 2005) for youth with ASD, suggesting these skills can be improved through intervention.

Achieving Independence and Mastery in School – Outpatient (AIMS-O) is a 7-session intervention (see Table 1) teaching academic EF skills using evidence-based strategies for youth with ASD to promote increased independence related to academics (Tamm *et al.* 2021). AIMS-O was developed by a team of psychologists with expertise in EF and ASD. AIMS-O was partially based on the evidence-based interventions targeting academic EF skills in youth with attention-deficit/hyperactivity disorder (ADHD; Langberg 2014, Abikoff *et al.* 2013). These interventions emerged from growing recognition that many of the academic problems exhibited by children with ADHD may represent behavioral manifestations of poor EF (Pennington and Ozonoff 1996), including problems with temporal and materials organization (i.e., often has difficulty organizing tasks and activities, often loses things, is often forgetful, and often fails to finish school-work, chores, or duties) (Langberg *et al.* 2011). For example, deficits in arousal, inhibitory control, delay tolerance, working memory, and time perception likely impede self-regulatory behaviors and interfere with organization and

planning (Abikoff et al. 2013). Such deficits are manifested as forgetting to complete or losing homework assignments, difficulties planning for the completion of long-term projects and studying for tests, and problems keeping class materials organized (Langberg et al. 2011). An initial trial of AIMS-O with 3 families showed that although parents and youth with ASD benefited from the intervention designed for youth with ADHD (e.g., gains in academic EF skills), significant work was needed to adapt the intervention for the ASD population (e.g., youth with ASD reported not fully understanding EF concepts, parents reported that youth struggled with implementing skills) (Tamm et al. 2020). Thus, the refined AIMS-O incorporates ASD specific evidence-based strategies including didactic instruction, repetition, individualized feedback, reinforcement, task analysis, visual supports, video modeling, graphic organizers, technology, and peer support (Steinbrenner et al. 2020). AIMS-O is administered by clinicians to parent and youth dyads in the outpatient setting. AIMS-O appears to improve EF skills, particularly organization and materials management, as rated by parents and classroom teachers (Tamm et al. 2021).

Adapting AIMS-O to be delivered in the naturalistic middle school setting where students actually need to use the skills may also be important to improve academic functioning and decrease barriers to accessing care. For example, in AIMS-O students work with their parents to use their planner to make a plan and start homework assignments, but it is critical that they also learn to write down and prioritize assignments in a planner while at school and then bring home the necessary materials. A review of services offered in the school setting in the context of an individualized education program (IEP;  $n = 23$  middle-schoolers with ASD without ID in 16 schools) confirmed that there are few school-based services addressing EF deficits (Duncan et al. in press), despite parents and teachers identifying a prevalence of such challenges in students with ASD (Tamm et al. 2020). Thus, a school-based adaptation of AIMS-O was developed (i.e., AIMS).

Successfully exporting a behavioral intervention to an educational setting involves more than just transferring it to the school environment. It involves integrating it into the school culture, and addressing concerns related to staffing, setting, and sustainability. The research team collaborated closely with multiple school districts by involving key stakeholders (administrators, teachers, special education personnel) in planning for adoption of the AIMS program by schools. Two focus groups with school personnel ( $n = 15$  from 14 different schools) were conducted in order to enhance our understanding of the profile of EF deficits and related academic challenges in middle-school youth with ASD and how school personnel address these deficits. Results indicated that middle school youth with ASD without

ID demonstrate significant EF deficits, particularly in relation to organization, planning and prioritizing, task initiation, persevering, maintaining focus, and flexibility, which negatively impact their ability to be successful in the general education environment (Duncan et al. in press). A wide range of services and strategies were reported to be employed in the classroom context to address EF challenges, but not in the context of a structured course designed to specifically target EF and study skills. School stakeholders expressed interest in using AIMS-O but requested that the intervention be adapted to be delivered across the course of an academic semester, be delivered by school personnel with support and consultation, and include a parent education component. Thus, the school-based version of AIMS was designed to be flexibly implemented during the school day to groups of up to six students with ASD for two classroom periods per week across an academic semester. Although much of the content is similar between AIMS-O and AIMS, having significantly more sessions over a longer time allows for increased didactics and additional practice. Additionally, AIMS incorporates new content in social communication relevant for academics (e.g., working on group projects) and school-specific adaptations (e.g., locker organization) (see Table 1).

In the current study, the feasibility (i.e., adherence to intervention manual, attendance, real world practice completion), satisfaction (i.e., adolescent ratings of ability to understand content and whether they liked the handouts, videos, and activities/games), and initial efficacy (i.e., parent and teacher ratings of academic EFs) of the school-based version of AIMS were investigated in a proof-of-concept trial with 6 students with ASD without ID. Specifically, our research questions were whether school personnel could feasibly deliver AIMS and whether students participating in AIMS would show improvements in EF and academic behaviors.

## Method

### Participants

Participants included 6 middle-school students with ASD at a school specializing in teaching students with ASD. The mean age was 12.83 ( $SD = 0.41$ ) years. The sample was predominantly male (83.3%) and Caucasian (83.3%). Eligible participants had a clinically-elevated standardized score (i.e.,  $T$ -score  $> 65$ ) on the Organization of Materials, Planning/Organization, or Monitor subscales of the Behavior Rating Inventory of Executive Function, Second Edition or BRIEF-2 (Gioia et al. 2015), by parent or teacher report. A diagnosis of ASD was confirmed using the Autism Diagnostic Observation Schedule, 2nd Edition (ADOS-2; Lord et al. 2012). An  $IQ \geq 80$  was confirmed using the Kaufman Brief Intelligence Test, Second Edition (KBIT-2) (Kaufman and Kaufman, 2004). The average

estimated IQ was 84.83 ( $SD = 24.93$ ). The primary AIMS leader was a 26-year-old special education teacher with 4 years of experience. A 25-year-old para-professional with 5 years of experience was the back-up leader and also provided behavioral support in each session (e.g., passing out tickets as part of the motivation system).

### Procedures

The study was approved by the Cincinnati Childrens Hospital Medical Center Institutional Review Board. School personnel identified individuals with ASD without ID that, in their perception, would benefit from an intervention targeting organization, planning, materials management, and study skills. Letters were sent to parents of these students by school personnel allowing families to opt in to being contacted by the research team. Those parents who opted in were contacted by phone and completed an initial phone screen and provided informed consent electronically. Parents were emailed the BRIEF-2 and a consent giving teachers permission to release information. Teachers were subsequently emailed the BRIEF-2. Middle-school students who met initial eligibility criteria provided assent and participated in an eligibility evaluation including the ADOS-2 and KBIT-2. Parents and classroom teachers of eligible students then completed additional rating scales. The primary AIMS leader and back-up leader participated in six hours of training prior to the start of the semester, including a detailed review of the intervention manual and materials as well as behavioral management strategies for youth with ASD. Students participated in the AIMS intervention 2-3 times per week for 45-minutes during the school day for a 16-week academic semester. AIMS was offered during a class period that was used for social skills intervention on non-AIMS days. The AIMS leader participated in a weekly 45-minute consultation session with research staff. The consultants highlighted the AIMS leader's strengths and challenges related to compliance with the AIMS manual and helped prepare for upcoming sessions. Additionally, parents attended three after-school sessions delivered by the AIMS leader via video conferencing offered after approximately one, two, and three months of treatment. Weekly snapshots providing a brief description of the content covered were emailed to parents and classroom teachers. At the end of the academic semester, parents and classroom teachers completed ratings of academic EF skills.

### AIMS intervention

AIMS involves teaching academic EF skills using evidence-based strategies for students with ASD (e.g., behavior agreement, visual supports, video modeling, technology, behavioral techniques such as reinforcement) to promote increased independence related to

academics. AIMS is divided into 5 modules targeting: (1) EF and Social Communication, (2) Problem Solving, (3) Organization Systems, (4) Planning and Prioritization, and (5) Study Strategies (see Table 1). AIMS includes two weekly 40-60 min sessions over the course of a full academic semester. The current school occasionally opted to offer an additional weekly session ( $n = 5$ ) to allow students additional time to work on their real world practice assignment. At the beginning of each session, students were provided with a visual schedule. Each session involved a review of a real world practice (i.e., AIMS homework) assignment and key concepts from previous sessions. The main content involved a didactic component (e.g., direct instruction, video clips, activities) illustrating key AIMS concepts (i.e., the content targeted at each session such as problem solving, study cards, organizational systems, etc.) followed by an in-session practice of strategies with coaching/feedback. Students were assigned an AIMS real-world practice assignment each session to promote additional practice. Some of the handouts and videos can be found at [www.aims-ef.com](http://www.aims-ef.com). A motivation system was implemented; students earned tickets valued at 10 cents for active participation and completion of real-world practice assignments and could trade them in in \$5 increments (up to \$25 per student). AIMS also includes three after-school parent sessions to promote generalization to home. The three parent sessions included an overview of the AIMS modules, which were also summarized in the weekly snapshots, and provided strategies promoting reinforcement of the adolescent practicing AIMS skills.

### Measures

Measures were selected to assess feasibility (i.e., adherence to intervention manual, attendance, real world practice completion), satisfaction (i.e., adolescent ratings of ability to understand content and whether they liked the handouts, videos, and activities/games), and initial efficacy of the school-based version of AIMS. To assess initial efficacy, measures were selected to evaluate whether AIMS impacted organization, planning, materials management, frequency of academic challenges related to EF as rated by parents and teachers, and frequency of problematic homework management behaviors as rated by parents.

#### Measures of feasibility

**Fidelity.** Each AIMS session was videotaped. Research staff coded each session for adherence using a 3-point coding scheme (0 = *non-adherent [did not cover the content]*, 1 = *partially adherent [introduced the content but covered less than 80% of content in accordance with manual specifications]*, and 2 = *adherent [covered 80% or more of content completely in accordance with manual specifications]*).

**Table 2. AIMS acceptability of intervention questionnaire.**

	M ± SD
<b>How well do you understand:</b>	
How executive functioning impacts academics	4.2 ± 0.84
Problem solving	4.4 ± 0.55
Keeping school materials organized	3.6 ± 1.34
How to organize backpack	4.2 ± 1.30
How to organize binder	3.6 ± 0.89
How to organize locker	4.0 ± 1.41
How to organize computer	3.4 ± 1.67
How to use planner	3.8 ± 1.30
Breaking down long term assignments	3.8 ± 1.64
Breaking down studying	4.0 ± 1.73
Study strategies	4.0 ± 1.22
Study cards	4.0 ± 1.73
Summarizing strategies	4.4 ± 0.55
How to use a problem solving plan	4.2 ± 0.89
<b>How much did you like the handouts</b>	<b>2.6 ± 1.14</b>
<b>How much did you like the videos</b>	<b>3.8 ± 1.79</b>
<b>How much did you like the activities and games</b>	<b>3.8 ± 1.30</b>
<b>How likely are you to use information and skills in the future</b>	<b>4.0 ± 1.73</b>

Note. 1 to 5 Likert scale, 5 = best.

### Attendance and real world practice completion.

Student attendance and compliance with real world practice assignments were recorded by research staff at each session. Specifically, students reported on real world practice assignment completion at the beginning of the session and this was noted on a tracking document. Unfortunately the quality of the real world practice assignments was not formally evaluated, although the AIMS leader addressed this with students as part of the review of real world practice in each session when needed.

### AIMS acceptability of intervention questionnaire (AAIQ).

Students provided feedback after the last AIMS session on a 5-point Likert scale ( $1 = \text{not at all}$  to  $5 = \text{a lot}$ ) for how well they understood the content, how much they liked the videos, activities/games, and handouts, and how likely they would be to use the information they learned in the future. This measure was developed by the research team to specifically align with AIMS in order to inform treatment refinement.

### Measures of EF and academic behaviors

**Homework problems checklist (HPC).** The HPC is a 20-item parent-report instrument assessing homework problems (Anesko et al. 1987, Langberg et al. 2010). Parents rate the frequency of homework behaviors on a 0 (*never*) to 3 (*very often*) scale. Factor analyses indicate that the HPC has two factors, Homework Completion and Homework Materials Management (Langberg et al. 2010).

**Children's organizational skills scale (COSS).** The COSS (Abikoff and Gallagher 2009) is a rating scale completed by parents and teachers assessing ability to organize time, materials and actions to complete tasks

on a 1 (*hardly ever*) to 4 (*just about all of the time*) scale. The COSS yields *T*-scores for Task Planning, Organized Actions, and Memory and Materials Management subscales.

### Adolescent academic problems checklist (AAPC).

The AAPC (Sibley et al. 2014) assesses frequency of observable academic problem behavior as perceived by parents and teachers on a 0 (*not at all*) to 3 (*very much*) scale. The AAPC generates two factors, Academic Executive Functioning Skills and Disruptive Behavior during Academics.

### Data analyses

Attendance, satisfaction, and fidelity results were summarized. The study is underpowered, as is typical for a treatment development trial assessing feasibility and signal of response, thus formal statistical analyses were not conducted. Instead Cohen's *d* effect sizes (Cohen 1992) correcting for dependence between means were computed [ $\sigma D = \sigma \cdot 2 \cdot (1 - \rho)$ ; [https://www.psychometrica.de/effect\\_size.html](https://www.psychometrica.de/effect_size.html)].

### Results

All 6 students completed the AIMS intervention and pre- and post-intervention teacher ratings were collected for all students. One student did not complete the AAIQ at the last session, and one parent did not provide ratings at post. The primary AIMS leader delivered all but 6 of the 34 sessions, which were delivered by the back-up leader. AIMS leader adherence to the manual was excellent (92.86% fully adherent, 6.12% partially adherent, and 1.02% non-adherent). Students on average attended 29.2 ( $SD = 5.3$ ) of 34 sessions and reported completing 23.2 ( $SD = 4.8$ ) of 27 real-world practice assignments. Parent attendance at the three parent education sessions was also good (6 attended session 1, and 5 attended sessions 2 and 3). Missed sessions were due to the COVID-19 pandemic and/or student illness.

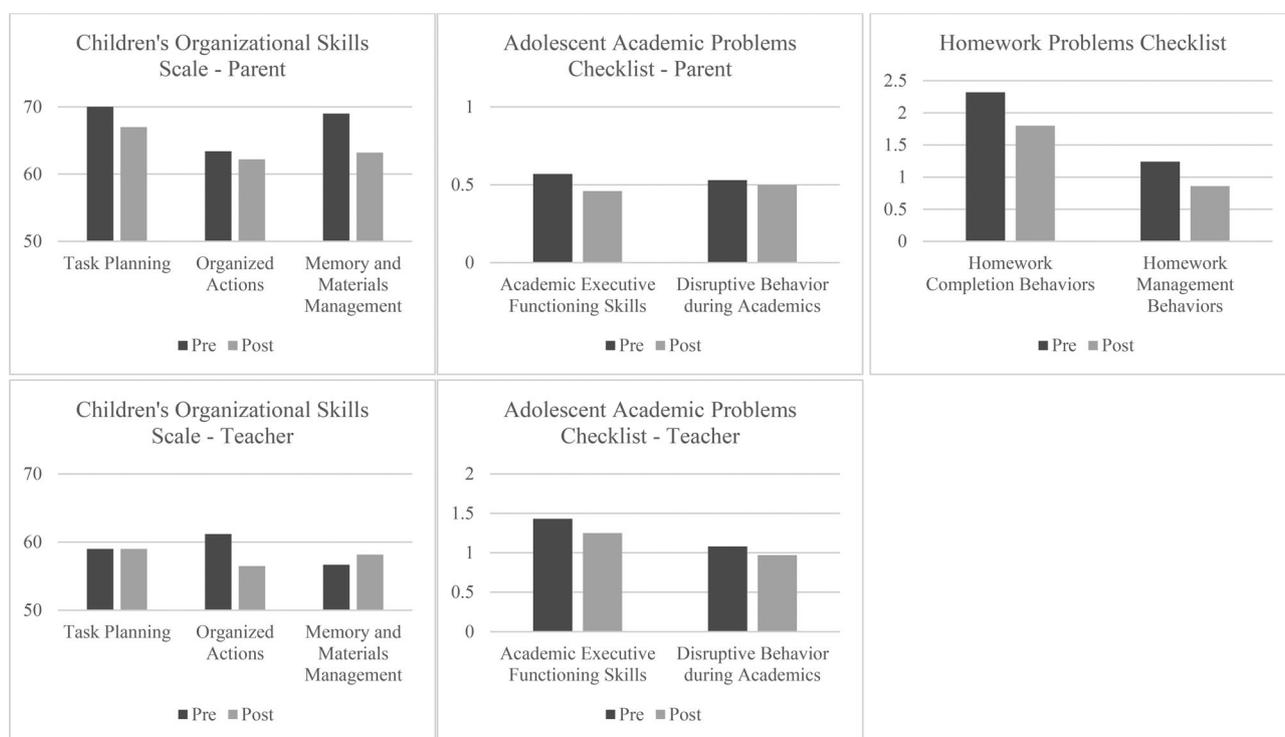
Students gave high AAIQ ratings ( $\geq 4$ ) for how well they understood backpack and locker organization skills, study skills, and problem solving plans, and reported plans to use the information learned in AIMS in the future (Table 2). Students' ratings were acceptable ( $> 3$ ) for their understanding of binder and computer organization skills, and lowest for how much they liked the handouts.

Parents reported improvements with a large effect size for the HPC factors and AAPC Academic Executive Functioning Skills, improvements with a moderate effect size for COSS Memory and Materials Management, and improvements with a small effect size for COSS Task Planning and Organized Actions (Table 3, Figure 1). Teachers reported improvements with a moderate effect size for COSS Organized

**Table 3. Effect sizes for rating scales completed before and after school-based AIMS.**

	Pre M (SD)	Post M (SD)	Cohen's d
<b>Parent Ratings</b>			
<i>Homework Problems Checklist – Parent (HPC)</i>			
Homework Completion Behaviors	2.32 (0.55)	1.80 (0.52)	.96
Homework Management Behaviors	1.24 (0.46)	0.86 (0.48)	.81
<i>Children's Organizational Skills Scale – Parent (COSS)</i>			
Task Planning	70.40 (13.80)	67.00 (14.35)	.24
Organized Actions	63.40 (4.93)	62.20 (4.86)	.25
Memory and Materials Management	69.00 (11.96)	63.20 (3.03)	.49
<i>Adolescent Academic Problems Checklist – Parent (AAPC)</i>			
Academic Executive Functioning Skills	0.57 (0.23)	0.46 (0.36)	1.12
Disruptive Behavior during Academics	0.53 (0.39)	0.50 (0.28)	.05
<b>Teacher Ratings</b>			
<i>Children's Organizational Skills Scale – Teacher (COSS)</i>			
Task Planning	59.00 (12.12)	59.00 (11.83)	0
Organized Actions	61.17 (8.76)	56.50 (7.06)	.48
Memory and Materials Management	56.67 (16.51)	58.17 (15.74)	-.09
<i>Adolescent Academic Problems Checklist – Teacher (AAPC)</i>			
Academic Executive Functioning Skills	1.43 (0.59)	1.25 (0.53)	.31
Disruptive Behavior during Academics	1.08 (0.87)	0.97 (0.80)	.13

Note. Cohen's d effect sizes corrected for dependence between means (>.2 = small; >.5 = medium; >.8 = large).



**Figure 1. Evidence of initial efficacy.**

Actions and a small effect size for AAPC Academic Executive Functioning Skills. Negligible effects were observed for parent- and teacher-rated AAPC Disruptive Behavior during Academics and teacher-rated COSS Task Planning and Memory and Materials Management.

**Discussion**

Although replication is warranted, this proof-of-concept trial shows that the AIMS intervention, an adaptation and extension of the AIMS-O intervention, can feasibly be delivered in the middle-school setting by school personnel, with high adherence to the manual. Students had good attendance and compliance with real world

practice assignments and reported understanding the content and planning to continue using skills in the future. Both parents and teachers reported improved EF and academic behaviors with parents particularly noting improved homework behaviors and academic EF skills and teachers particularly observing improved organizational skills. Unsurprisingly, given the focus of AIMS and low scores at baseline, a negligible effect was observed for parent- and teacher-rated AAPC Disruptive Behavior during Academics subscale.

Large effect sizes were observed for parent report of Homework Completion behaviors (e.g., efficiency of work completion, distractibility, inattention, and parent-child interactions during homework), Homework

Management behaviors (e.g., consistently records homework, brings home necessary materials), and Academic Executive Functioning Skills (e.g., takes notes, organizes work, records homework in a daily agenda, maintains organized folders, and follows instructions), and a moderate effect size was observed for Memory and Materials Management (e.g., ability to track assignments, recall due dates, and keep track of papers, books, and supplies). These results are particularly compelling as the parents were less involved in the AIMS intervention compared to AIMS-O sessions, the latter which involved a significant role for parents at all 7 sessions.

Effect sizes for teacher ratings were smaller in magnitude, but suggest improvements on Academic Executive Functioning Skills and Organized Actions (e.g., ability to use practical routines and tools to stay organized). Notably, teacher COSS ratings at pre-intervention were also lower than that reported by parents, which may be partially explained by the specialized school having systems in place to help students manage their tasks and materials, and therefore providing less room for improvement. Although lower, the teacher COSS scores were still in the borderline range for clinical problems in the various EF domains; it may be beneficial to engage teachers in the intervention process to boost the impact of AIMS on academic behaviors.

It is also important to not underestimate the meaning of discrepancies between informants and to use them to understand the child's functioning more fully (Talbot et al. 2018). It is likely that when discrepancies are observed they reflect real-world variations in children's behaviors exhibited across contexts (De Los Reyes et al. 2009). Teachers noted moderate effects for COSS Organized Actions and parents noted moderate effects for COSS Memory and Materials Management. These findings could possibly indicate that teachers observed the adolescent utilizing organizational skills such as having an organized binder, backpack, locker, etc. at school, while parents noticed improvements in the management of materials needed for tasks and assignments and improved homework management and completion behaviors as rated on the HPC at home, potentially resulting from the adolescent using these organization systems in the school context.

Small (parent) to no (teacher) impact of AIMS was observed for COSS Task Planning which assesses an adolescent's ability to complete tasks on time, manage time, and plan the actions needed to carry out tasks, homework, and projects. Refinements to AIMS may be warranted to increase focus on the use of a planner and other prioritization skills, particularly in the classroom context. Additional possible AIMS refinements include improving the quality of the handouts given the relatively lower ratings for this item on the AIMS Acceptability of Intervention Questionnaire.

Overall, the observed effect sizes are largely in line with those observed for parent and teacher following AIMS-O (Tamm et al. 2021). It should also be noted that effect sizes for the youth with ASD were in the range obtained for youth with ADHD in the original ADHD intervention from which AIMS-O and AIMS were adapted [i.e., moderate to large effect sizes on the HPC factors (Ciesielski et al. 2019; Langberg et al. 2008)]. Thus, it appears that AIMS positively impacts students' ability to use strategies to manage and organize school work, which are significant problems for middle-school students with ASD that impact academic functioning (Tamm et al. 2020).

### Limitations and future directions

The sample size was small and conducted in a specialized school for students with ASD, limiting generalizability. There was no active control group to ensure that the gains observed were specifically due to AIMS. Relatedly, individuals in the AIMS intervention may have received other treatment (e.g., therapy) during the semester and this was not specifically discouraged nor captured. Ratings were obtained by parents who were aware and teachers who were likely aware that the student was participating in an intervention targeting EF. Additionally, no real-world academic outcomes (e.g., grades) were obtained. Future studies will examine use of AIMS strategies (e.g., writing assignments in a planner, organizing backpack) prior to treatment, during treatment, and after treatment to enhance understanding of skill acquisition and generalization. Our assessment of AIMS treatment acceptability was only obtained at post, was limited to adolescent report (i.e., did not include other stakeholders such as school administrators and parents), and did not get at other aspects of acceptability (e.g., burden, perceived effectiveness, fit with ethical values, and self-efficacy) (Sekhon et al. 2022). Future work will be needed to assess AIMS in the general education setting with a larger sample of fully-included participants, utilization of objective academic outcomes and/or masked raters, and an active comparison control group to account for expectancy effects, time, and attention.

### Conclusions

Taken together with previous treatment development efforts of the clinic-based version of AIMS-O (Tamm et al. 2021), AIMS appears to be a promising intervention for improving key EF behaviors relevant for academic performance in middle-school students with ASD. Given the dearth of evidence-based treatments for middle-schoolers with ASD targeting critical academic EFs such as organization systems and study strategies, AIMS holds promise as treatment that could be implemented in general middle-school settings. A

randomized clinical trial is needed to replicate and confirm specificity of findings.

## Conflict of interest

The authors report no conflict of interest.

## Funding

The research reported here was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R324A180053 to Cincinnati Children's Hospital Medical Center. The opinions expressed are those of the authors and do not represent views of the Institute or the U.S. Department of Education.

## ORCID

Leanne Tamm  <http://orcid.org/0000-0001-6066-1669>

Sydney M. Risley  <http://orcid.org/0000-0002-4145-5293>

Elizabeth Hamik  <http://orcid.org/0000-0002-7740-7306>

Angela Combs  <http://orcid.org/0000-0001-9391-7835>

Lauren B. Jones  <http://orcid.org/0000-0001-8366-0511>

Jamie Patronick  <http://orcid.org/0000-0002-9425-5244>

Tat Shing Yeung  <http://orcid.org/0000-0002-7326-2859>

Allison K. Zoromski  <http://orcid.org/0000-0001-7223-0145>

Amie Duncan  <http://orcid.org/0000-0002-6317-4302>

## References

- Abikoff, H. A. and Gallagher, R. 2009. *The children's organizational skills scales technical manual*. North Tonawanda: Multihealth Systems, Inc.
- Abikoff, H. A., Gallagher, R., Wells, K. C., Murray, D. W., Huang, L., Lu, F. and Petkova, E. 2013. Remediating organizational functioning in children with ADHD: immediate and long-term effects from a randomized controlled trial. *Journal of Consulting and Clinical Psychology*, 81, 113–128.
- Ameis, S. H., Haltigan, J. D., Lyon, R. E., Sawyer, A., Mirenda, P., Kerns, C. M., Smith, I. M., Vaillancourt, T., Volden, J., Waddell, C., Zwaigenbaum, L., Bennett, T., Duku, E., Elsabbagh, M., Georgiades, S., Ungar, W. J., Zaidman-Zait, A., Lai, M. C. and Szatmari, P. and Pathways in, A. S. D. S. T. 2022. Middle-childhood executive functioning mediates associations between early-childhood autism symptoms and adolescent mental health, academic and functional outcomes in autistic children. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, 63, 553–562.
- Anesko, K. M., Schoiock, G., Ramirez, R. and Levine, F. M. 1987. The homework problem checklist: assessing children's homework problems. *Behavioral Assessment*, 9, 179–185.
- Baixaui, I., Rosello, B., Berenguer, C., Tellez de Meneses, M. and Miranda, A. 2021. Reading and writing skills in adolescents with Autism Spectrum Disorder without intellectual disability. *Frontiers in Psychology*, 12, 646849.
- Berenguer, C., Rosello, B. and Leader, G. 2018. A review of executive functions in autism spectrum disorder and attention deficit

- hyperactivity disorder. *Journal of Educational and Developmental Psychology*, 8, 107–119.
- Brown, K. E. and Mirenda, P. 2006. Contingency mapping: use of a novel visual support strategy as an adjunct to functional equivalence training. *Journal of Positive Behavior Interventions*, 8, 155–164.
- Buescher, A. V., Cidav, Z., Knapp, M. and Mandell, D. S. 2014. Costs of autism spectrum disorders in the United Kingdom and the United States. *JAMA Pediatrics*, 168, 721–728.
- Ciesielski, H. A., Tamm, L., Vaughn, A., Cyran, J. and Epstein, J. N. 2019. Academic success groups for middle-school children with ADHD in the outpatient mental health setting. *Journal of Attention Disorders*, 23, 409–417.
- Cohen, J. 1992. A power primer. *Psychological Bulletin*, 112, 155–159.
- De Los Reyes, A., Henry, D. B., Tolan, P. H. and Wakschlag, L. S. 2009. Linking informant discrepancies to observed variations in young children's disruptive behavior. *Journal of Abnormal Child Psychology*, 37, 637–652.
- Dorminy, K. P., Luscre, D. and Gast, D. L. 2009. Teaching organizational skills to children with high functioning autism and asperger's syndrome. *Education and Training in Developmental Disabilities*, 44, 538–550.
- Duncan, A., Risley, S., Combs, A., Lacey, H. M., Hamik, E., Fershtman, C., Kneeskern, E., Patel, M., Crosby, L., Hood, A., Zoromski, A. K. and Tamm, L. *in press*. *School challenges and services for mainstreamed middle schoolers with autism*. Focus on Autism and Other Developmental Disabilities.
- Gioia, G. A., Isquith, P. K., Guy, S. C. and Kenworthy, L. 2015. *Behavior rating inventory of executive function, second edition, professional manual*. Lutz: Psychological Assessment Resources, Inc.
- Hugh, M. L., Ahlers, K., Joshi, M. and Locke, J. 2021. School-implemented interventions for preschool to high school students with Autism: an update on recent research. *Current Psychiatry Reports*, 23, 54.
- Kaufman, A. S. and Kaufman, N. L. 2004. *Kaufman brief intelligence test - second edition*. Circle Pines: Aps.
- Keen, D., Webster, A. and Ridley, G. 2016. How well are children with autism spectrum disorder doing academically at school? An overview of the literature. *Autism: The International Journal of Research and Practice*, 20, 276–294.
- Kenworthy, L., Anthony, L. G., Naiman, D. Q., Cannon, L., Wills, M. C., Luong-Tran, C., Werner, M. A., Alexander, K. C., Strang, J., Bal, E., Sokoloff, J. L. and 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.
- Kim, S. H., Bal, V. H. and Lord, C. 2018. Longitudinal follow-up of academic achievement in children with autism from age 2 to 18. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, 59, 258–267.
- Kiuru, N., Wang, M.-T., Salmela-Aro, K., Kannas, L., Ahonen, T. and Hirvonen, R. 2020. Associations between adolescents' interpersonal relationships, school well-being, and academic achievement during educational transitions. *Journal of Youth and Adolescence*, 49, 1057–1072.
- Langberg, J. M. 2014. *Improving children's homework, organization, and planning skills: a parent's guide*. Bethesda: National Association of School Psychologists.
- Langberg, J. M., Arnold, L. E., Flowers, A. M., Altaye, M., Epstein, J. N. and Molina, B. S. 2010. Assessing homework problems in children with ADHD: validation of a parent-report measure and evaluation of homework performance patterns. *School Mental Health*, 2, 3–12.
- Langberg, J. M., Epstein, J. N., Girio, E. L., Becker, S. P., Vaughn, A. J. and Altaye, M. 2011. Materials organization, planning, and homework completion in middle school students with ADHD: impact on academic performance. *School Mental Health*, 3, 93–101.
- Langberg, J. M., Epstein, J. N., Urbanowicz, C. M., Simon, J. O. and Graham, A. J. 2008. Efficacy of an organization skills intervention to improve the academic functioning of students with Attention-Deficit/Hyperactivity Disorder. *School Psychology Quarterly*, 23, 407–417.
- Lord, C., Rutter, M., DiLavore, P. C., Risi, S., Gotham, K. and Bishop, S. L. 2012. *Autism Diagnostic Observation Schedule, Second Edition (ADOS-2) Modules 1-4*. Los Angeles, California: Western Psychological Services.

- Pennington, B. F. and Ozonoff, S. 1996. Executive functions and developmental psychopathology. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, 37, 51–87.
- Pugliese, C. E., Anthony, L., Strang, J. F., Dudley, K., Wallace, G. L. and Kenworthy, L. 2015. Increasing adaptive behavior skill deficits from childhood to adolescence in autism spectrum disorder: role of executive function. *Journal of Autism and Developmental Disorders*, 45, 1579–1587.
- Rosenthal, M., Wallace, G. L., Lawson, R., Wills, M. C., Dixon, E., Yerys, B. E. and Kenworthy, L. 2013. Impairments in real-world executive function increase from childhood to adolescence in autism spectrum disorders. *Neuropsychology*, 27, 13–18.
- Sekhon, M., Cartwright, M. and Francis, J. J. 2022. Development of a theory-informed questionnaire to assess the acceptability of healthcare interventions. *BMC Health Services Research*, 22, 279.
- Sibley, M. H., Altszuler, A. R., Morrow, A. S. and Merrill, B. M. 2014. Mapping the academic problem behaviors of adolescents with ADHD. *School Psychology Quarterly: The Official Journal of the Division of School Psychology, American Psychological Association*, 29, 422–437.
- Steinbrenner, J. R., Hume, K., Odom, S. L., Morin, K. L., Nowell, S. W., Tomaszewski, B., Szendrey, S., McIntyre, N. S., Yücesoy-Ozkan, S. and Savage, M. N. 2020. *Evidence-based practices for children, youth, and young adults with Autism*. Chapel Hill, NC: The University of North Carolina at Chapel Hill, Frank Porter Graham Child Development Institute, National Clearinghouse on Autism Evidence and Practice Review Team.
- Talbott, E., Karabatsos, G. and Zurheide, J. L. 2018. Informant similarities, twin studies, and the assessment of externalizing behavior: a meta-analysis. *Journal of School Psychology*, 67, 31–55.
- Tamm, L., Duncan, A., Vaughn, A., McDade, R., Estell, N., Birnschein, A. and Crosby, L. 2020. Academic needs in middle school: perspectives of parents and youth with Autism. *Journal of Autism and Developmental Disorders*, 50, 3126–3139.
- Tamm, L., Zoromski, A. K., Kneeskern, E. E., Patel, M., Lacey, H. M., Vaughn, A. J., Ciesielski, H. A., Weadick, H. K. and Duncan, A. W. 2021. Achieving independence and mastery in school: an open trial in the outpatient setting. *Journal of Autism and Developmental Disorders*, 51, 1705–1718.
- Tschida, J. E. and Yerys, B. E. 2021. Real-world executive functioning for autistic children in school and home settings. *Autism*. doi: 10.1177/13623613211041189.
- Wilczynski, S. M., Fusilier, I., Dubard, M. and Elliott, A. 2005. Experimental analysis of proximity as a social stimulus: increasing on-task behavior of an adolescent with autism. *Psychology in the Schools*, 42, 189–196.