Research Article

Early Achievements for Education Settings: An Embedded Teacher-Implemented Social Communication Intervention for Preschoolers With Autism Spectrum Disorder

Anne-Michelle Engelstad,[a] Calliope Holingue,[a,b,c] and Rebecca J. Landa[a,d]

Purpose: Early Achievements for Education Settings (EA-ES) is a teacher-implemented naturalistic developmental behavioral intervention for preschoolers with autism spectrum disorder (ASD) targeting core social communication impairments. The purpose of this pilot randomized controlled clinical trial (RCT) was to examine promise of efficacy of this iteratively developed intervention when implemented in authentic education settings. We examined (1a) whether a high level of implementation fidelity was attained by EA-ES trained teachers and (1b) whether their fidelity attainment differed from that of untrained teachers; and (2) whether the EA-ES intervention showed promise of improving child social, communication, and cognitive outcomes as determined by within- and between-group comparisons of children in EA-ES classrooms and children in classrooms randomized to the business as usual condition.
Method: Participants included six preschool teachers and 43 eligible preschoolers with ASD. Classrooms were randomized to EA-ES or business as usual. Analyses of intervention effects using baseline and postintervention data were conducted on teachers' fidelity of EA-ES implementation and children's performance on a proximal measure of social and communication behavior and on a distal standardized measure of verbal and nonverbal functioning.
Results: Teachers trained to implement EA-ES attained a high level of implementation fidelity, with significantly greater gains compared to untrained teachers. Children receiving EA-ES showed significantly greater gain from baseline to postintervention in frequency of produced initiation of joint attention and nonverbal cognitive functioning compared to children in business-as-usual classrooms. A trend toward significance for Group × Time effects was detected for frequency of spontaneous verbalizations produced, favoring the EA-ES group.
Conclusions: EA-ES shows promise of feasibility for teacher implementation in group contexts and for improving social communication and cognitive skills in preschoolers with ASD. Implications of results for future research and speech-language pathologist–teacher collaboration to increase language intervention dosage are discussed.

The majority of preschoolers with autism spectrum disorder (ASD) receive their early intervention services in public schools (Hume et al., 2005). Given that the increased prevalence of ASD in the United States (Baio et al., 2018) has mostly been noted within 2- and 3-year-olds (Hertz-Picciotto & Delwiche, 2009) and that experts are able to reliably diagnose ASD before the third birthday (Ozonoff et al., 2015), a growing number of children

[a]Center for Autism and Related Disorders, Kennedy Krieger Institute, Baltimore, MD
[b]Department of Mental Health, Johns Hopkins University School of Public Health, Baltimore, MD
[c]Department of Neuropsychology, Kennedy Krieger Institute, Baltimore, MD
[d]Psychiatry and Behavioral Sciences, Johns Hopkins University School of Medicine, Baltimore, MD
Correspondence to Rebecca J. Landa: Landa@kennedykrieger.org

Editor: Laura Green
Received October 16, 2019
Revision received February 6, 2020
Accepted February 12, 2020
https://doi.org/10.1044/2020_PERSP-19-00155
Publisher Note: This article is part of the Forum: Intervention Findings Addressing Unique Communication Needs of Young Children With Autism Spectrum Disorders.

Disclosures
Financial: Anne-Michelle Engelstad has no relevant financial interests to disclose. Calliope Holingue has no relevant financial interests to disclose. Rebecca J. Landa has no relevant financial interests to disclose.
Nonfinancial: Anne-Michelle Engelstad has no relevant nonfinancial interests to disclose. Calliope Holingue has no relevant nonfinancial interests to disclose. Rebecca Landa is the developer of the Early Achievements for Education Settings intervention and training materials, but receives no royalties. The research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

with ASD are entering public preschool classrooms. These children present with social and communication impairments that differ qualitatively from other neurodevelopmental disorders (American Psychiatric Association, 2013). Yet, as young children with ASD begin school, they enter a milieu unprepared to optimize their social and communication outcomes (Marsh et al., 2017). One reason for this likely pertains to a research-to-practice gap that has resulted in a paucity of evidence-based interventions that (a) target ASD-related social and communication deficits and (b) can be successfully and feasibly implemented by classroom teachers.

Communication Impairment in Young Children With ASD

Communication disorder in young children with ASD affects language and social aspects of functioning. The language component of the communication disorder is characterized by late acquisition of language milestones and reduced diversity of words, word combinations, and gestures, along with the presence of stereotypic verbal behavior (Landa et al., 2013; Watson et al., 2013; Weismer et al., 2010; Wetherby et al., 2007). The limited repertoire of conventional lexical and gesture forms constrains children's ability to communicate, in a differentiated way, about a range of objects, events, people, and qualities. Even when spoken words emerge, many children with ASD have impoverished symbolic representations (Wetherby et al., 2007), resulting in diminished comprehension and production. This, in combination with the impairment in generativity observed in children with ASD (Dichter et al., 2009), likely curtails learning to flexibly combine their existing words in novel ways (Kohler & Malott, 2014). The impact of such difficulties could include reduced communicative specificity and effectiveness, as well as reduced ability to contribute new information to communicative exchanges and to elaborate on topics. The social component of the communication disorder in young children with ASD is characterized by decreased frequency of initiation of communicative bids (especially to initiate joint attention) and reduced communicative reciprocity (American Psychiatric Association, 2013; Wetherby et al., 2007). Diminished frequency of communicative initiations, especially for social purposes, often results in children with ASD functioning in a "responder" role in communicative interactions; transactional processes of communication are subsequently impeded (Wetherby et al., 2007). Cascading effects are likely, whereby communicative exchanges occur less frequently (Yoder & McDuffie, 2006), are briefer, and are content impoverished. The result is reduced linguistic and social input and reduced opportunities to practice and engage in dynamic language and social learning interactions (Massand et al., 2015). This is concerning because early social and communication functions are important predictors of long-term outcomes (Kover et al., 2016).

Of the social aspects of communication impairment in ASD, impairment in initiation of joint attention (IJA) may have the greatest implications for language learning. IJA is a goal-oriented behavior reflecting spontaneous seeking to secure another person's attention in order to share experience about an object, person, or event of interest to the child. A child's IJA shows social motivation and ability to coordinate and synchronize one's own attention with others. In typical development, IJA, in the form of triadic gaze (e.g., gaze to the referent, partner, and back to the referent), begins to emerge at age 6 months (Bhat et al., 2011). At around 8–10 months of age in typical development, this gives way to pointing, showing, and social giving as forms of IJA. When a child initiates joint attention, a topic is established. Adults' communication about that topic (the referent of the child's IJA; Baldwin, 1995) spotlights referent-related associated features, relations, and concepts, enhancing the child's processing and encoding of information about the referent (Kim & Mundy, 2012; Mundy et al., 2016). For example, a child might hear a loud plane and point it out to his mother, initiating joint attention to the plane. His mother, responding to his IJA, might say, "You see the plane! It is flying so fast." This communication from the child's mother about the referent (the plane, in this case) highlights features of the plane (they fly and are fast). The child encodes this information into his semantic network. Frequent practice with the rich triadic (self–referent–other person) multimodal (visual, auditory, tactile, linguistic, social, motor) events that occur surrounding a child's IJA affords brain–behavior experiences that likely entrain a distributed neural network (Mundy & Newell, 2007). Thus, joint attention is considered a pivotal early intervention target. This notion is supported by experimental work. Kasari et al. (2006) found that preschoolers with ASD randomized to receive an intervention targeting joint attention (rather than to the intervention targeting play or to the control condition) showed greater pre- to postintervention joint attention gains, but not expressive or receptive language gains, compared to those randomized to a control condition. However, 12 months postintervention, children who had received intervention targeting joint attention or play showed greater language gains than did controls (Kasari et al., 2008). Furthermore, children with the lowest baseline language levels showed greater expressive language gains if they had been in the joint attention rather than the play intervention or control conditions (Kasari et al., 2008).

Intervention needs of young children with ASD are extensive. The general consensus is that 15–25 hr per week of intervention should be delivered (Corsello, 2005), with greater intensity of intervention being associated with better outcomes (Linstead et al., 2017). This extends beyond what speech-language pathologists (SLPs) feasibly are able to provide, given their caseloads (Brandel & Loeb, 2011; Katz et al., 2010). To approach such levels of intensity, equipping teachers to implement evidence-based intervention strategies is necessary. However, the intervention approach must be feasible for teachers to implement, given the other demands on their time and resources.

Targeting Core Deficits: About the Early Achievements Intervention

In order to address the need for feasible teacher-implemented interventions for preschoolers with ASD, Early Achievements (EA), a comprehensive clinical model, was adapted for education settings. The original randomized comparative effectiveness trial of the EA intervention was conducted in a clinical research setting and examined social, communication, and cognitive outcomes of toddlers (M_{age} = 28 months) with ASD and co-occurring cognitive impairment (2 *SD*s below the mean) who were randomized to one of two conditions: EA or EA with high dosage learning opportunities targeting interpersonal synchrony (IS) skills (joint attention, imitation, shared affect; EA + IS; Landa et al., 2011). In both EA conditions, children received a comprehensive intervention targeting social, communication, language, play, and cognitive functions using naturalistic developmental behavioral intervention (NDBI; Schreibman et al., 2015; described below) and structured teaching approaches in a nursery school group-based context for 10 hr a week across 6 months. Children in both groups received daily intervention in whole group (five to six children), dyads (two children), and, for priming skills and to establish basic play skills, 1:1 contexts. Intervention was delivered by an early childhood special educator with the support of two teaching assistants.

EA + IS was designed to target social and communication deficits of ASD using a socially valid, integrated, routine-embedded intervention approach (Landa et al., 2011). Interventionists created a learning environment wherein targeted communicative content was supported by strategically planned and placed visually salient pictures and objects, as well as by the story in the book that was used in a book-sharing instructional activity each day. Communicative interactions with peers and adults were scaffolded throughout the intervention activities. During shared book reading and other group activities, thematically and story-related event sequences were spotlighted as the interventionist facilitated children's initiation of and response to others' communication bids, expanded children's utterances, scaffolded communicative turn-taking, and mapped language onto children's topically relevant nonverbal behavior. Thematically and story-related props were an integral part of staging this social and communicative environment across instructional activities (e.g., snack, art, sensory motor). Props provided concrete and multiple exemplars of targeted vocabulary, as well as referents for joint attention bids. The objects chosen as props were high in affordances (e.g., a firetruck with a ladder and slot for a driver) in order to motivate communicative initiations, facilitate communicative turn-taking, and create opportunities for interventionists to expand child utterances. Using clear and consistent prompting hierarchies, interventionists supported children to interact with these objects in playful and socially contingent ways, with increasing play complexity and duration of joint engagement.

In Landa et al.'s 2011 clinic-based comparative effectiveness study, significantly greater gains in socially engaged imitation (paired with directed gaze) and nonverbal cognition were observed in the EA + IS compared to the EA group. Also, only children in the EA + IS condition exhibited significant gains in generalized play and expressive language functioning, as well as frequency of IJA (Landa et al., 2011). In a follow-up study, Landa and Kalb (2012) found that ASD severity decreased in children after receiving 6 months of EA intervention, regardless of original intervention condition. However, after the children stopped receiving the intervention, ASD severity worsened until, by the final follow-up time point (T) 3 years after EA or EA + IS post-intervention assessment, ASD severity had returned to the elevated pretreatment levels (Landa & Kalb, 2012). This trend occurred despite the fact that 92.7% of parents reported their children were receiving special education or applied behavior analysis services in the 6 months following the intervention and that 66.7% of parents reported their children were receiving these services through the final follow-up T (Landa & Kalb, 2012). These findings suggest that the services children received after EA or EA + IS treatment may have lacked the focus on social communication, play, and interpersonal synchrony that would have been needed to sustain the mitigated ASD symptomatology. Indeed, very few interventions shown to be effective in targeting ASD core deficits have been translated for use by preschool teachers.

Research-to-Practice Gap

Intervention appears to have the most substantial impact on language, social, cognitive, and adaptive functioning in young children with ASD when delivered in research contexts and by research team members; effect sizes in a meta-analysis of such studies ranged from 0.42 to 0.76 (Reichow, 2012). In contrast, a meta-analysis of interventions routinely provided in the community without guidance from researchers (hospital, clinic, home, and school), as well as "treatment as usual," identified much lower effect sizes, ranging from 0.17 to 0.37 when examining change over time, not between treatment and control groups (Nahmias et al., 2019). The results of these meta-analyses, paired with the very small number of studies identified in a 2019 search of What Works Clearinghouse (U.S. Department of Education, n.d.) as effective in authentic educational settings for children with ASD, indicate a research-to-practice gap.

To better assess the research-to-practice gap relevant for preschoolers with ASD, one must consider the studies excluded from Nahmias et al.'s (2019) meta-analysis: those involving community providers trained in intervention implementation by research team members. Such studies represent a body of work in which researcher–community partnerships are formed to directly address the research-to-practice gap in early ASD intervention. We identified seven such studies conducted within the United States, employing NDBI strategies, and assessing social and/or communication outcomes and not focused on a single behavior.

Five of the seven identified studies focused on improving joint engagement, joint attention, and, in four of these five studies, play. Two of the studies examined the advancing social-communication and play (ASAP) intervention across a school year. Three examined short-term (6–8 weeks) implementations of the Joint Attention Symbolic Play Emotion Regulation (JASPER) intervention (Chang et al., 2016; Lawton & Kasari, 2012; Wong, 2013). These interventions were delivered in 1:1 and/or small group activities. The most consistent treatment effect was reduced duration of child unengagement and greater duration of child engagement (Boyd et al., 2018; Chang et al., 2016; Lawton & Kasari, 2012; Wong, 2013). The single case design ASAP study indicated that gains in social communication and play appeared more clearly once a 1:1 context (delivered by a speech-language pathologist) was added to the previously group-based implementation of the intervention (Dykstra et al., 2012). Within JASPER studies, treatment effects were detected for joint attention, but only on measures of classroom behavior, not on researcher-administered measures (Chang et al., 2016; Lawton & Kasari, 2012; Wong, 2013). More multiword joint attention–related language production (e.g., "let's play") and single-word regulatory utterances (requests) were noted in the JASPER than the waitlist group (Chang et al., 2016). Significant group differences in simple and functional play types were noted on an observational and a research-administered measure (Chang et al., 2016). Though infrequently observed in either group, greater gains in symbolic play were noted in the JASPER than the waitlist control group (Wong, 2013). Teachers who received ASAP or JASPER training exhibited higher fidelity of implementation (FOI) than control teachers (Boyd et al., 2018; Chang et al., 2016; Lawton & Kasari, 2012). Intensive coaching during teachers' JASPER implementation was provided (up to 60 coaching sessions in 8 weeks; Chang et al., 2016). The above five studies highlight the malleability of joint engagement, an early-developing behavior in typical development, and that with an intensive intervention focus, joint attention gains are possible in teacher-implemented intervention for preschoolers with ASD having mild to no cognitive delays in 1:1 (Lawton & Kasari, 2012) and small group play-based sessions (Chang et al., 2016; Wong, 2013).

The remaining two studies targeted a broader range of developmental outcomes. Both of these studies examined the Learning Experiences and Alternate Program for Preschoolers and their Parents (LEAP; Boyd et al., 2014; Strain & Bovey, 2011) intervention, a child-contingent, peer-mediated intervention implemented within typical routines in inclusive classrooms paired with parent skill training. Results of Strain and Bovey's (2011) study indicated that a 2-year comprehensive professional development (PD) program with job-embedded coaching (including training of an onsite supervisor to support implementation of LEAP strategies) led to better teacher FOI (90% for comprehensively trained, 38% for self-trained) and child outcomes (reduced autism symptom severity; improved language, cognitive, and social skills) than a self-learning approach in which teachers learn to implement the intervention using the intervention manual. Children in the comprehensively trained LEAP classrooms received high-fidelity LEAP intervention for 17 hr a week for 2 years. Subsequently, LEAP was examined in a comparative quasi-experimental study, with comparison conditions including teachers trained to expertise in the TEACCH autism program and a non–model-specific high-quality Early Childhood Special Education classroom (Boyd et al., 2014). No significant Group × Time interaction effects was detected. Boyd et al.'s (2014) findings indicate that young children with ASD do well when enrolled in high-quality special education classrooms.

More interventions targeting core communication deficits of ASD designed for teacher implementation with preschoolers with ASD are needed. Taking into consideration the need for feasible, adoptable, and scalable interventions, such interventions should be compatible with teachers' pedagogy and practices (Fishman et al., 2018; Mandell et al., 2013); able to be implemented in group instructional contexts (Mandell et al., 2013); supplemental to, rather than replacing, school district curricula (Mandell et al., 2013); and cost effective with training demands minimized, while still empowering teachers to achieve high FOI. Here, we report on a pilot randomized controlled clinical trial (RCT) examining the promise of a teacher-implemented supplemental intervention for preschoolers with ASD, EA for Education Settings (EA-ES), derived from the EA + IS intervention described above.

EA-ES

Given the evidence of the EA intervention to effect significant social communication and interpersonal synchrony gains (Landa et al., 2011) with long-term benefit for communication and cognitive outcomes (Landa & Kalb 2012), and the research-to-practice gap related to teacher-implemented ASD interventions for preschool-aged children, EA + IS was adapted for education settings. The piloted version of EA-ES, examined in this study, was designed to target the communication and social core deficits of ASD by embedding the EA + IS strategies within existing instructional activities: story time (hereafter, "book sharing"), art, and mealtime (e.g., snack or breakfast). During a 2-year iterative process of adapting EA + IS for education settings, deliberate decisions were made about how to simplify and modify the intervention, including determining the most important instructional targets to retain, designing the instructional approach and contexts, and refining the PD program based on feedback from teachers and administrators to support teachers' successful implementation of EA-ES (Wilson & Landa, 2019). Given the number of children enrolled in preschool classrooms and amount of staffing available, we eliminated the 1:1 intervention components used in the original EA intervention, as well as skill priming and play instructional activities. No instructional activities were added to or replaced teachers' existing instructional activities, which often are prescribed by schools' protocols and/or curricula.

The purpose of this pilot RCT was to examine promise of efficacy of this iteratively developed intervention when implemented by teachers in authentic education settings. We tested the hypothesis that teachers receiving the EA-ES PD training would attain a significantly higher level of implementation fidelity compared to teachers not trained in the intervention method. The secondary aim was to test the hypothesis that children receiving the EA-ES intervention would show greater improvement in social communication and cognitive outcomes as determined by within-group comparison and by between-group comparisons with children in classrooms randomized to the business-as-usual (BAU) condition.

Method

Study Design and Sample

This pilot RCT was approved by the Johns Hopkins University School of Medicine Institutional Review Board and was registered on https://clinicaltrials.gov. All participating teachers and parents of children provided informed consent using Institutional Review Board–approved consent forms. Participation lasted the course of the school year; all PD and data collection reported herein were collected within that school year. Enrollment of teachers and children began in August. Baseline assessments were conducted within the first 2 months of the school year. Following baseline data collection, classrooms were randomized. Randomizing six classrooms at the classroom level using a computerized random number generator resulted in three classrooms (three teachers, three instructional assistants [IAs], and 19 children) being assigned to the EA-ES treatment condition and three classrooms (three teachers, four IAs, and 24 children) being assigned to the BAU condition by a statistician not directly involved with the study. Teachers were not informed of condition assignment until completion of baseline data collection. All classrooms provided half-day instruction to students, with five of the six classrooms enrolling both their a.m. and p.m. classes in the study (the sixth classroom had only an a.m. class). This resulted in 11 half-day classes. Enrollment of children continued until November 19, up to 1 month after the teachers in EA-ES condition received the first workshop. These 11 children (n = 2 EA-ES, n = 9 BAU) were permitted to join after the first workshop because they were newly enrolled in their classrooms.

After condition assignment, two classes were withdrawn from participation. One involved a teacher (EA-ES condition) who withdrew her only enrolled half-day class after EA-ES training had begun due to classroom personnel challenges. The other involved a teacher (BAU condition) who withdrew her p.m. class due to children's severe challenging behaviors, but continued participation with her a.m. class.

Classroom Eligibility

Classrooms were recruited from a suburban public mid-Atlantic school district. There were no incentives for study participation. Eligibility criteria for classroom participation included having at least two eligible children with ASD and a teacher certified to teach in the state in which the study was conducted. See Table 1 for teacher demographic characteristics. All five teachers that completed the study had degrees in education. Two (one EA-ES, one BAU) had bachelor's degrees in special education. Three (one EA-ES, two BAU) had master's degrees in education. Two (one EA-ES, one BAU) classrooms were inclusive, and three (one EA-ES, two BAU) were self-contained.

Child Eligibility

Eligibility criteria for children included being between ages 36 and 60 months at time of consent, being enrolled in a preschool classroom of a participating teacher, meeting criteria for ASD per the Autism Diagnostic Observation Schedule-2 (ADOS-2; Lord et al., 2012) and expert clinical judgment, and having a developmental quotient of at least 40 based on the early learning composite of the Mullen Scales of Early Learning (MSEL; Mullen, 1995). Exclusion criteria were known genetic disorder, uncorrected hearing or vision impairment, and history of a head injury that resulted in loss of consciousness. From the 11 classes, 43 eligible children were consented to participate in the study. Attrition of the two classrooms (EA-ES = 1, BAU = 1 see above) resulted in the loss of five child participants (EA-ES = 3, BAU = 2). The flowchart of participation through each phase of the RCT, as recommended by the Consolidated Standards of Reporting Trials, is depicted in Figure 1.

Description of EA-ES and BAU Conditions

None of the teachers had been trained in EA-ES prior to participating in this pilot RCT. Four participating children, all in the BAU condition, previously had been in classrooms of teachers trained to implement EA-ES and thus were excluded from analyses.

EA-ES Intervention Condition

Teachers in the EA-ES condition were trained to strategically engineer the learning environment and to use NDBI strategies to target skills that support children's language and social communication development: joint attention, language, socially contingent imitation, peer-to-peer engagement, and use of objects related to targeted language. Teachers were first taught to do this in the EA book-sharing activity and then taught to generalize use of the strategies to other contexts throughout the day.

Strategic engineering of the environment began with minimizing distractions in order to focus children's attention to story-related props, which, as in EA + IS, presented exemplars of targeted vocabulary, as well as referents for joint attention bids. Teachers were taught to implement the following NDBI strategies: providing clear and developmentally appropriate antecedent cues, least-to-most prompting, natural and child-contingent reinforcement, event casting, and expanding. For example, teachers provided opportunities for children to initiate joint attention to an item of importance in the story, usually aligned with vocabulary selected by the teacher as primary language targets. Teachers provided clear antecedents as illustrated in the following example. "It's time to read a book, but…hmm...

Table 1. Characteristics of teachers and children in the pilot randomized controlled clinical trial.

Teacher variables	EA-ES (*n* = 2) *M* (*SD*) or *n* (%)	BAU (*n* = 3) *M* (*SD*) or *n* (%)
Gender (Female)	2 (100%)	3 (100%)
Race (White, non-Hispanic/Latino)	2 (100%)	3 (100%)
Years of teaching	25.0 (12.7)	4.0 (3.5)
Years of teaching children with ASD	24.0 (14.1)	3.3 (3.1)
Child variables	**EA-ES (*n* = 15) *M* (*SD*) or *n* (%)**	**BAU (*n* = 16) *M* (*SD*) or *n* (%)**
Age at pretest (months)	48.0 (8.0)	46.0 (6.7)
Gender		
Female	6 (40%)	3 (18.8%)
Male	9 (60%)	13 (81.3%)
Race**		
Asian	4 (26.7%)	1 (6.3%)
Black	1 (6.7%)	7 (43.8%)
Multiracial	2 (13.4%)	3 (18.8%)
White	8 (53.3%)	5 (31.3%)
Ethnicity[a]		
Hispanic/Latino	0 (0%)	1 (6.3%)
Non-Hispanic/Latino	14 (93%)	14 (87.5%)
Maternal education*		
High school diploma or less	0 (0%)	6 (43%)
Some college or greater	14 (100%)	8 (57%)
Paternal education		
High school diploma or less	8 (57%)	3 (21%)
Some college or greater	6 (43%)	11 (79%)
Family SES (Hollingshead)***	54.2 (14.3)	37.8 (15.5)
ADOS calibrated severity score*	5.9 (1.6)	7.2 (1.9)
MSEL composite score	58.6 (12.2)	53.0 (4.3)
Number of school days missed	9.9 (8.6)	14.8 (11.5)

Note. EA-ES = Early Achievements for Education Settings; BAU = business as usual; SES = socioeconomic status; ADOS = Autism Diagnostic Observation Schedule; MSEL = Mullen Scales of Early Learning.

[a]Not estimable due to low variability in data.
*$p \le .10$ **$p \le .05$ ***$p \le .01$.

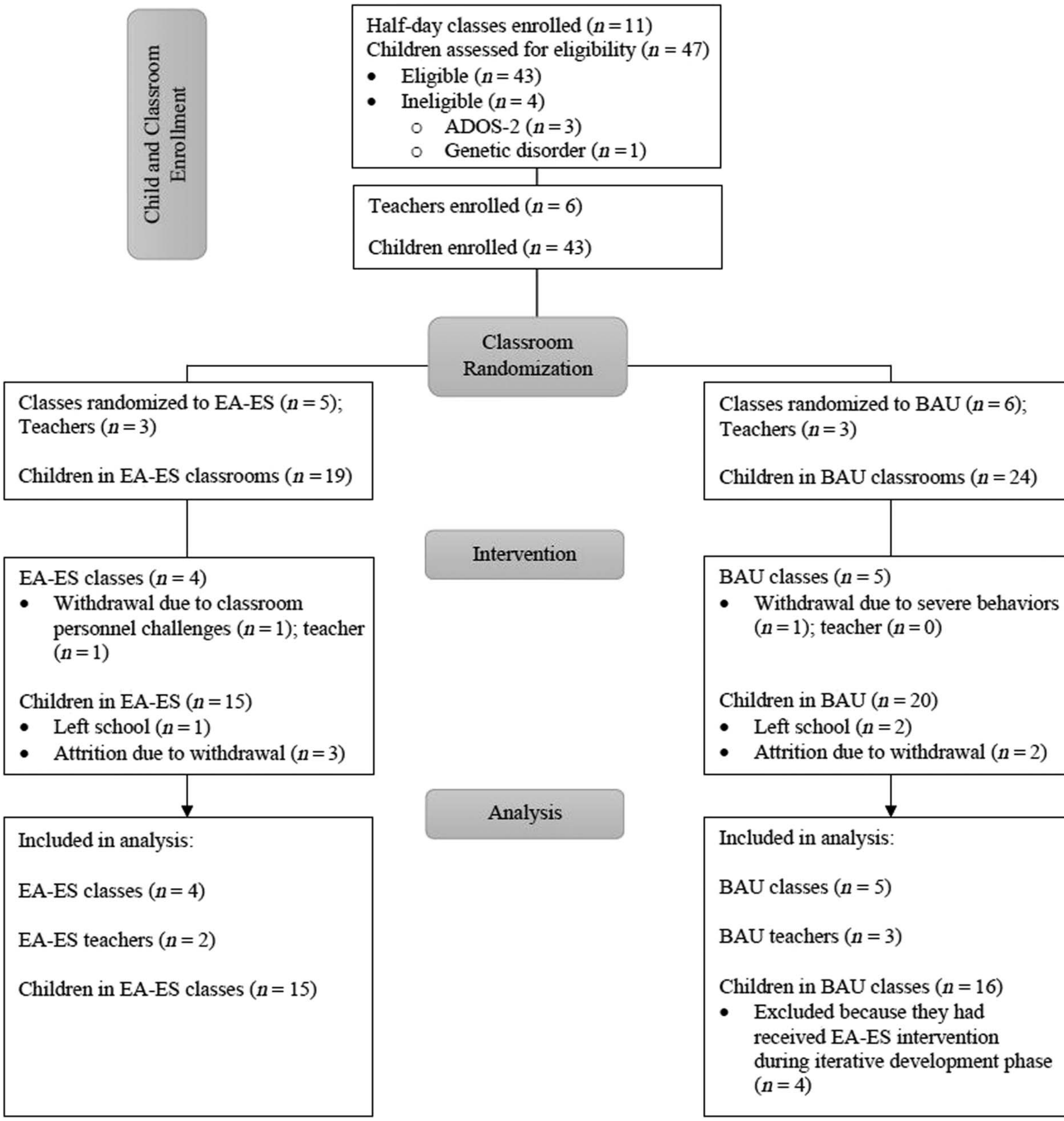
(teacher visually searches the area) does anyone see our book?" Children were prompted as necessary to initiate joint attention by pointing to the book or commenting (e.g., "there it is!") with a least-to-most prompting hierarchy. Teachers naturally reinforced children's IJA to the targeted object/picture by providing a verbal affirmation of the child's behavior and/or allowing them to interact with the referent.

Teachers selected their own books, but were trained in criteria for book selection at the first workshop. Teachers were encouraged to select books with content that was familiar to the children and relevant to the children's life experiences. Teachers were trained to support child engagement, initiation, and meaning construction throughout the book-sharing activity by using an activities-based approach informed by principles of embodied and situated cognition. When an event sequence occurred in the book (e.g., a snowball fight), teachers supported meaning construction related to the event by staging relevant props (e.g., a "snowball"), supporting children's initiation of relevant language or gestures by using scaffolded cues described above, and contingently reinforcing initiations by creating a turn-taking opportunity (e.g., throwing the snowball). These instructional strategies fostered children's learning across all five EA-ES targeted skill domains (e.g., peer-to-peer engagement and language were targeted as children threw the snowball to peers, commenting, "my turn," "throw to me," or, "Mathias threw the snowball"). In the EA-ES approach, the same book is used for 2–3 weeks to permit children's increasing familiarity and the scaffolding of more complex skills (McKeown & Beck, 2014). Teachers in the EA-ES condition continued to implement their school district's designated curriculum and attended district-wide or school-required PD events throughout the school year.

EA-ES Training and Coaching

After baseline data collection for teachers and children, participating teachers randomized to the EA-ES condition attended the first of seven 6-hr workshops facilitated by the last author, developer of EA-ES, and principal investigator of the study, as well as two staff trained to fidelity in the implementation of EA-ES at the Kennedy Krieger Institute's Center for Autism and Related Disorders (CARD) in Maryland. Workshops were distributed across 5 months of the school year (October through February) to introduce intervention components during book sharing (Workshops 1

Figure 1. The flowchart of participation through each phase of the randomized controlled clinical trial, as recommended by the Consolidated Standards of Reporting Trials. ADOS-2 = Autism Diagnostic Observation Schedule-2; EA-ES = Early Achievements for Education Settings; BAU = business-as-usual.



and 2), generalize the intervention strategies to other contexts (Workshop 3), review and understand additional ways to construct instructional activities and use instructional strategies to promote child engagement and development (Workshop 4), experience additional opportunities to practice the nuances of implementation of NDBI strategies (Workshop 5), address management of child behavioral dysregulation and problem solve barriers to implementation of EA-ES strategies (Workshop 6), and, finally, to consolidate knowledge and skills related to intervention targeting communication in children with ASD and sustaining EA-ES implementation (Workshop 7). Experiential workshop activities included practicing use of EA-ES instructional strategies to scaffold children's development of EA-ES targeted skills, actively analyzing intervention implementation in video examples, selecting and modifying instructional materials, planning differentiated learning activities, role-playing intervention implementation, and engaging in problem-solving discussions (see Table 2 for workshop descriptions and sample activities).

Table 2. EA-ES professional development workshop descriptions and sample activities.

Workshop	Content	Sample activities
1	Introduction to EA-ES; book sharing; theme; adapting books	• Identify book theme • Book selection criteria • How to use books to target intervention goals
2	Targeting social skills; teaching through embodiment	• Environmental engineering • Practice
3	Review; addressing common core standards and IEP goals; EA-ES in other instructional activities	• Map common core benchmarks in reading, listening, and speaking onto EA-ES targets and activities • Designing instructional activities around sample IEP goals
4	How to target social skills; instruction planning "think tank"	• Rationale behind instructional targets (deeper dive) • Practice how to embed instruction for social and language targets in the selected book • Planning concrete instructional materials and activities
5	Naturalistic developmental behavioral intervention strategies	• Guided video review • Practice • Planning
6	Behavior management; video review; team collaboration; effective and efficient planning	• Guided video review • Problem-solving strategies • Planning
7	Booster and consolidation session: communication; sustaining EA-ES; review of essential concepts	• Designing instructional activities: review • Practice expanding and extending child utterances • Think tank: sustaining EA intervention

Note. EA-ES = Early Achievements for Education Settings; IEP = Individualized Education Program.

At the first workshop EA-ES teachers met their intervention coach, a speech-language pathologist who had been trained to fidelity in implementation of EA-ES by the developer of the intervention (R. Landa) and who supervised his own Achievements Group at the CARD clinic. The coach visited the classrooms of EA-ES teachers weekly using an evidence-based coaching approach (Snyder et al., 2015). Coaching began the week after the first workshop and continued until April of the same school year; teachers received a mean of 18 job-embedded coaching sessions (range: 16–20). The coach facilitated teachers' self-reflection before the class began, provided job-embedded coaching as teachers implemented EA-ES instructional activities, and, during debriefing periods conducted while children were engaged with IAs or after school, delivered supportive and constructive feedback on the teacher's EA-ES implementation. During the debriefing session, the coach engaged the teacher in problem solving, goal-setting, and action planning. For more information on EA-ES and the PD model utilized in the study, please visit the EA website (www.earlyachievements.org).

BAU Condition

Teachers in the BAU condition delivered instruction and implemented their school district's designated curriculum as they typically would and attended district-wide or school-required PD events throughout the school year. No training was provided to teachers in the BAU condition by research team members.

Measures

Primary Teacher Outcome: FOI

A rigorous method was used to assess teachers' implementation of EA-ES intervention components, the primary variable in this study. To do so, video recordings of teachers in both conditions during implementation of their book-sharing instruction were collected at baseline (September), each month of the EA-ES training period (October following the first two workshops through April when the final coaching session occurred), and at postintervention (May) after training and coaching were completed for the EA-ES condition. Research assistants, study team members who were not trained in EA-ES, collected the video recordings. These tapes (n = 76) were coded for FOI of EA-ES intervention components. Coding was completed by early intervention specialists at CARD who were not involved in the training or coaching of study participants. Teachers having both an a.m. and a p.m. classroom had two fidelity tapes at each monthly T (one for each class to measure implementation across groups of children having different learning and behavioral profiles). For one teacher (BAU) of an a.m. class only, baseline measurement was postponed by 1 month due to severe aggressive behavior of children in her class that required alternate use of her instructional time, and thus, her BAU instructional delivery did not begin until November. Two FOI datapoints were missing: T1 for one EA-ES teacher's a.m. class only and T5 for one BAU teacher's a.m. class only. Coding commenced after all data had been collected so that videotapes could be randomized across time and condition, ensuring coders were naïve to timing of data acquisition during the baseline and intra- and postintervention periods, as well as group assignment. The EA-ES FOI scale was composed of 35 items distributed across five categories of intervention components. Items were coded with either a 3-point Likert-type scale indicating frequency or quality of the EA-ES strategy, or a dichotomous yes/no indicating whether the strategy was present or not. Coders trained on an initial pool of video recordings, coming to consensus when there was disagreement between coders. Following training, every 10th video was spot-checked for percentage agreement, and a consensus meeting was held if agreement fell below 80%. Interrater reliability was assessed for over 34% of independently coded FOI videotapes (n = 26). Agreement, across two raters, was excellent (average intraclass correlation coefficient = .98).

Primary Child Outcomes: Social Communication Behaviors

Five-minute child behavior samples, recorded during a teacher-led book-sharing activity, were collected at baseline, 6 monthly intra-intervention Ts (November through April), and postintervention. Intra-intervention child classroom-based data collection did not begin until November because EA-ES teachers did not receive the first workshops until mid-October, and we prioritized utilization of research staff classroom-based data collection time in October to gather teacher FOI data. Thus, there are seven monthly intra-intervention datapoints for teacher FOI and six for child social communication behaviors; child Ts T1–T6 approximately align with teacher Ts T2–T7. As stated above, 11 children enrolled in school after delivery of the first workshop in mid-October. These children received their baseline measurement at the time that their classmates were receiving their first intra-intervention measurement; thus, these late enrollments did not have six intra-intervention Ts. Every effort was made to collect baseline data as soon after enrollment as possible, once informed consent and eligibility screening were complete. The average number of school days elapsed from consent to collection of baseline data was 6.27 school days (range: 1–13).

The 5-min videos were coded for frequency of IJA, directed gestures, and spontaneous directed communicative verbalizations. Behavior definitions were adapted from the existing social communication literature and norm-referenced measures such as the Communication and Symbolic Behavior Scales: Developmental Profile (Wetherby & Prizant, 2002), Early Social Communication Scales (Mundy et al., 2003), and ADOS-2. IJA was defined as a child's production of a pointing gesture or approximation thereof to draw another person's attention toward a visual stimulus or event. Directed gestures met one or more of the following criteria: The gesture was paired with eye contact, the child approached another person or addressed a person by name before gesturing, and/or the child made a relevant gesture in response to a question or comment by another person. The production of a pointing gesture during IJA was not dually coded as a directed gesture. However, a child's production of a pointing gesture associated with choice-making or requesting was coded as a directed gesture if the above criteria were met. Spontaneous verbalizations met the following criteria: were not preceded by a model and were not produced in response to a close-ended question (e.g., yes/no) or in response to a question in which the answer was implied or provided (e.g., teacher: "Do you want the red or green apple?" child: "Green"). Thus, none of the spontaneous communicative verbalizations were echolalic events.

The child behavior coding team consisted of research assistants who were untrained in the EA-ES model. Research assistants did not code the video from classrooms in which they also taped. Rather, videos they were assigned to code were from classrooms with which they were unfamiliar. This procedure avoided bias and served as a precaution in case a teacher revealed their classroom's condition by discussing coaching or training activities when the taper was in the room. Coders trained on the coding schema by studying these behavioral definitions outlined in a coding manual and by coding an initial pool of behavior samples under the guidance of expert coders. Coders participated in regular consensus meetings after the initial training period to maintain group alignment. Interrater reliability was assessed for 35% of independently coded behavior samples (n = 81). Intraclass correlation coefficients (1,k) were calculated for each of the four raters, with one being the gold-standard rater to whom all other coders were compared, for all three social communication behaviors (Bartko et al., 1966; Fisher 1958). The intraclass correlation coefficients over the duration of the study were as follows: IJA, 0.94; directed gestures, 0.81; and spontaneous verbalizations, 0.97. These values all denote excellent reliability according to Cicchetti's guidelines (1994).

Secondary Child Outcomes: Standardized Child Measures

The MSEL is a developmental assessment normed for birth through 68 months. The MSEL has shown validity in independent samples of young children with ASD and developmental disorders (Bishop et al., 2011; Farmer et al., 2016). The MSEL Expressive Language, Receptive Language, Visual Reception, and Fine Motor subscales were administered to participating children at baseline and postintervention at their schools by trained research staff who were naïve to group membership. The Gross Motor subscale was not administered because norms do not extend beyond age 30 months, and this subscale score is not incorporated in the early learning composite. The early learning composite, having a mean of 100 (SD = 15), serves as a developmental quotient. Baseline early learning composite scores for each group provide a norm-referenced indicator of children's overall developmental functioning when they entered the study. Age-equivalent scores served as dependent variables in analyses for each of the administered MSEL subscales because many children scored at the lowest possible standard score (20) at baseline, resulting in a floor effect that made it impossible to distinguish performance between children scoring at or below 20. Use of age-equivalent scores avoided consequences of such floor effects (Rogers et al., 2012) and thus enabled detection of developmental progression during the school year. Verbal (average of Expressive and Receptive Language age-equivalent scores) and nonverbal (average of Visual Reception and Fine Motor age-equivalent scores) composite scores were computed (Rogers et al., 2012).

Analysis

Teacher FOI

Linear mixed-effects models were used to estimate the effect of group, time, and Group × Time on teacher fidelity scores (a continuous variable). A random intercept was used for "teacher" to account for the nonindependent, repeated fidelity measures over time. Time was modeled as a dummy variable because of nonlinearity in fidelity scores over time.

Child Outcomes

Unadjusted Mean Differences in Variables Over Time, Within and Between Groups

We summarized the mean, standard deviation (SD), and mean differences in child outcome measures (social communication behaviors, and MSEL verbal and nonverbal composite scores) from baseline to postintervention within and between EA-ES and BAU groups. To obtain an unadjusted estimate of the magnitude of difference between these child outcome measures over time within and between the two groups, Hedge's *g* was calculated using pooled weighted standard deviations. Hedge's *g* is appropriate for sample sizes less than 20 (Rosenthal & Rubin 1986). Linear mixed-effects models were used to obtain an estimate for the Group × Time interaction (i.e., whether the mean difference from baseline to postintervention differed significantly in the EA-ES vs. BAU group).

Linear Mixed-Effects Modeling: Adjusted for Baseline Variables

Next, we carried out linear mixed-effects models to estimate the association between group, time, and Group × Time interactions on each child outcome measure separately, with a random intercept for child, to account for the nonindependent repeated measures for each child. Child outcome measures were modeled continuously. Because there was a nonlinear relation between child outcome measures and time, we modeled time as a dummy variable. Each T (intra-intervention T1 through postintervention) was modeled relative to baseline.

Although children were randomized to the EA-ES and BAU groups, which in theory has the benefit of producing two groups with no baseline differences, the sample size of this study is small and chance differences may occur. Thus, to control for between-group differences at baseline, regression modeling was used to adjust for baseline MSEL composite (M = 100, SD = 15), ADOS-2 Calibrated Severity Score (maximum possible score = 10, with 10 representing the greatest ASD symptom severity; Gotham et al., 2009), number of absences during the school year, family socioeconomic status (Hollingshead, 1975), and child race (Asian, Black, multiracial, White; reference: White) to minimize the potential for confounding. Absences were defined as days of school missed that were above and beyond school holidays, professional days, and weather-related closures. For regression models with MSEL nonverbal and verbal composites as outcomes, we did not adjust for MSEL composite because of complete overlap in these variables.

All analyses were performed in R Version 3.6.1 (2019–07–05; R Core Team, 2019). Linear mixed-effects models were performed with the lmerTest package in R (Kuznetsova et al., 2015).

Results

Descriptive

Demographic characteristics of teachers and children who received the full study protocol in this pilot RCT are reported in Table 1. Examination of baseline characteristics across conditions on all variables in Table 1 revealed significant differences in demographic factors (more Asian and White children compared to Black children, greater proportion of mothers with at least some college experience, and higher family socioeconomic status in the EA-ES group compared to the BAU group). Additionally, there was a trend toward significance for lower ADOS-2 calibrated severity scores compared to the BAU group (5.9 vs. 7.2, $p < .10$).

Teacher FOI

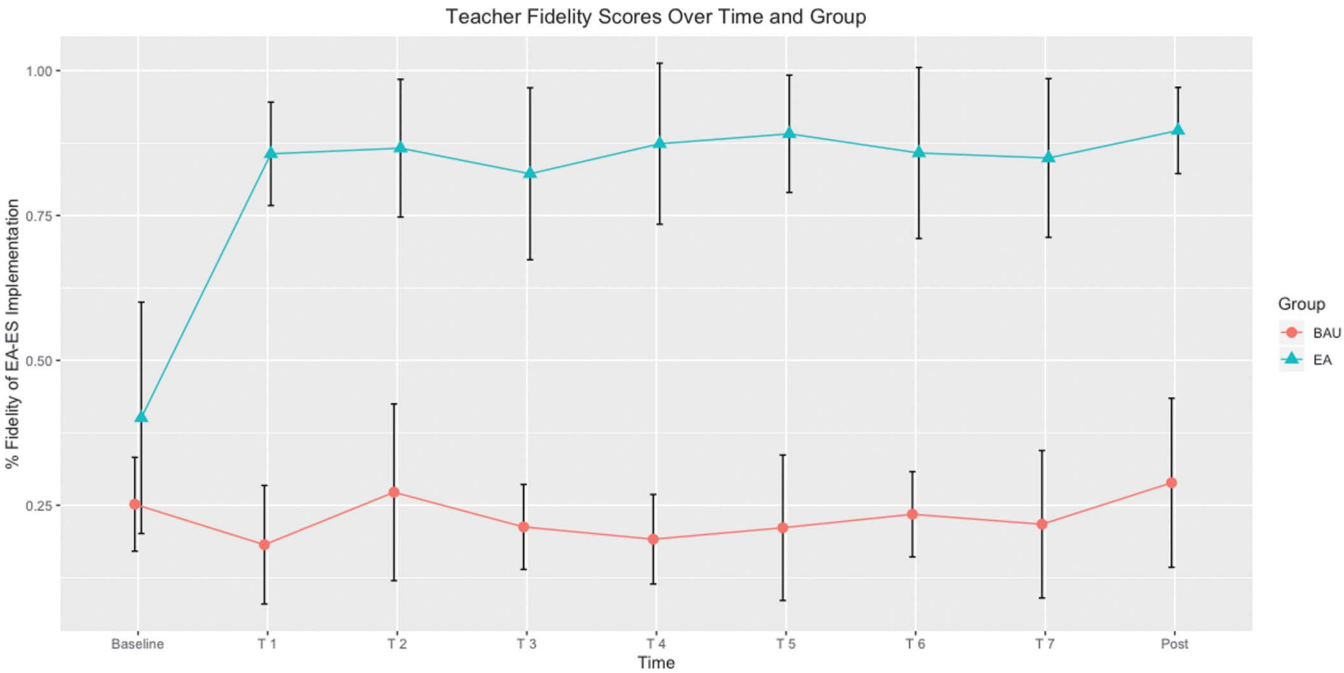
Teachers' implementation of the EA-ES intervention components at baseline, as measured by the researcher-coded FOI measure, was 25% and 40% for the BAU and EA-ES groups, respectively. At the posttraining measurement (about 1 month after the last coaching session), teachers' FOI attainment was 29% and 90% for the BAU and EA-ES groups, respectively, showing that the EA-ES teachers attained high fidelity of EA-ES intervention implementation. At each T (T1, T2, T3, T4, T5, T6, T7, posttraining), the EA-ES group had significantly higher FOI scores relative to baseline than did the BAU group (estimates ranged from 0.45 to 0.54, $p < .0001$; see Figure 2).

Child Outcomes

Unadjusted Mean Differences in Variables Over Time, Within Group

Values of the primary and secondary child outcome measures at baseline and postintervention in the EA-ES and BAU group are summarized in Table 3. The EA-ES group showed increases on all three primary and both secondary child outcome measures from baseline to postintervention (see Table 3). The average, unadjusted mean differences from baseline to postintervention reflected gains in frequency of production for IJA of 1.8, directed gestures of 0.5, and spontaneous verbalizations of 3.7, and for MSEL nonverbal and verbal composites of 8.0 and 4.0 months, respectively (see Table 3 and Figure 3). *t* tests revealed statistically significant differences within the EA-ES group from baseline to postintervention in IJA, spontaneous verbalizations, and MSEL nonverbal composite score (ps < .05). Hedge's *g* effect sizes were calculated to estimate the magnitude of change from baseline to postintervention

Figure 2. Teacher fidelity scores over time and group. BAU = business-as-usual; EA-ES = Early Achievements for Education Settings.



within the EA-ES group. All Hedge's g effect sizes were positive, demonstrating that the child's performance on outcome measures increased from baseline to postintervention in the EA-ES group (see Table 3). Large effect sizes were observed for frequency of IJA (g = 0.9) and MSEL nonverbal composite (g = 0.9). Medium effect sizes were observed for spontaneous verbalizations (g = 0.7) and MSEL verbal composite (g = 0.5). The effect size observed for directed gestures was small (g = 0.2).

In the BAU group, the average unadjusted mean differences from baseline to postintervention reflected decreased frequency of production of IJA (–1.1) and directed gestures (–0.6), and gains in frequency of production of spontaneous verbalizations (1.2). Gains in MSEL nonverbal and verbal composites of 4.0 and 4.2 months, respectively, were observed. t tests revealed no statistically significant differences from baseline to postintervention for any of the dependent variables in the BAU group (see Table 3 and Figure 3). Small Hedge's g effect sizes were observed for all child outcome variables within the BAU group: –0.4 (decrease), 0.3, and 0.3 for directed gestures, spontaneous verbalizations, and MSEL verbal composite, respectively. A medium effect size (0.5) was observed for MSEL nonverbal composite.

Table 3. Unadjusted differences between baseline and postintervention child outcome measures within and between groups.

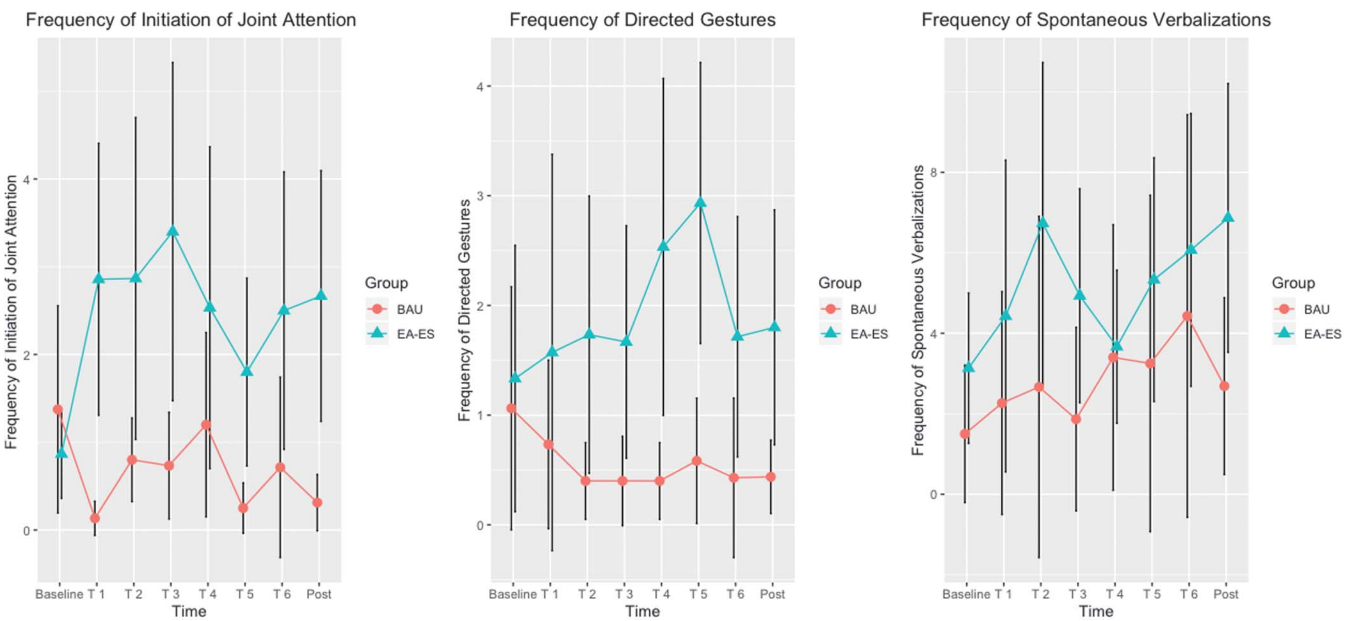
	BAU		EA-ES			Group × Time
Measure	**Baseline *M* (*SD*)**	**Post *M* (*SD*)**	**Baseline *M* (*SD*)**	**Post *M* (*SD*)**	***g*[a]**	**Estimate (*p*)[b]**
IJA	1.4 (2.2)	0.3 (0.6)	0.9 (0.9)	2.7 (2.6)**	0.9	2.9**
Gesture	1.1 (2.1)	0.4 (0.6)	1.3 (2.2)	1.8 (1.9)	0.2	1.1
Verbalizations	1.5 (3.2)	2.7 (4.1)	3.1 (3.4)	6.9 (6.0)**	0.74	2.6
MSEL NV	29.8 (7.2)	33.8 (9.5)	33.3 (6.4)	41.3 (9.8)***	0.9	4.0
MSEL V	19.8 (10.6)	24.0 (14.3)	29.3 (8.7)	33.3 (8.8)	0.5	–0.2

Note. BAU = business as usual; EA-ES = early achievements for education settings; IJA = initiation of joint attention; MSEL NV = Mullen Scales of Early Learning nonverbal composite; MSEL V = Mullen Scales of Early Learning verbal composite. t test p-value for difference in within group means (baseline to postintervention).

[a]Hedge's g effect size for differences between groups. [b]Regression estimate and p-value for group × time interaction testing whether difference in child outcome measures Baseline to Post differs by group.

*$p \leq 0.1$; **$p \leq .05$; ***$p \leq .01$.

Figure 3. Frequency of initiation of joint attention (left), frequency of directed gestures (center), and frequency of spontaneous verbalizations (right). BAU = business-as-usual; EA-ES = Early Achievements for Education Settings.



Unadjusted Mean Differences in Outcome Variables Over Time, Between Group

In comparisons examining differences in child outcome measures from baseline to postintervention by group (EA-ES vs. BAU group), large effect sizes were observed for IJA (g = 1.2) and MSEL nonverbal composite (g = 0.9). Medium effect sizes were observed for directed gestures (g = 0.5) and spontaneous verbalizations (0.6), and negligible for MSEL verbal composite (g = –0.03).

To assess for the statistical significance of these Group × Time interactions, we carried out a linear mixed-effects model with group, T, and Group × T terms. In these unadjusted models, there was evidence that the EA-ES group had a significantly greater change in IJA from baseline to postintervention relative to the BAU group (estimate = 2.9; p < .05). However, in these unadjusted models, no additional changes in child outcome measure over time were significantly different in the EA-ES compared to the BAU group. We next used linear mixed-effects models to adjust for random baseline differences between the EA-ES and BAU groups, which could confound results.

Child Outcomes Using Linear Mixed-Effects Modeling: Adjusted for Baseline Variables

Child Primary Dependent Variables (IJA, Directed Gestures, Spontaneous Verbalizations)

There was a significant Group × Time interaction for frequency of IJA. Comparing change from baseline to postintervention measurements, the frequency of IJA produced in the 5-min behavioral sample increased by 3.44 events more in the EA-ES group than in the BAU group (p < .001). Frequency of IJA also was significantly higher at all other Ts (T1 through T7) relative to Baseline in the EA-ES compared to the BAU group; estimates ranged from 2.34 to 3.61, p < .05 (see Table 4) in the 5-min behavior samples.

There was a significant Group × Time interaction for frequency of directed gestures at intra-intervention T5 and T6 relative to baseline. Frequency of directed gestures produced in the 5-min behavioral sample increased by 1.96 events more in the EA-ES group than the BAU group (0.03) from baseline to intra-intervention T5 and 1.86 events more from baseline to intra-intervention T6 (p = .05). However, there were no significant Group × Time interactions at other Ts, including at postintervention (see Table 4).

There was a trend toward significance for a Group × Time effect for frequency of spontaneous verbalizations produced in the 5-min behavioral sample. Comparing change from baseline to postintervention, the EA-ES group produced 3.19 more spontaneous verbalizations than the BAU group (95% confidence interval [CI] [–0.35, 6.73]; p = .08). No significant between-group differences were detected in the magnitude of change in frequency of directed gestures produced at any of other monthly intra-intervention measurements compared to baseline (see Table 4).

Child Secondary Dependent Variables (MSEL Nonverbal and Verbal Composites)

A significant Group × Time interaction was detected for the nonverbal composite score (estimate = 4.36; 95% CI [1.05, 7.67]; p = .01). No significant Group × Time interaction effect was detected for the verbal composite

Table 4. Linear mixed effect models group by time interactions on child outcome measures.

Dependent variable	Group × Time interaction	Estimate	95% Confidence interval	*p* value
IJA	EA-ES x Timepoint 1	3.61	(1.81, 5.41)	< .001
	EA-ES x Timepoint 2	3.01	(1.23, 4.78)	< .01
	EA-ES x Timepoint 3	3.50	(1.74, 5.26)	< .001
	EA-ES x Timepoint 4	2.34	(0.58, 4.10)	< .01
	EA-ES x Timepoint 5	2.40	(0.56, 4.25)	< .05
	EA-ES x Timepoint 6	3.23	(1.14, 5.33)	< .01
	EA-ES x Timepoint Post	3.44	(1.68, 5.20)	< .001
Gesture	EA-ES x Timepoint 1	0.51	(−1.33, 2.35)	.59
	EA-ES x Timepoint 2	1.19	(−0.63, 3.01)	.20
	EA-ES x Timepoint 3	0.89	(−0.91, 2.69)	.33
	EA-ES x Timepoint 4	1.96	(0.16, 3.77)	.03
	EA-ES x Timepoint 5	1.86	(−0.02, 3.74)	.05
	EA-ES x Timepoint 6	1.20	(−0.93, 3.33)	.27
	EA-ES x Timepoint Post	1.13	(−0.67, 2.93)	.22
Verbalizations	EA-ES x Timepoint 1	−0.05	(−3.67, 3.57)	.98
	EA-ES x Timepoint 2	2.57	(−1.00, 6.15)	.16
	EA-ES x Timepoint 3	1.19	(−2.35, 4.74)	.51
	EA-ES x Timepoint 4	−1.03	(−4.57, 2.51)	.57
	EA-ES x Timepoint 5	0.31	(−3.40, 4.02)	.87
	EA-ES x Timepoint 6	2.24	(−1.98, 6.46)	.30
	EA-ES x Timepoint Post	3.19	(−0.35, 6.73)	.08
MSEL NV	EA-ES x Timepoint Post	4.36	(1.05, 7.67)	.01
MSEL V	EA-ES x Timepoint Post	−0.27	(−3.54, 2.99)	.86

Note. IJA = initiation of joint attention; EA-ES = Early Achievements for Education Settings; MSEL NV = Mullen Scales of Early Learning nonverbal composite; MSEL V = Mullen Scales of Early Learning verbal composite.

(estimate = –0.27; 95% CI [–3.54, 2.99]; p = .86; see Table 4).

Discussion

This pilot RCT demonstrated that EA-ES, a group-based supplemental, embedded social and communication intervention, shows promise as a feasible and effective teacher-implemented intervention for preschoolers with ASD. This addresses a gap in existing interventions for implementation by teachers of preschoolers with ASD in authentic educational settings. Teachers randomized to the EA-ES condition made significantly greater gains in fidelity of EA-ES implementation compared to teachers in the BAU condition. Preschoolers with ASD enrolled in EA-ES classrooms showed significantly greater gains in frequency of producing IJA and in nonverbal cognitive functioning than those in BAU classrooms. This indicates that exposure to the EA-ES intervention, even for part of the school year and for a limited amount of time each day, likely had a meaningful impact on aspects of functioning that are of fundamental importance for social, communication, and language development and for a successful transition to school (Marsh et al., 2017). Therefore, use of EA-ES with children with ASD during the preschool period, a formative time in preparing children for the transition to school, may serve as a protective factor for success in this transition.

Teachers participating in this study led classrooms having many complex elements. All classrooms provided group intervention, used school-prescribed curricula not well aligned with the learning needs of children with ASD, and experienced discontinuity of instructional delivery due to frequent school closures (weather-related, holidays, professional days when schools were closed for children). Particular challenges to teachers' ability to consistently implement evidence-based instructional strategies involved the complex learning needs and behavioral dysregulation of students with ASD, and the sporadic, but year-long transition of new students with special needs, especially ASD, into their classrooms as children reached 3 years of age (Wilson & Landa, 2019). For many children, this transition was difficult and was associated with high levels of behavior dysregulation that frequently required teachers to interrupt their instruction to apply positive behavior supports (Carr et al., 1991; Mandell et al., 2013; Marsh et al., 2017). An associated challenge is the contagion effect of one child's behavioral dysregulation on other children with ASD in the classroom. These factors likely have a cumulative deleterious effect on dosage of intervention received by preschoolers with ASD.

Despite the challenges discussed above, teachers randomized to the EA-ES condition responded quickly to the EA-ES training and began adopting the intervention components. Indeed, EA-ES teachers exceeded the benchmark for fidelity attainment of 80% (Reichow 2011; Wilczynski & Christian, 2008), a standard often not reached in school-based intervention studies (e.g., Mandell et al., 2013; Strain & Bovey, 2011). Informal feedback from teachers revealed that three primary factors were particularly supportive of their fidelity attainment: workshop content and interactive and collaborative nature of the

PD program, compatibility of EA-ES with their practices and pedagogy, and rapid improvement in child engagement.

PD Program

The first two interactive workshops, provided about a week apart, introduced all the intervention components, provided active learning experiences (Borko, 2004; Desimone et al., 2002), and provided time to plan lessons and prepare needed intervention materials. Coaching enabled teachers to problem-solve as they integrated new strategies into their practice of teaching and to synthesize novel elements (Borko, 2004). The result was scaffolded implementation success early in the training process, and sustainment of high fidelity as teachers became more independent in implementation and coaching supports was gradually decreased. The coach's consistently positive, supportive input put teachers at ease and facilitated honesty about perceived implementation challenges. This permitted a differentiated training process, which was needed to address different classroom demands, resources, and learning styles across teachers (Stover et al., 2011; Tomlinson & McTighe, 2006).

Addressing Teachers' Practices, Pedagogy, and Paradigms

EA-ES was designed to maximize feasibility of implementation in part by aligning the intervention components and implementation requirements with teachers' practices and pedagogy. Examples of alignment with teachers' practices are as follows. First, EA-ES is embedded within existing activities and was designed to supplement, not to replace, schools' existing curricula. This reduced the amount of new learning required of teachers and fostered school administrators' buy-in, which further empowered teachers to implement new instructional strategies. Replacing teachers' instructional practices with a new intervention may be met with resistance and difficulty attaining high levels of fidelity, indicating low levels of adoption of the new intervention as observed by Mandell et al. (2013). In Mandell et al.'s study, teachers of primary school-aged children with ASD were trained in a replacement intervention, Strategies for Teaching based on Autism Research (Arick et al., 2004). Teachers' were unsuccessful in reaching the fidelity benchmark, possibly due to feasibility issues with learning to implement many new intervention components (Mandell et al., 2013).

Another EA-ES feature aligned with teachers' practices is its design to be implemented in group learning activities. This efficient and cost-effective feature supports teachers' ability to promote the target skills that rely on engagement with others, such as reciprocal peer-to-peer interaction, imitation, and ecologically valid communicative exchanges. Targeting these core impairments of ASD within existing classroom routines facilitates acquisition and generalization of skills needed for a successful transition to school (Marsh et al., 2017). Interventions that require 1:1 instruction, even for part of the intervention's implementation (e.g., Strategies for Teaching based on Autism Research, ASAP), may not be feasible for consistent implementation by teachers, given most schools' student-to-teacher staffing ratios (Mandell et al., 2013) and teachers' self-reported weak level of intention to provide daily 1:1 instruction (Fishman et al., 2018). A pedagogically aligned EA-ES element is the child-centered instructional approach. Teachers embraced the opportunity to learn new ways to increase child engagement that were offered through select set of NDBI strategies along with strategies aligned with embodied (target-related hands-on learning) and situated cognition (target-related environmental engineering) that resulted in the accessibility and redundancy of information children needed at their developmental level.

As teachers began to implement EA-ES, child engagement informally was observed by teachers and the coach to increase. This engagement can be inferred by visually inspecting the graphs of social communication behavior displayed in Figure 3. Although we did not measure child engagement per se, attention engagement is a very early-developing function and one of the first things to improve in children with ASD in response to child-contingent adult behavior (Wimpory et al., 2007) and to receiving evidence-based interventions, even when those interventions are implemented by school staff (Boyd et al., 2018; Lawton & Kasari, 2012). Such engagement is fundamental to children's ability to make advances in social, language, and cognitive domains and is further discussed below. Our fidelity data indicate that EA-ES-trained teachers became intentional about targeting specific skills and appropriately chose whether to prompt or reinforce child behaviors. As teachers attuned to child behaviors occurring in response to their cues, it is likely that they became more aware of each student's developmental level, enabling them to advance in providing more refined differentiated instruction. Differentiation of instruction likely further facilitated children's attention engagement, attempts to perform targeted behaviors (see Figure 3), and, anecdotally, behavior regulation (Wimpory et al., 2007).

Alignment of EA-ES with teachers' practices, resources, and pedagogy (e.g., valuing book sharing as a potent emergent literacy activity; Lickteig & Russell, 1993) created a context for success as teachers encountered the need for paradigm shifts when advancing into the more independent implementation of EA-ES. For example, while book sharing is a familiar practice and pedagogically embraced activity, the books commonly used in preschool special education and early childhood education classrooms contain language, plot, and illustrations that are too complex and insufficiently redundant to maximize children's successful meaning construction. As teachers learned to modify their implementation of book sharing and integrate EA-ES goals into that activity, three of the paradigmatic shifts they encountered included (a) use of a more intentional instructional process by targeting specific skills and using multisensory experiences to promote child learning in contrast to reading straight through a book, (b) relying less on question-asking as an engagement strategy and relying more on the use of strategies to bait child initiation, and (c) progressing to a more granular level of thinking about child skill and concept development than they had been prepared to do in their preservice training.

Child Gains

Two sets of measures were conducted with child participants: measures of primary child outcomes of social communication behavior, obtained during 5-min samples of behavior within a 15-min classroom instructional activity delivered by the teacher (proximal measures); and examiner-administered standardized measures (distal measures) of secondary outcomes. Medium-to-large treatment effects, favoring the EA-ES group, were observed for most outcome variables. After adjusting analyses for number of school absences and baseline level of cognitive impairment and ASD severity, statistically significant group differences were detected for frequency of IJA (proximal measure) and nonverbal cognitive development (distal measure). In addition, the EA-ES group, compared to the BAU group, showed significantly greater improvement for two intra-intervention Ts compared to baseline performance for frequency of directed gestures (proximal measure). These robust results were obtained in about 6 months of receiving a group teacher-implemented intervention for a brief time 3 or more times per week.

The social communication behaviors measured herein represent areas of major difficulty for young children with ASD. The EA-ES intervention was associated with a significant improvement in a core deficit area of ASD, the ability to initiate communicatively with others by initiating joint attention, and, during the intervention period, directing gesture, even in children who produced, on average, approximately one IJA bid at the baseline measurement. Despite the EA-ES group's gain of producing, on average, 3.8 more spontaneous initiations of meaningful (nonecholalic) communicative linguistic utterances (not undifferentiated or unconventional vocalizations), nearly doubling their production of these spontaneous verbalizations from baseline to postintervention compared to the BAU group (who showed no measurable change), criterion for statistical significance was not reached. It is impressive that children in the EA-ES group were able to generate these increased levels of social and communication behaviors amid the "noise" of unexpected and challenging events that frequently occur in group early education contexts involving young children with ASD (e.g., dysregulation of a child, interruptions occurring when personnel enter the classroom to escort children to therapy sessions or make a delivery to the classroom). Failure to detect significant group differences for spontaneous verbalizations quite likely is related to low power due to small sample size.

Accelerated nonverbal cognitive development also was associated with receiving the EA-ES intervention. Children in the EA-ES group began the school year with nonverbal skills lagging about 1.5 years behind the age-expected level. This reflects a slow growth rate, with developmental gains of about 6–7 months per year. With exposure to the EA-ES intervention, children's rate of nonverbal development was accelerated, with advances of 8 developmental months within about 8 calendar months. Several components of the EA-ES intervention may have supported this accelerated nonverbal cognitive development and meaning construction. For example, the embodied learning approach of EA-ES involved use of pictures and objects, with multiple exemplars, during book sharing to scaffold children's comprehension of targeted concepts and story events. Children learned object functions, how objects relate to other objects, and how objects and agents (story characters represented through dolls or stuffed animals) relate to bring about events in the story. Such direct experience likely supported visual discrimination, category formation, the ability to learn how to use objects by watching others' meaningful object use, eye–hand coordination, and so forth. Such skills and knowledge were assessed by measures of young children's nonverbal functioning. Despite these gains in nonverbal development, the groups did not differ in rate of language development as measured by the MSEL. This is not surprising given that teachers did not directly teach the vocabulary on the MSEL language subscales. Furthermore, the literature shows minimal vocabulary gains in neurotypically developing preschoolers who received teacher-implemented interventions (Justice et al., 2005; Storkel et al., 2017; Wasik et al., 2016). In addition, Kasari and colleagues (Kasari et al., 2006, 2008) report that, despite immediate intervention effects on joint attention, intervention-related effects on language were not observed until 1 year after the intervention had ended.

Our findings in gains across IJA, directed gesture, and nonverbal domains demonstrate promise of the EA-ES intervention as a viable supplement and complement to schools' existing curriculum. Gains in these areas likely prime children for language learning and for future social learning (Mundy, 2018). The ability to establish joint attention with others, for example, demonstrates the capability to establish a common attentional focus, or perspective, with others. This is necessary, but not sufficient, for language acquisition and for learning from instruction (Kasari et al., 2008). Developmental gains in joint attention and nonverbal cognitive ability from baseline to postintervention, with growing representational skills during the intervention period (measured by directed gestures), support advances in children's ability to construct meaning from the world around them, enabling them to engage with people and objects (in dyadic and triadic interaction), thereby affording them ever more social, linguistic, play, cognitive, and motor learning experiences. A major clinical implication of findings reported by Landa and Kalb (2012) is that ongoing intervention targeting social and communication impairments of ASD is needed after early intervention. Furthermore, a recent report from our team (Greenslade et al., 2019) suggests that intervention for core ASD social and communication impairments will be needed at least through adolescence. That report showed that children with ASD diagnosis rigorously documented at age 3 years exhibited pragmatic communication impairment 5–9 years later (Greenslade et al., 2019).

To capitalize on the joint attention and nonverbal child gains effected by EA-ES, there is an important role for SLPs. SLPs trained to implement EA-ES would bring their expertise to a collaboration with teachers to define the vocabulary and language goals to be targeted during book sharing. SLPs could increase the dosage of language-specific intervention by providing small-group booster book sharing or book-extension sessions with a spotlight on language, offering a high level of differentiation that may not be achieved easily in teacher-led whole-group activities (Palincsar et al., 2000). One reported barrier to an SLP–teacher collaborative intervention approach in school settings is the amount of planning time required of SLPs (Dykstra et al., 2012; Throneburg et al., 2000). Using the same book for 2–3 weeks helps to reduce planning time. Collaborating with teachers on identifying the books and materials to be used, how/where to target the language goals across the pages of the book, and opportunities for child initiation of communication, as well as the NDBI strategies, need only be done once per book (archiving the materials for repeated use each year), with nuanced changes to individualize level of language complexity for different children each year.

There is emerging evidence that a collaborative approach to intervention between SLPs and teachers is associated with more robust child language gains than are observed when children receive SLP pull-out services (Hadley et al., 2000; Throneburg et al., 2000). Although such collaboration is recommended to maximize children's language and literacy development (Justice et al., 2009) and support generalization (Wilcox et al., 1991), such a collaborative approach is uncommon (Suleman et al., 2014) and more empirical research is needed to understand added value for child language learning (Archibald, 2017).

Limitations and Directions for Future Research

This study was funded as a pilot RCT following an iterative development process. Accordingly, a major limitation was the small sample size. There was attrition of two teachers facing complex classroom situations that were unrelated to the study (multiple children with severe behavioral challenges that interfered with instructional delivery; personnel challenges). Another limitation is the absence of data on parent linguistic profile or language spoken at home; these are variables that may impact child language learning. Although the recruited child sample in this pilot RCT was racially and economically diverse, all classrooms were recruited from a single school district, potentially limiting the generalizability of the results to other school districts across the United States.

Although overall child social communication gains were robust, trajectories across the school year were nonlinear. There were observed dips in the EA-ES group's production of IJA, use of directed gesture, and spontaneous verbalizations following robust gains in these skills once the intervention had begun. Variability in social communication behavior is commonly noted in intervention studies (e.g., Boyd et al., 2018; Dykstra et al., 2012; Lawton & Kasari, 2012). More research is needed to understand how timing of school closings (e.g., weekly closings across 2 months) and absence, resulting in inconsistent receipt of intervention, affects rate of learning. Indeed, even in children with neurotypical development, missed instruction had an adverse effect on learning (e.g., language; Hubbs-Tait et al., 2002; Justice et al., 2008). Such effects could be amplified in children with ASD, who often returned to school after holidays and extended weather-related school closings with amplified levels of dysregulation, likely challenging teachers' delivery of systematic and consistently enriched evidence-based instruction (Wilson & Landa, 2019).

Due to the small sample size in this pilot RCT, analyses were underpowered, likely contributing to the lack of statistical significance in the Group × Time association with spontaneous communicative verbalizations. Given the substantial gains in the EA-ES group's IJA and directed gesture, as well as in spontaneous communicative verbalizations that did not reach criteria for statistical significance when compared to the BAU group, gains in spoken language are expected to follow. As discussed above, intervention researchers have found that, even with gains in joint attention, spoken language gains may not present until long after intervention has ended (Kasari et al., 2006, 2008).

Implications of these limitations for future research include the following. An important next step is a fully powered RCT to examine the efficacy of EA-ES, with over recruitment of classrooms in case of attrition that may happen due to unforeseen circumstances. Such a study likely would enable investigators to further examine effects of EA-ES PD on teachers' implementation of the EA-ES intervention training. Given the unique barriers associated with school district protocols (e.g., staffing policies, student-to-teacher ratios) and curricula (e.g., books that may not be developmentally appropriate for preschoolers with ASD), the inclusion of multiple school districts across multiple geographic regions in future research will permit examination of the generalizability of results. An important focus of future research should be to examine the impact of training SLPs to incorporate EA-ES intervention targets and instructional methods as part of a teacher–SLP collaborative approach. The resulting additional dosage of intervention may prevent or attenuate dips in child performance related to inconsistent receipt of intervention due to competing priorities for teachers or missed school days (e.g., due to weather, illness, professional days). To investigate whether the gains in joint attention observed in EA-ES children moderate expressive language development, a future study should collect follow-up data from children in both conditions at a T 1 or 2 years following intervention.

Concluding Remarks

This study, in which special educators were trained by clinical researchers to target high impact social communication skills to preschoolers with ASD, addresses a research-to-practice gap in the fields of special education and speech-language pathology. The results of the study provide evidence that teachers of preschoolers with ASD effectively learn and implement objectively defined evidence-based instructional strategies when provided systematic PD with job-embedded coaching. Also, preschoolers with ASD who receive teacher-implemented EA-ES for brief periods during the week for about 6 months demonstrate significantly greater gains in social and nonverbal cognitive development than children in BAU classrooms. Finally, the study supports the importance of combining the expertise of SLPs, who are uniquely positioned to promote social communication skills in children, and preschool teachers, who have the power to embed potent social communication learning opportunities into their instruction throughout the day, supporting acquisition and generalization of target skills. EA-ES may provide a mechanism to support collaboration between teachers and SLPs in school settings, which could amplify the impact of the intervention on children's social and communication development and provide a strong foundation for entry into kindergarten.

Acknowledgments

This study was funded by the Institute of Education Sciences Award No. R324A120330 awarded to the Hugo W. Moser Research Institute at Kennedy Krieger (PI: Landa). The opinions expressed represent those of the authors and do not represent views of the Institute or the U.S. Department of Education.

We wish to thank the coach Michael Molinaro, study coordinator Eileen Swanekamp, and research staff who assisted with this project, including Rebecca German, Avery Rain, and Hillary Stalknecht. We also thank the school administrators, the teachers who participated, and the parents who agreed to have their children participate.

References

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

Archibald, L. M. (2017). Working memory and language learning: A review. *Child Language Teaching and Therapy, 33*(1), 5–17. https://doi.org/10.1177/0265659016654206

Arick, J. R., Krug, D. A., Loos, L., & Falco, R. (2004). *The STAR program: Strategies for teaching based on autism research: Level III*. Pro-Ed.

Baio, J., Wiggins, L., Christensen, D. L., Maenner, M. J., Daniels, J., Warren, Z., Kurzius-Spencer, M., Zahorodny, W., Robinson Rosenberg, C., White, T., Durkin, M. S., Imm, P., Nikolaou, L., Yeargin-Allsopp, M., Lee, L. C., Harrington, R., Lopez, M., Fitzgerald, R. T., Hewitt, A., . . . Dowling, N. F. (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*(6), 1–23. https://doi.org/10.15585/mmwr.ss6706a1

Baldwin, D. A. (1995). Understanding the link between joint attention and language. In C. Moore & P. J. Dunham (Eds.), *Joint attention: Its origins and role in development* (pp. 131–158). Erlbaum.

Bartko, J. J. (1966). The intraclass correlation coefficient as a measure of reliability. *Psychological Reports, 19*(1), 3–11. https://doi.org/10.2466/pr0.1966.19.1.3

Bhat, A. N., Landa, R. J., & Galloway, J. C. (2011). Current perspectives on motor functioning in infants, children, and adults with autism spectrum disorders. *Physical Therapy, 91*(7), 1116–1129. https://doi.org/10.2522/ptj.20100294

Bishop, S. L., Guthrie, W., Coffing, M., & Lord, C. (2011). Convergent validity of the Mullen Scales of Early Learning and the differential ability scales in children with autism spectrum disorders. *American Journal on Intellectual and Developmental Disabilities, 116*(5), 331–343. https://doi.org/10.1352/1944-7558-116.5.331

Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher, 33*(8), 3–15. https://doi.org/10.3102/0013189X033008003

Boyd, B. A., Hume, K., McBee, M. T., Alessandri, M., Gutierrez, A., Johnson, L., Sperry, L., & Odom, S. L. (2014). Comparative efficacy of LEAP, TEACCH and non-model-specific special education programs for preschoolers with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 44*(2), 366–380. https://doi.org/10.1007/s10803-013-1877-9

Boyd, B. A., Watson, L. R., Reszka, S. S., Sideris, J., Alessandri, M., Baranek, G. T., Crais, E. R., Donaldson, A., Gutierrez, A., Johnson, L., & Belardi, K. (2018). Efficacy of the ASAP intervention for preschoolers with ASD: A cluster randomized controlled trial. *Journal of Autism and Developmental Disorders, 48*(9), 3144–3162. https://doi.org/10.1007/s10803-018-3584-z

Brandel, J., & Loeb, D. F. (2011). Program intensity and service delivery models in the schools: SLP survey results. *Language, Speech, and Hearing Services in Schools, 42*(4), 461–490. https://doi.org/10.1044/0161-1461(2011/10-0019

Carr, E. G., Taylor, J. C., & Robinson, S. (1991). The effects of severe behavior problems in children on the teaching behavior of adults. *Journal of Applied Behavior Analysis, 24*(3), 523–535. https://doi.org/10.1901/jaba.1991.24-523

Chang, Y. C., Shire, S. Y., Shih, W., Gelfand, C., & Kasari, C. (2016). Preschool deployment of evidence-based social communication intervention: JASPER in the classroom. *Journal of Autism and Developmental Disorders, 46*(6), 2211–2223. https://doi.org/10.1007/s10803-016-2752-2

Cicchetti, D. V. (1994). Guidelines, criteria, and rules of thumb for evaluating normed and standardized assessment instruments in psychology. *Psychological Assessment, 6*(4), 284–290. https://doi.org/10.1037/1040-3590.6.4.284

R Core Team. (2019). *R: A language and environment for statistical computing*. R foundation for statistical computing. https://www.R-project.org/

Corsello, C. M. (2005). Early intervention in autism. *Infants & Young Children, 18*(2), 74–85. https://doi.org/10.1097/00001163-200504000-00002

Desimone, L. M., Porter, A. C., Garet, M. S., Yoon, K. S., & Birman, B. F. (2002). Effects of professional development on teachers' instruction: Results from a three-year longitudinal study. *Educational Evaluation and Policy Analysis, 24*(2), 81–112. https://doi.org/10.3102/01623737024002081

Dichter, G. S., Lam, K. S., Turner-Brown, L. M., Holtzclaw, T. N., & Bodfish, J. W. (2009). Generativity abilities predict communication deficits but not repetitive behaviors in autism spectrum disorders. *Journal of Autism and Developmental Disorders, 39*(9), 1298–1304. https://doi.org/10.1007/s10803-009-0742-3

Dykstra, J. R., Boyd, B. A., Watson, L. R., Crais, E. R., & Baranek, G. T. (2012). The impact of the advancing social-communication and play (ASAP) intervention on preschoolers with autism spectrum disorder. *Autism, 16*(1), 27–44. https://doi.org/10.1177/1362361311408933

Farmer, C., Golden, C., & Thurm, A. (2016). Concurrent validity of the differential ability scales, second edition with the Mullen Scales of Early Learning in young children with and without neurodevelopmental disorders. *Child Neuropsychology, 22*(5), 556–569. https://doi.org/10.1080/09297049.2015.1020775

Fisher, R. A. (1958). *Statistical methods for research workers*. Hafner.

Fishman, J., Beidas, R., Reisinger, E., & Mandell, D. S. (2018). The utility of measuring intentions to use best practices: A longitudinal study among teachers supporting students with autism. *Journal of School Health, 88*(5), 388–395. https://doi.org/10.1111/josh.12618

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*(5), 693–705. https://doi.org/10.1007/s10803-008-0674-3

Greenslade, K. J., Utter, E. A., & Landa, R. J. (2019). Predictors of pragmatic communication in school-age siblings of children with ASD and low-risk controls. *Journal of Autism and Developmental Disorders, 49*(4), 1352–1365. https://doi.org/10.1007/s10803-018-3837-x

Hadley, P. A., Simmerman, A., Long, M., & Luna, M. (2000). Facilitating language development for inner-city children: Experimental evaluation of a collaborative, classroom-based intervention. *Language, Speech, and Hearing Services in Schools, 31*(3), 280–295. https://doi.org/10.1044/0161-1461.3103.280

Hertz-Picciotto, I., & Delwiche, L. (2009). The rise in autism and the role of age at diagnosis. *Epidemiology, 20*(1), 84–90. https://doi.org/10.1097/EDE.0b013e3181902d15

Hollingshead, A. B. (1975). *Four factor index of social status*. Yale University. https://nibo.in.net/490699.pdf

Hubbs-Tait, L., Culp, A. M., Huey, E., Culp, R., Starost, H. J., & Hare, C. (2002). Relation of head start attendance to children's cognitive and social outcomes: Moderation by family risk. *Early Childhood Research Quarterly, 17*(4), 539–558. https://doi.org/10.1016/S0885-2006(02)00189-8

Hume, K., Bellini, S., & Pratt, C. (2005). The usage and perceived outcomes of early intervention and early childhood programs for young children with autism spectrum disorder. *Topics in Early Childhood Special Education, 25*(4), 195–207. https://doi.org/10.1177/02711214050250040101

Justice, L. M., Kaderavek, J. N., Fan, X., Sofka, A., & Hunt, A. (2009). Accelerating preschoolers' early literacy development through classroom-based teacher–child storybook reading and explicit print referencing. *Language, Speech, and Hearing Services in Schools, 40*(1), 67–85. https://doi.org/10.1044/0161-1461(2008/07-0098)

Justice, L. M., Mashburn, A., Pence, K. L., & Wiggins, A. (2008). Experimental evaluation of a preschool language curriculum: Influence on children's expressive language skills. *Journal of Speech, Language, and Hearing Research, 51*(4), 983–1001. https://doi.org/10.1044/1092-4388(2008/072)

Justice, L. M., Meier, J., & Walpole, S. (2005). Learning new words from storybooks: An efficacy study with at-risk kindergartners. *Language, Speech, and Hearing Services in Schools, 36*(1), 17–32. https://doi.org/10.1044/0161-1461(2005/003)

Katz, L. A., Maag, A., Fallon, K. A., Blenkarn, K., & Smith, M. K. (2010). What makes a caseload (un)manageable? School-based speech-language pathologists speak. *Language, Speech, and Hearing Services in Schools, 41*(2), 139–151. https://doi.org/10.1044/0161-1461(2009/08-0090)

Kasari, C., Freeman, S., & Paparella, T. (2006). Joint attention and symbolic play in young children with autism: A randomized controlled intervention study. *The Journal of Child Psychology and Psychiatry, 47*(6), 611–620. https://doi.org/10.1111/j.1469-7610.2005.01567.x

Kasari, C., Paparella, T., Freeman, S., & Jahromi, L. B. (2008). Language outcome in autism: Randomized comparison of joint attention and play interventions. *Journal of Consulting and Clinical Psychology, 76*(1), 125–137. https://doi.org/10.1037/0022-006X.76.1.125

Kim, K., & Mundy, P. (2012). Joint attention, social-cognition, and recognition memory in adults. *Frontiers in Human Neuroscience, 6*, 172. https://doi.org/10.3389/fnhum.2012.00172

Kohler, K. T., & Malott, R. W. (2014). Matrix training and verbal generativity in children with autism. *The Analysis of Verbal Behavior, 30*(2), 170–177. https://doi.org/10.1007/s40616-014-0016-9

Kover, S. T., Edmunds, S. R., & Weismer, S. E. (2016). Brief report: Ages of language milestones as predictors of developmental trajectories in young children with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 46*(7), 2501–2507. https://doi.org/10.1007/s10803-016-2756-y

Kuznetsova, A., Brockhoff, P. B., & Christensen, R. H. B. (2015). Package "lmertest": R package (Version 2.0–33) [Computer software]. https://cran.r-project.org/web/packages/lmerTest/index.html

Landa, R. J., Gross, A. L., Stuart, E. A., & Faherty, A. (2013). Developmental trajectories in children with and without autism spectrum disorders: The first 3 years. *Child Development, 84*(2), 429–442. https://doi.org/10.1111/j.1467-8624.2012.01870.x

Landa, R. J., Holman, K. C., O'Neill, A. H., & Stuart, E. A. (2011). Intervention targeting development of socially synchronous engagement in toddlers with autism spectrum disorder: A randomized controlled trial. *The Journal of Child Psychology and Psychiatry, 52*(1), 13–21. https://doi.org/10.1111/j.1469-7610.2010.02288.x

Landa, R. J., & Kalb, L. G. (2012). Long-term outcomes of toddlers with autism spectrum disorders exposed to short-term intervention. *Pediatrics, 130*(Suppl. 2), S186–S190. https://doi.org/10.1542/peds.2012-0900Q

Lawton, K., & Kasari, C. (2012). Teacher-implemented joint attention intervention: Pilot randomized controlled study for preschoolers with autism. *Journal of Consulting and Clinical Psychology, 80*(4), 687–693. https://doi.org/10.1037/a0028506

Lickteig, M. J., & Russell, J. F. (1993). Elementary teachers read-aloud practices. *Reading Improvement, 30*(4), 202–208.

Linstead, E., Dixon, D. R., Hong, E., Burns, C. O., French, R., Novack, M. N., & Granpeesheh, D. (2017). An evaluation of the effects of intensity and duration on outcomes across treatment domains for children with autism spectrum disorder. *Translational Psychiatry, 7*(9), e1234. https://doi.org/10.1038/tp.2017.207

Lord, C., Rutter, M., DiLavore, P., Risi, S., Gotham, K., & Bishop, S. (2012). *Autism Diagnostic Observation Schedule—2nd Edition (ADOS-2)*. Western Psychological Corporation.

Mandell, D. S., Stahmer, A. C., Shin, S., Xie, M., Reisinger, E., & Marcus, S. C. (2013). The role of treatment fidelity on outcomes during a randomized field trial of an autism intervention. *Autism, 17*(3), 281–295. https://doi.org/10.1177/1362361312473666

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*(3), 184–196. https://doi.org/10.5498/wjp.v7.i3.184

Massand, E., Karmiloff-Smith, A., & Mitchell, K. (2015). Cascading genetic and environmental effects on development: Implications for intervention. In K. Mitchell (Ed.), *The genetics of neurodevelopmental disorders* (pp. 275–288). https://doi.org/10.1002/9781118524947

McKeown, M. G., & Beck, I. L. (2014). Effects of vocabulary instruction on measures of language processing: Comparing two approaches. *Early Childhood Research Quarterly, 29*(4), 520–530. https://doi.org/10.1016/j.ecresq.2014.06.002

Mullen, E. M. (1995). *Mullen Scales of Early Learning*. American Guidance Service Inc.

Mundy, P., Delgado, C., Block, J., Venezia, M., Hogan, A., & Seibert, J. (2003). *A manual for the abridged Early Social Communication Scales (ESCS)*. University of Miami.

Mundy, P., Kim, K., McIntyre, N., Lerro, L., & Jarrold, W. (2016). Brief report: Joint attention and information processing in children with higher functioning autism spectrum disorders. *Journal of Autism and Developmental Disorders, 46*(7), 2555–2560. https://doi.org/10.1007/s10803-016-2785-6

Mundy, P., & Newell, L. (2007). Attention, joint attention, and social cognition. *Current Directions in Psychological Science, 16*(5), 269–274. https://doi.org/10.1111/j.1467-8721.2007.00518.x

Mundy, P. (2018). A review of joint attention and social-cognitive brain systems in typical development and autism spectrum disorder. *European Journal of Neuroscience, 47*(6), 497–514. https://doi.org/10.1111/ejn.13720

Nahmias, A. S., Pellecchia, M., Stahmer, A. C., & Mandell, D. S. (2019). Effectiveness of community-based early intervention for children with autism spectrum disorder: A meta-analysis. *The Journal of Child Psychology and Psychiatry, 60*(11), 1200–1209. https://doi.org/10.1111/jcpp.13073

Ozonoff, S., Young, G. S., Landa, R. J., Brian, J., Bryson, S., Charman, T., Chawarska, K., Macari, S. L., Messinger, D., Stone, W. L., Zwaigenbaum, L., & Iosif, A.-M. (2015). Diagnostic stability in young children at risk for autism spectrum disorder: A baby siblings research consortium study. *The Journal of Child Psychology and Psychiatry, 56*(9), 988–998. https://doi.org/10.1111/jcpp.12421

Palincsar, A. S., Collins, K. M., Marano, N. L., & Magnusson, S. J. (2000). Investigating the engagement and learning of students with learning disabilities in guided inquiry science teaching. *Language, Speech, and Hearing Services in Schools, 31*(3), 240–251. https://doi.org/10.1044/0161-1461.3103.240

Reichow, B. (2011). Development, procedures, and application of the evaluative method for determining evidence-based practices in autism. In B. Reichow, P. Doehring, D. Cicchetti, & F. Volkmar (Eds.), *Evidence-based practices and treatments for children with autism*. Springer. https://doi.org/10.1007/978-1-4419-6975-0_2

Reichow, B. (2012). Overview of meta-analyses on early intensive behavioral intervention for young children with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 42*(4), 512–520. https://doi.org/10.1007/s10803-011-1218-9

Rogers, S. J., Estes, A., Lord, C., Vismara, L., Winter, J., Fitzpatrick, A., Guo, M., & Dawson, G. (2012). Effects of a brief early start Denver model (ESDM)–based parent intervention on toddlers at risk for autism spectrum disorders: A randomized controlled trial. *Journal of the American Academy of Child & Adolescent Psychiatry, 51*(10), 1052–1065. https://doi.org/10.1016/j.jaac.2012.08.003

Rosenthal, R., & Rubin, D. B. (1986). Meta-analytic procedures for combining studies with multiple effect sizes. *Psychological Bulletin, 99*(3), 400–406. https://doi.org/10.1037/0033-2909.99.3.400

Schreibman, L., Dawson, G., Stahmer, A. C., Landa, R., Rogers, S. J., McGee, G. G., Kasari, C., Ingersoll, B., Kaiser, A. P., Bruinsma, Y., McNerney, E., Wetherby, A., & Halladay, A. (2015). Naturalistic developmental behavioral interventions: Empirically validated treatments for autism spectrum disorder. *Journal of Autism and Developmental Disorders, 45*(8), 2411–2428. https://doi.org/10.1007/s10803-015-2407-8

Snyder, P. A., Hemmeter, M. L., & Fox, L. (2015). Supporting implementation of evidence-based practices through practice-based coaching. *Topics in Early Childhood Special Education, 35*(3), 133–143. https://doi.org/10.1177/0271121415594925

Storkel, H. L., Voelmle, K., Fierro, V., Flake, K., Fleming, K. K., & Romine, R. S. (2017). Interactive book reading to accelerate word language by kindergarten children with specific language impairment: Identifying an adequate intensity and variation in treatment response. *Language, Speech, and Hearing Services in Schools, 48*(1), 16–30. https://doi.org/10.1044/2016_LSHSS-16-0014

Stover, K., Kissel, B., Haag, K., & Shoniker, R. (2011). Differentiated coaching: Fostering reflection with teachers. *The Reading Teacher, 64*(7), 498–509. https://doi.org/10.1598/RT.64.7.3

Strain, P. S., & Bovey, E. H. (2011). Randomized, controlled trial of the LEAP model of early intervention for young children with autism spectrum disorders. *Topics in Early Childhood Special Education, 31*(3), 133–154. https://doi.org/10.1177/0271121411408740

Suleman, S., McFarlane, L., Pollock, K., Schneider, P., Leroy, C., & Skoczylas, M. (2014). Collaboration: More than "working together": An exploratory study to determine effect of interprofessional education on awareness and application of models of specialized service delivery by student speech-language pathologists and teachers. *Canadian Journal of Speech-Language Pathology and Audiology, 37*(4), 298–307. https://www.cjslpa.ca/

Tomlinson, C. A., & McTighe, J. (2006). *Integrating differentiated instruction and understanding by design: Connecting content and kids*. Association for Supervision and Curriculum Development.

Throneburg, R. N., Calvert, L. K., Sturm, J. J., Paramboukas, A. A., & Paul, P. J. (2000). A comparison of service delivery models: Effects on curricular vocabulary skills in the school setting. *American Journal of Speech-Language Pathology, 9*(1), 10–20. https://doi.org/10.1044/1058-0360.0901.10

U.S. Department of Education. (n.d.). *What Works Clearinghouse*. http://ies.ed.gov/ncee/wwc/

Wasik, B. A., Hindman, A. H., & Snell, E. K. (2016). Book reading and vocabulary development: A systematic review. *Early Childhood Research Quarterly, 37*(4), 39–57. https://doi.org/10.1016/j.ecresq.2016.04.003

Watson, L. R., Crais, E. R., Baranek, G. T., Dykstra, J. R., & Wilson, K. P. (2013). Communicative gesture use in infants with and without autism: A retrospective home video study. *American Journal of Speech-Language Pathology, 22*(1), 25–39. https://doi.org/10.1044/1058-0360(2012/11-0145)

Weismer, S. E., Lord, C., & Esler, A. (2010). Early language patterns of toddlers on the autism spectrum compared to toddlers with developmental delay. *Journal of Autism and Developmental Disorders, 40*(10), 1259–1273. https://doi.org/10.1007/s10803-010-0983-1

Wetherby, A. M., & Prizant, B. M. (2002). *Communication and symbolic behavior scales: Developmental profile*. Brookes. https://doi.org/10.1037/t11529-000

Wetherby, A. M., Watt, N., Morgan, L., & Shumway, S. (2007). Social communication profiles of children with autism spectrum disorders late in the second year of life. *Journal of Autism* *and Developmental Disorders, 37*(5), 960–975. https://doi.org/10.1007/s10803-006-0237-4

Wilcox, M. J., Kouri, T. A., & Caswell, S. B. (1991). Early language intervention: A comparison of classroom and individual treatment. *American Journal of Speech-Language Pathology, 1*(1), 49–62. https://doi.org/10.1044/1058-0360.0101.49

Wilczynski, S. M., & Christian, L. (2008). The national standards project: Promoting evidence based practice in autism spectrum disorders. In J. K. Luiselli, D. C. Russo, W. P. Christian, & S. M. Wilcyznksi (Eds.), *Effective practices for children with autism: Educational and behavior support interventions that work* (pp. 37–60). Oxford University Press. https://doi.org/10.1093/med:psych/9780195317046.003.0003

Wilson, K. P., & Landa, R. J. (2019). Barriers to educator implementation of a classroom-based intervention for preschoolers with autism spectrum disorder. *Frontiers in Education,* (4) Article 27. https://doi.org/10.3389/feduc.2019.00027

Wimpory, D. C., Hobson, R. P., & Nash, S. (2007). What facilitates social engagement in preschool children with autism? *Journal of Autism and Developmental Disorders, 37*(3), 564–573. https://doi.org/10.1007/s10803-006-0187-x

Wong, C. S. (2013). A play and joint attention intervention for teachers of young children with autism: A randomized controlled pilot study. *Autism, 17*(3), 340–357. https://doi.org/10.1177/1362361312474723

Yoder, P. J., & McDuffie, A. S. (2006). Treatment of responding to and initiating joint attention. In T. Charman & W. Stone (Eds.), *Social & communication development in autism spectrum disorders: Early identification, diagnosis, & intervention* (pp. 117–142). Guilford.