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ORIGINAL PAPER

School Age Outcomes of Children with Autism Spectrum Disorder Who Received Community-Based Early Interventions

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Abstract
This study followed children with Autism Spectrum Disorder (ASD) from early intervention into their early schooling years, when they were aged between 6 and 9 years, on autism symptom severity and cognitive functioning. The children, matched at pre-intervention, were compared on type of community provided service: 31 were in receipt of community-based group Early Start Denver Model and 28 had received other community provisions for ASD. Irrespective of groups, cognitive functioning was found to have significantly improved by school age compared to pre-intervention. Autism symptom severity increased during the same developmental period, seemingly driven by an increase in restricted and repetitive behaviours over time. In contrast, both groups displayed improved social affect by school age.

Keywords Autism spectrum disorder · Early Start Denver Model · Community · Early intervention · Long-term · School age

Introduction

Early intervention (EI) is defined as intervention implemented as soon as the disability is first identified, with the aim of reducing the impact of disability for the individual, their family, and the wider community (Productivity Commission 2011). These interventions include those that are community-based, which refers to interventions that are conducted in, and of relevance to, the community. EI for Autism Spectrum Disorder (ASD) is typically delivered within the period of early childhood (American Psychiatric Association 2013), and relies on early detection and diagnosis of ASD. Advancements in the detection of early markers of ASD, possible in children from as young as 12 months (Barbaro and Dissanayake 2013), has paved the way for increased utilization of EI.

The developmental benefits for children with an ASD in receipt of EI, including improvements in language, cognitive functioning, and adaptive behaviour, have been well established (Reichow 2012; Smith and Iadarola 2015). Certainly, one-to-one delivery of EI by trained clinicians has shown significant improvements at a group level (Dawson et al. 2010; Hayward et al. 2009; Sallows and Graupner 2005; Smith et al. 2000). Intervention based on a specific treatment modality may also benefit children more than 'eclectic' approaches (Warren et al. 2011). However, emerging research continues to question this assertion. Recently, Boyd et al. (2014) found that high quality teacher practices are as beneficial to children with ASD in the short-term as two comprehensive treatment models, LEAP (Leaning Experiences and Alternative Program) and TEACCH (Treatment and Education of Autistic and Communication Handicapped Children). In addition to the delivery modalities available, a variety of EI models are now available for children with ASD.

Behaviourally-based interventions have been the cornerstone of interventions for ASD, which are typically focused on the application of learning theory to foster skill development (Prior et al. 2011). Furthermore, developmental interventions involve supporting children's development and their interpersonal relationships (Prior et al. 2011). Increasingly, interventions draw upon aspects of both behavioural and developmental science (Schreibman et al. 2015), and many draw upon different EI approaches rather than subscribing to one model of intervention. These are sometimes called

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'eclectic interventions' (Prior et al. 2011) which typically utilize a combination of treatment strategies, for which there is some evidence-base.

There is a strong evidence base supporting EI methods that draw upon theories of behavioural learning and developmental science, and that are delivered within naturalistic contexts. These interventions have been described as 'Naturalistic Developmental Behavioural Interventions' (NDBI; Schreibman et al. 2015). One such model is the Early Start Denver Model (ESDM), designed specifically for young children aged from 12 to 60 months (Rogers 2013; Rogers and Dawson 2010). The ESDM is a comprehensive EI that facilitates social engagement and active learning, and aims to minimise the impact of autism symptoms on children's learning by targeting deficits in attention, imitation, language, play skills, affect sharing and social orientation (Rogers et al. 2012).

The first randomised control trial (RCT) of the ESDM, using one-to-one therapist to child delivery, with children with ASD aged 2 years at the start of intervention, showed significant improvements in cognitive functioning and adaptive behaviour in comparison to children receiving a 'treatment as usual' community-based intervention (Dawson et al. 2010) which accord more closely to an 'eclectic' intervention. Moreover, continued improvements in cognition and behaviour, as well as decreased symptom severity, were observed following ESDM cessation, at a 2-year follow-up to the RCT (Estes et al. 2015).

Estes et al. (2015) compared the outcomes of children who had received the ESDM at age 6 years to those in the community-based treatment as usual group. Both groups had received equivalent hours of intervention during the original RCT. While no group differences were found immediately post-treatment on core autism symptoms, the ESDM group showed improved core autism symptoms as well as in adaptive behaviour by the 2-year follow-up compared to the comparison group. Although the two groups were not distinguishable in cognitive functioning at follow-up, significant gains in cognition were demonstrated in both groups at the school age follow-up.

Emerging research supports the effectiveness of the ESDM when delivered in a group setting (Vivanti et al. 2017). Eapen et al. (2013) examined the outcomes of children aged between 36 and 58 months at the commencement of group-based ESDM provided in a community child-care setting. Children received 15–20 h of group therapy, and 1 h of 1:1 ESDM intervention per week for approximately 10 months. Significant gains were found in cognitive functioning and adaptive behaviour post intervention, and parents also reported a significant decrease in autism severity as assessed by the Social Communication Questionnaire (Rutter et al. 2003). However, this study did not include a comparison group.

In their study, Vivanti et al. (2014) found that pre-school children who were in receipt of 1 year of community-based group ESDM showed superior gains in cognitive and language functioning compared to matched peers who received other EI (eclectic) services in a similar community setting. Although both groups made significant gains over time, there were no group differences in adaptive behaviour or autism severity post-treatment. While research examining the outcomes of community-based group ESDM is scarce, research investigating outcomes of children with ASD following intervention cessation and into their early school years is rarer still.

Relatively little is known about the school age outcomes for children with ASD who previously received EI, with the majority of studies focused on shorter-term outcomes (Starr et al. 2016). In their review of EI outcomes in children at primary school, Starr et al. (2016) note that while some children made additional progress beyond the gains made during the course of intervention, other children regressed in their abilities. Thus, further examination of outcomes at school age for children with ASD who received EI is clearly warranted to determine if EI does result in sustained developmental outcomes.

Aims and Hypotheses

The objective in the current study was to examine the school age outcomes of children with ASD who received community-based group EDSM in comparison to children in receipt of other community EI provisions for ASD. Based on the findings of Vivanti et al. (2014), it was hypothesised that children in the ESDM group would make greater gains in overall cognitive functioning from pre-intervention to school age relative to a comparison group who did not receive the ESDM. Informed by the findings of a limited number of school age outcome studies (Starr et al. 2016), we expected that autism symptom severity would remain stable from baseline to the early school years in both groups.

Method

Participants

A total of 59 children with a confirmed diagnosis of ASD who were attending school and aged between 72 and 108 months participated in the study. All children were aged between 18 months and 5 years at enrolment into EI. Thirty-one participants had previously been enrolled in a community-based group ESDM program at the Victorian Autism Specific Early Learning Care Centre (ASELCC), Victoria, Australia. The remaining 28 comparison group participants had been enrolled in other community intervention

programs, with 18 recruited from the AEIOU Foundation (AEIOU), Queensland, Australia and 10 from the Olga Tennison Autism Research Centre (OTARC), Victoria, Australia.

Selection Criteria

ESDM group. Children who had received a minimum of 15 h per week of group-based ESDM intervention for at least 1 year at the ASELCC between 2010 and 2013 were considered for inclusion in the current study. To be eligible for enrolment in EI, children needed a diagnosis of ASD and had to be under 5 years of age. All ASD diagnoses, as per the Diagnostic and Statistical Manual of Mental Disorders (DSM), Forth Edition, Text Revised (DSM-IV-TR; American Psychiatric Association [APA] 2000) or DSM, Fifth Edition (DSM-V; APA, 2013), were confirmed at intake by trained clinicians at the EI centre using the Autism Diagnostic Observation Schedule, Generic (ADOS-G; Lord et al. 2000).

Comparison group. All children in the comparison group had received EI services for a minimum of 12 months. Children recruited from the AEIOU and OTARC, in addition to having a confirmed ASD diagnosis using the ADOS-G (Lord et al. 2000), were selected for recruitment at school age based on their baseline characteristics, to retrospectively match the ESDM sample. As there were no significant differences between the children recruited from the AEIOU and OTARC on the outcome measures examined, as well as cognitive functioning at baseline, they were combined (all $p > .10$; as shown in Table 1) to form the comparison group.

Participant characteristics are presented in Table 2, with the ESDM and comparison groups being (retrospectively) matched on all variables at baseline. These groups were also matched on chronological age at follow-up.

Table 2 Participant characteristics at baseline and follow-up

	ESDM ($N=31$)	Comparison ($N=28$)	*t* test p value
Gender, M, F	27, 4	25, 3	–
Chronological age T1 (months): M (SD)	39.16 (9.91)	35.46 (7.62)	0.12
ADOS, calibrated severity score: M (SD)	7.39 (2.09)	6.68 (2.20)	0.21
ADOS, SA: M (SD)	14.23 (4.69)	12.36 (4.56)	0.13
ADOS, RRB: M (SD)	4.74 (1.98)	4.00 (2.00)	0.16
MSEL, ELC: M (SD)	55.42 (8.74)	58.46 (12.06)	0.28
MSEL, verbal DQ: M (SD)	50.61 (23.27)	48.14 (22.66)	0.68
MSEL, nonverbal M (SD)	64.80 (20.80)	68.87 (17.38)	0.42
Chronological age T2 (months): M (SD)	79.97 (7.99)	84.07 (11.05)	0.11

ESDM Early Start Denver Model, *M* male, *F* female, *T1* time 1, *ADOS* Autism Diagnostic Observation Schedule, *SA* social affect, *RRB* restricted and repetitive behaviours, *MSEL* Mullen Scales of Early Learning, *ELC* early learning composite, *DQ* developmental quotient, *T2* time 2

Recruitment

Recruitment into the follow-up study took place between December, 2014 to January, 2016, and the researchers were blind to the intervention outcomes of all children at the time of recruitment. Caregivers were invited to participate by letter, and then phoned 1 week later to ascertain their interest in doing so. Following caregiver consent, an appointment for the assessment was made over the phone, and caregivers were mailed an information pack detailing the research including the assessment process, and the names of the researchers and their contact details.

Table 1 Comparison group characteristics at baseline and follow-up outcomes

	AEIOU ($N=18$)	OTARC ($N=10$)	*t* test p value
MSEL T1, ELC: M (SD)	57.06 (12.17)	61.00 (12.06)	0.42
MSEL T1, verbal DQ: M (SD)	52.48 (24.20)	40.33 (18.13)	0.18
MSEL T1, nonverbal DQ: M (SD)	65.79 (17.29)	74.44 (16.97)	0.21
ADOS T2, calibrated severity score: M (SD)	7.39 (2.17)	8.40 (1.71)	0.22
ADOS T2, SA: M (SD)	10.33 (3.40)	12.40 (4.48)	0.18
ADOS T2, RRB: M (SD)	4.89 (2.08)	5.10 (1.79)	0.79
WASI T2, FSIQ: M (SD)	81.06 (17.32)	85.90 (21.08)	0.52
WASI T2, VCI: M (SD)	75.44 (16.29)	79.20 (19.70)	0.59
WASI T2, PRI: M (SD)	90.50 (20.75)	94.40 (23.30)	0.65

AEIOU AEIOU Foundation, *OTARC* Olga Tennison Autism Research Centre, *MSEL* Mullen Scales of Early Learning, *T1* time 1, *ELC* early learning composite, *DQ* developmental quotient, *ADOS* Autism Diagnostic Observation Schedule, *T2* time 2, *SA* social affect, *RRB* restricted and repetitive behaviours, *FSIQ* full scale intelligence quotient, *VCI* verbal comprehensive index, *PRI* perceptual reasoning index

The families of 40 children who had previously attended the ASELCC and were attending school were invited to participate in the study, with 31 accepting the invitation (78%). The caregivers of five children declined participation (e.g., due to time constraints, possible stress on the child), with a further four families unable to be contacted. All children had been enrolled in the ESDM program for between 1 and 3 calendar years; nine children were enrolled for 1 year, 17 enrolled for 2 years, and five enrolled for 3 years.

The recruitment of children in the ESDM group commenced prior to the recruitment of the comparison children. Forty children who met study inclusion criteria from the AEIOU and OTARC, were invited to participate. The caregivers of 28 children (70%) provided consent for participation. Twelve caregivers declined participation (e.g., due to time constraints) or could not be contacted.

Community-Based Group Early Start Denver Model

The group-based ESDM uses the ESDM principles and strategies (manualised in Vivanti et al. 2017) to target individual learning objectives within group activities. A semi-structured assessment protocol based on the ESDM curriculum checklist, completed by trained therapists together with the primary caregivers, is used to identify each child's learning objectives across multiple developmental domains. These goals are then implemented within naturalistic classroom routines that offer constant opportunities for teaching interactions between the children and staff during play activities (e.g., book activities or song routines), administered to small circle groups comprising three to four children. Play activities and classroom routines are based on a naturalistic approach (i.e., involving materials, games and an interaction style that are typically present in a mainstream preschool environment) and designed to incorporate objects/subjects that are based on the children's interests. The aim is to enhance engagement in play, verbal and nonverbal communication, gestural and vocal imitation, social engagement (including giving and sharing objects turn-taking, joint attention), and activities relevant to cognitive goals such as matching or counting, social goals, and play skills.

The ASELCC was funded by the federal government to provide EI to children with ASD within the childcare centre, and caregivers paid the standard childcare fees (Australian Government 2010). The therapists comprised early education teachers, childcare workers (diploma or certificate III trained), and allied health professionals (a speech pathologist, psychologist, and an occupational therapist) who work together as an interdisciplinary team. Children were based in one of two playrooms, with no more than 10 allocated to a playroom. Chronological age determined playroom allocation with one playroom dedicated to children older than 36 months of age at entry, while the other playroom was dedicated to children younger than 36-months. The staff to child ratio was typically 1:3. In addition, six 2-h information sessions on the ESDM strategies were held for caregivers who were encouraged to implement the strategies at home. Although ESDM therapists were required to exhibit fidelity of the intervention implementation, caregivers were not required to do so.

Fidelity of Intervention

Staff delivering the ESDM met fidelity guidelines as detailed in Rogers and Dawson (2010). Staff were initially trained by Professor Rogers, and certified as therapists following submission of videos and achieving 80% fidelity. Staff were required to submit at least two videos that were reviewed by independent certified ESDM trainers at the MIND Institute at UC Davis, who used a treatment adherence scale to rate 13 therapist behaviours (Rogers & Dawson), following training. The number of videos staff were required to submit was determined by when 80% fidelity was achieved. All primary staff achieved fidelity within 8 months from the time of training by Professor Rogers. Two of these staff went on to become certified ESDM trainers, who also delivered training onsite as needed. To ensure treatment adherence, ongoing supervision and support was provided intermittently by these two onsite ESDM trainers, and fidelity spot-checked over the course of the intervention year. This included live supervision of sessions, answering staff questions, clarifying concepts, discussing the use of certain techniques for specific children, and reviewing goals.

Comparison Group Community-Based Intervention

The AEIOU provided community-based EI for children with ASD in a group-based setting. The intervention was of a similar intensity to the ESDM program, with 15–25 h of intervention provided each week within a childcare environment. The program was supported by organisational, state, and federal funding and caregivers paid childcare costs. Each child received an individualised plan for intervention, based on their strengths and needs. The intervention program delivered at the AEIOU was informally manualised (e.g., organisational policies and procedures; see Paynter et al. 2015 for program elements). Each AEIOU centre included a program manager, supported by a senior therapy team that provided coaching and supervision, who oversaw the program and checked consistency with an internal manual. Program reviews were regularly conducted across the centres but did not include a formal fidelity process. Therefore, treatment adherence was unable to be tested. Four learning areas guided teaching goals; social and emotional, language and communication, physical, and cognitive. Structured large and small group activities provided opportunities for

teaching. Further teaching opportunities occurred frequently throughout the day, including during free play, snack time, outside play, and self-help activities. Applied Behaviour Analysis (ABA) (e.g., pivotal response training, naturalistic teaching strategies; see National Autism Centre 2009) and TEACCH program strategies (e.g. structured teaching/work sessions; Schopler 1994), as well as the use of visual supports (e.g., visual schedules), were implemented. If appropriate, as determined by assessment, Augmentative communication systems (e.g., Picture Exchange Communication System PECS; Frost and Bondy 1994) were also used. Speech and occupational therapy consultations were conducted within the classrooms.

Intervention was provided at two child care sites which ran the same intervention program, with approximately 30 children enrolled at each site. Children were separated into three classrooms at each site based on their ability level, with approximately 10 children in each classroom. Each classroom was run by an early years or special education teacher and included a multidisciplinary team, including speech pathologists, occupational therapists, early years teachers, and childcare professionals. The majority of staff held a minimum of bachelor degree qualifications, while some staff held diploma or certificate level training (e.g. childcare workers). The staff to children ratio varied from 1:2 to 1:4 depending on the ability level of the children. Primary caregivers were provided with ongoing training by allied health and teaching staff, including training on developing play skills, managing challenging behaviour, transitions, and communication strategies.

The participants recruited from the OTARC had all attended it for an early behavioural and developmental assessment provided by early childhood professionals trained in administration of the ADOS (Lord et al. 2000), the Autism Diagnostic Interview-Revised (ADI-R; Lord et al. 1994), and the Mullen Scales of Early Learning (MSEL; Mullen 1995). All children who attended this centre did so following referral from community paediatric or childcare services, were aged less than 3 years, and had been identified as developing autism. Caregivers were provided with comprehensive assessment reports that provided recommendations specific to their child's developmental needs. This included information regarding early intervention services, speech pathology services, suitable workshops and playgroups, as well as associated funding options.

At the school age follow-up, caregivers provided retrospective information regarding the range of EI services received by their child following their assessment and diagnosis. All children were reported as receiving at least one form of EI. The most commonly cited interventions received included speech therapy (90%), occupational therapy (80%), and group-based EI (60%). A small number of children reported receiving individual EI provided in the home environment (20%) and individual psychological services (20%). Age at EI commencement ranged from 18 months to 3 years (M = 2.39; SD = 0.57), with the duration of EI ranging from two to four and a half years (M = 3.05; SD = 0.76). Due to the limited information obtained regarding the intensity of EI services received by the children, this data was unable to be reported.

Measures

The measures administered to participants at the school age follow-up were part of a larger battery of testing, including assessment of adaptive functioning, social skills, problem behaviour, peer play behaviour, and attitude towards school.

Autism Symptom Severity

Symptom severity was measured by the Autism Diagnostic Observation Schedule, Generic (ADOS-G; Lord et al. 2000) at pre-intervention to confirm diagnostic status, and the Autism Diagnostic Observation Schedule, Second Edition (ADOS-2; Lord et al. 2012) was administered at the school age follow-up. The ADOS-G is a semi-structured, standardised observational measure that assesses ASD through communication, social interaction, and stereotyped behaviours and restricted interests. It has sound psychometric properties (Lord et al. 2002). To allow comparison of autism symptom severity across different ADOS modules, the calibrated severity algorithms introduced by Gotham, Risi, Pickles, and Lord (2007) were used. These algorithms provide a social affect (SA) score, a restricted and repetitive behaviours (RBB) score, and an overall severity score (SA + RRB). Only clinicians trained on the administration, scoring, and interpretation of the ADOS-G by an accredited ADOS trainer trained to research reliability completed the assessments.

Like the ADOS-G (Lord et al. 2000), the ADOS-2 is a semi-structured, standardised observational measure of ASD, and measures SA and RRB (Lord et al. 2012). ADOS-2 trained researchers with research reliability administered and scored the assessments. Scores were entered into the revised algorithm as previously described, which was published with the ADOS-2. The ADOS-2 has sound psychometric properties.

Cognitive Functioning

Cognitive functioning was measured by the Mullen Scales of Early Learning (MSEL; Mullen 1995) at pre-intervention and by Wechsler Abbreviated Scales of Intelligence (WASI; Wechsler 1999) or the Wechsler Abbreviated Scales of Intelligence, Second Edition (WASI-II; Wechsler 2011) at the school age follow-up. The MSEL is commonly used

for assessing children aged between zero to 5 years and 8 months with neurodevelopmental concerns (Akshoomoff 2006; Burns et al. 2012). The receptive language (RL), expressive language (EL), fine motor (FM), and visual reception (VR) scales were administered. These four areas combine to calculate the early learning composite (ELC), which is a standard score (population M = 100; SD = 15) that summarises the child's cognitive functioning. As many participants had a standard T score of 20 on the MSEL, developmental quotient scores (DQ: age equivalent scores/chronological age × 100) were produced from subscale Age Equivalent scores to help match the groups at T1. An average of the RL and EL DQs yielded a verbal developmental quotient (VDQ), while the average of FM and VR DQs yielded a non-verbal developmental quotient (NVDQ).

The WASI and WASI-II measures both consist of the four subtests: block design, vocabulary, matrix reasoning, and similarities (Wechsler 1999, 2011). The vocabulary and similarities subtests combine to give a verbal comprehension index (VCI), while the block design and matrix reasoning subtests combine to give a perceptual reasoning index (PRI). In turn, these index scores combine to yield a full scale intelligence quotient, four scales (FSIQ-4). All measures of cognitive functioning used have good psychometric properties. As the WASI/WASI-II does not provide age equivalents below the age of 6 years, quotient scores could not be calculated at follow-up, and verbal and non-verbal cognitive functioning could not be compared longitudinally. Although the MSEL and WASI scores are not numerically equivalent, they both provide a measure of overall cognitive functioning based on a standard score, as well at estimates of developmental delay/intellectual disability, and have been used previously (Clark et al. 2017).

Procedure

Ethics approval was granted by La Trobe University's Human Ethics Committee (UHEC14-058) and the AEIOU Foundation's Research Advisory Group for the study protocol. The assessments used in the current study included the baseline (T1) assessment undertake prior to receipt of EI, at the respective EI centre by trained professionals, and assessment at the school age follow-up (T2). The assessments at each time point were independent, with different clinicians undertaking these assessments. Moreover, the assessors at school-age, also trained to undertake the assessments, were blind to the intervention outcomes of children at the time of this assessment. School age assessments were conducted at one of two sites in a comfortable testing room, and video cameras were used to record the assessments to assist with scoring. The ADOS-2 was administered first to help establish rapport with the child, followed by the WASI or WASI-II.

Research Design

To examine the outcomes between groups, 2 × 2 analysis of variance/multivariate analysis of variance (ANOVAs/MANOVAs) were utilised with Group (ESDM; Comparison) as the between subjects factor and Time (pre-intervention, T1; school age follow-up, T2) as the within subjects factor. All data was checked for violations of assumptions for ANOVA and MANOVA. Univariate outliers were adjusted by assigning a value one unit larger or smaller, when appropriate, than the next most extreme value in the relevant dataset (Tabachnick & Fidell, 2013). No other serious violations were identified.

Results

Autism Symptom Severity

The ADOS severity scores are presented in Table 3, which indicates no main effect of Group [F (1,57) = 6.31, p = .339, *Partial Eta Squared* = 0.02] or interaction effect [F (1,57) = 0.53, p = .470, *Partial Eta Squared* = 0.01]. There was a significant main effect of Time [F (1,57) = 6.00,

Table 3 Participant ADOS overall, SA, and RRB symptom severity at pre-intervention and follow-up

	Time	ESDM		Comparison		Group			Time			Group × time		
		M	SD	M	SD	*F*	*p*	*ES*	*F*	*p*	*ES*	*F*	*p*	*ES*
ADOS severity	1	7.39	2.09	6.68	2.20	6.31	0.34	0.02	6.00	0.02	0.10	0.53	0.47	0.01
	2	7.97	2.60	7.75	2.05									
SA	1	14.23	4.69	12.36	4.56	2.45	0.12	0.04	6.23	0.02	0.10	0.14	0.71	0.00
	2	12.48	5.27	11.07	3.87									
RRB	1	4.74	1.98	4.00	2.00	1.36	0.25	0.02	4.32	0.04	0.07	0.48	0.49	0.01
	2	5.23	2.49	4.96	1.95									

ESDM Early Start Denver Model, *ADOS* Autism Diagnostic Observation Schedule, *SA* social affect, *RRB* restricted and repetitive behaviour

$p = .017$, *Partial Eta Squared* = 0.10], indicating that autism severity increased from T1 to T2.

In order to further examine change in autism severity over time, a MANOVA was conducted on the SA anad RRB domain scores. A significant multivariate effect of Time (F (2,56) = 8.23, $p = .001$, *Pillai's Trace* = 0.23, *Partial Eta Squared* = 0.23) was revealed; again, there was no main effect of Group [F (2,52) = 1.21, $p = .306$, *Pillai's Trace* = 0.04, *Partial Eta Squared* = 0.04] or interaction effect [F (2,56) = 0.24, $p = .786$, *Pillai's Trace* = 0.01, *Partial Eta Squared* = 0.01].

The univariate analyses revealed (see Table 3 for ANOVA results) a significant main effect of Time for both SA and RRB, with moderate effect sizes. As evident in Table 3, the SA scores decreased significantly over time (p = .015), while the RRB scores increased from T1 to T2 (p = .042).

Cognitive Functioning

As shown in Table 4, the ANOVA on cognitive functioning (MSEL ELC standard score at T1 and WASI FSIQ standard score at T2) revealed no main effect of Group (F (1,57) = 1.82, $p = .183$, *Partial Eta Squared* = 0.03) or interaction effect [F (1,57) = 0.88, $p = .354$, *Partial Eta Squared* = 0.02]. The main effect of Time was significant [F (1,57) = 130.86, $p = .000$, *Partial Eta Squared* = 0.70], with cognitive functioning improving from T1 to T2.

The improvement in cognition over time is also evident when examining the number of children with scores below 70. Intelligence Quotient (IQ) scores, based on the MSEL ELC standard score at T1 and the WASI/WASI-II FSIQ standard score at T2, were categorised as follows: < 70, 70 < 84, and ≥ 85. Table 5 shows that the percentage of children with an IQ placed in the Intellectual Disability range (< 70) fell from T1 to T2 in both groups.

Verbal and Non-verbal Cognitive Functioning

A between-groups multivariate analysis of variance (MANOVA) was conducted on verbal (WASI VCI) and non-verbal (WASI PRI) cognitive functioning at follow-up (T2). As evident in Table 6, there was no significant difference [F (2,56) = 2.26, $p = .114$, *Pillai's Trace* = 0.08, *Partial Eta Squared* = 0.08] indicating that verbal and non-verbal cognitive functioning at follow-up were similar between the two groups.

Table 4 Participant cognitive functioning at pre-intervention and follow-up

	Time	ESDM		Comparison		Group			Time			Group × time		
		M	SD	M	SD	*F*	*p*	*ES*	*F*	*p*	*ES*	*F*	*p*	*ES*
MSEL/WASI	1	55.42	8.74	58.46	12.06	1.82	0.18	0.03	130.86	< 0.001	0.70	0.88	0.35	0.02
	2	76.06	20.82	82.79	18.51									

ESDM Early Start Denver Model, *MSEL* Mullen Scales of Early Learning, *WASI* Wechsler Abbreviated Scales of Intelligence

Table 5 Summary of IQ standard scores placed within the ID range at pre-intervention and follow-up

	T1 (MSEL ELC)				T2 (WASI/WASI-II FSIQ)			
	ESDM		Comparison		ESDM		Comparison	
	N	%	*N*	%	*N*	%	*N*	%
IQ < 70 (ID range)	27	87.10	21	75.00	12	38.71	7	25.00
IQ 70 < 85	4	12.90	7	25.00	8	25.81	9	32.14
IQ ≥ 85	0	0	0	0	11	35.48	12	42.86

IQ intelligence quotient, *ID* intellectual disability, *MSEL* Mullen Scales of Early Learning, *ELC* early learning composite, *WASI* Wechsler Abbreviated Scales of Intelligence, *WASI-II* Wechsler Abbreviated Scales of Intelligence, second edition, *FSIQ* full scale intelligence quotient, *ESDM* Early Start Denver Model

Table 6 Participant verbal and non-verbal cognitive functioning at follow-up

	ESDM		Control		Group comparison		
	M	SD	M	SD	*F*	*p*	*ES*
VCI	74.19	22.86	76.79	17.31	2.26	0.11	0.08
PRI	81.23	20.58	91.89	21.34			

ESDM Early Start Denver Model, *VCI* verbal comprehension index, *PRI* perceptual reasoning index

Discussion

The current study sought to investigate school age outcomes of children with ASD in receipt of community-based group ESDM and those in receipt of other community provisions for ASD. The groups, matched at pre-intervention on autism symptom severity and cognition, showed increased cognitive functioning at school age compared to baseline. These increases in cognition were observed despite an overall increase in symptom severity over the same developmental period. By school age, children in both groups were found to have similar cognitive functioning and autism symptoms, with one group not showing superior gains over the other.

This is the first study to date comparing school age outcomes of children who received community-based group ESDM with children who received other community provisions for ASD. As noted above, the two groups were indistinguishable at school age on both symptom severity and cognitive functioning. These findings contrast with those from Vivanti et al. (2014) who found greater gains in cognitive functioning and receptive language in the ESDM group immediately post intervention compared to a comparison group receiving other community intervention. Our current findings are, however, in keeping with those of Estes et al. (2015) who also showed that the cognitive advantage of children in receipt of ESDM relative to children in receipt of another EI may be lost following intervention cessation, and by school age, with both groups making significant gains over time. They are also consistent with the recent findings of Boyd et al. (2014) comparing the LEAP and TEACCH programs with high quality teacher practices. They also found that programs of comparable quality were just as beneficial to children with ASD as those based on a comprehensive treatment model, suggesting that common intervention factors rather than a specific intervention package may be driving EI outcomes.

The groups were also indistinguishable at school age in verbal and non-verbal cognitive functioning. Both groups had higher mean scores in the domain of non-verbal cognitive functioning as opposed to verbal cognitive functioning, a profile common in ASD (Lincoln et al. 1995; Mayes and Calhoun 2003). These results mimic those reported by Estes et al. (2015), with verbal and nonverbal cognitive functioning found to be similar at school age between the ESDM group and those who received intervention in a community setting.

The improved cognitive outcomes by early school age in both groups in the current study were striking. The ESDM group made a mean gain of 21 standard scores in overall cognitive functioning by school age, whereas the comparison made a gain of 24 standard scores. This is comparable to the gains of 30 and 20 standard scores made by the ESDM and comparison group, respectively, between baseline (Dawson et al. 2010) and follow-up (Estes et al. 2015) in the 1:1 ESDM studies. In the current study, by school age, only 39% of the ESDM group had an IQ below 70 compared to 87% at pre-intervention. For the comparison group, only 25% had an IQ below 70, compared to 75% at pre-intervention. Thus, children made significant gains over time and, importantly, more than would have been expected in typical development.

It is likely that the advantage observed in cognition immediately following receipt of the ESDM (post-intervention) relative to children receiving other interventions in the community (Dawson et al. 2010; Vivanti 2014) is lost as a result of receipt of other services in the period post intervention to school age (Estes et al. 2015). Importantly, children in both groups made gains in cognition, and these gains were made despite a significant increase in autism severity at school age compared to pre-intervention. This increase in symptom severity was driven by a significant increase in RRB over time. In contrast, the SA symptoms were found to decrease within the same developmental period. A similar trend in improved SA behaviour was found by Vivanti et al. (2014) from pre- to post-intervention in both the intervention and comparison groups. In contrast to our findings on overall autism severity, Estes et al. (2015) found that children with ASD receiving ESDM decreased in their overall symptom severity by school age. The majority of research examining school age children who had been in receipt of early intervention has demonstrated stability in autism symptomatology (Starr et al. 2016), although this research still remains limited.

While caregivers provided details regarding the EI services their child received, information about the hours per week of intervention was not able to be ascertained for a small number of children in the comparison group. Therefore, it cannot be confidently stated that all children in the comparison group received EI at an equivalent level of intensity to the ESDM group. Greater developmental benefits from EI have been associated with a younger age at entry into EI (Clark et al. 2017; Granpeesheh et al. 2009; Perry et al. 2011; Vivanti et al. 2011). As both groups were matched on age of entry into intervention, perhaps it is not surprising that their gains by school age were equivalent, and may suggest that the quality of EI, even within the community settings, is of a similar standard. Certainly, the interventions received by most children in the comparison group drew upon strategies from a number of evidence-based interventions. Nonetheless, there is a lack of research examining the outcomes for children who access community-based provisions for ASD, especially in an Australian community setting. Based on the findings of the current study, the intervention provisions

offered within the community-based settings studied here were shown to be effective in promoting cognitive development, as was the group ESDM, also delivered within a community-based setting.

Limitations and Future Directions

A main limitation in the current study was the variability in EI received by children in the comparison group. While the ESDM group received intensive manualised intervention, with treatment adherence formally assessed with ESDM fidelity checks, no such formal intervention guidelines were implemented for children in the comparison group. Therefore, it is unclear which types of EI children benefitted from, which is a concern that has begun to be addressed in the literature (Hume et al. 2011). There was no fidelity data available on EI received by the comparison group, and no means to means to determine the quality of service received by these children. Furthermore, the details of the EI services received by the children who attended the OTARC were limited and provided retrospectively by caregivers. Unlike those recruited from the AEIOU, these children received referrals to intervention services rather than enrolment into a specific EI service. Based on the qualitative information provided by caregivers at the school age follow-up, children who attended the OTARC had received a variety of EIs for an extended period of time following diagnosis. Nonetheless, limited information was available regarding the intensity of EI received by these children. Therefore, limits are placed on the comparability of the two groups of children in terms of the hours of services they received, which may have impacted the results.

A further limitation, common to longitudinal research, was the use of different measures across time. Due to the limited age range of the MSEL measure, an alternative measure of cognitive functioning was sought for the current school age follow-up assessments. As a result, comparison of verbal and non-verbal cognitive functioning could not be compared between the two groups over time, and were compared only at the follow-up assessment. Future research should aim to utilize measures in the early developmental period that will able to be used across the age spectrum. Consideration should also be given to other aspects of functioning that may benefit from longitudinal examination, just as peer interaction behaviours and problem behaviours, so these measures can be introduced as early as possible in the course of research. While the outcomes in the current study showed comparable outcomes between the groups, only a limited number of outcomes were examined. Replication of the current research is also essential before firm conclusions can be established.

Conclusions

The early school age outcomes for children with an ASD who have received EI during their preschool years are promising. The current study found that children in receipt of EI, regardless of whether they received community-based group ESDM intervention or other community provided interventions for ASD, had improved significantly in their cognitive functioning by school age compared to pre-intervention. This is despite increases in symptom severity during this developmental period, which appeared to be driven by an increase in RRBs. In contrast, children in both groups improved in SA symptoms, and it may well be their increased skills in social communication that provided children with the increased opportunities to engage and learn from others. Further research is needed to extend upon the current findings. While it is clear that community-based early interventions for children with ASD can assist them into their vital early school years by equipping them to learn, it is now critical that future research targets our understanding of the common components in different interventions that drive developmental change over time in these children.

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Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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References

Akshoomoff, N. (2006). Use of the Mullen Scales of Early Learning for the assessment of young children with autism spectrum

disorders. *Child Neuropsychology, 12*(4–5), 269–277. https://doi.org/10.1080/09297040500473714.
American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders, text revised* (4th Edn.). Washington, DC: American Psychiatric Association.
American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th Edn.). Arlington, VA: American Psychiatric Association.
Australian Government. (2010). Early Learning and Care Centres Program Guidelines. Retrieved May 4, 2017, from https://www.dss.gov.au/sites/default/files/documents/06_2015/early_learning_and_care_centres_program_guidelines.pdf.
Barbaro, J., & Dissanayake, C. (2013). Early markers of autism spectrum disorders in infants and toddlers prospectively identified in the Social Attention and Communication Study. *Autism, 17*(1), 64–86. https://doi.org/10.1177/1362361312442597.
Boyd, B. A., Hume, K., McBee, M. T., Alessandri, M., Gutierrez, A., Johnson, 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.
Burns, T. G., King, T. Z., & Spencer, K. S. (2012). Mullen Scales of Early Learning: The utility in assessing children diagnosed with autism spectrum disorders, cerebral palsy, and epilepsy. *Applied Neuropsychology, 2*(1), 33–42. https://doi.org/10.1080/21622965.2012.682852.
Clark, M. L. E., Barbaro, J., & Dissanayake, C. (2017). Continuity and change in cognition and autism severity from toddlerhood to school age. *Journal of Autism and Developmental Disorders, 47*(2), 328–339. https://doi.org/10.1007/s10803-016-2954-7.
Clark, M. L. E., Vinen, Z., Barbaro, J., & Dissanayake, C. (2017). School age outcomes of children diagnosed early and later with autism spectrum disorder. *Journal of Autism and Developmental Disorders*. https://doi.org/10.1007/s10803-017-3279-x.
Dawson, G., Rogers, S., Munson, J., Smith, M., Winter, J., Greenson, J., … Varley, J. (2010). Randomized, controlled trial of an intervention for toddlers with autism: The Early Start Denver Model. *Pediatrics, 125*(1), 17–23. https://doi.org/10.1542/peds.2009-0958.
Eapen, V., Črnčec, R., & Walter, A. (2013). Clinical outcomes of an early intervention program for preschool children with autism spectrum disorder in a community group setting. *BMC Pediatrics, 13*(3). https://doi.org/10.1186/1471-2431-13-3.
Estes, A., Munson, J., Rogers, S. J., Greenson, J., Winter, J., & Dawson, G. (2015). Long-term outcomes of early intervention in 6-year-old children with autism spectrum disorder. *Adolescent Psychiatry, 54*(7), 580–587. https://doi.org/10.1016/j.jaac.2015.04.005.
Frost, L. A., & Bondy, A. S. (1994). *The picture exchange communication system training manual*. Cherry Hill, NJ: PECs, Inc.
Gotham, K., Risi, S., Pickles, A., & Lord, C. (2007). The autism diagnostic observation schedule: Revised algorithms for improved diagnostic validity. *Journal of Autism and Developmental Disorders, 37*(4), 613–627. https://doi.org/10.1007/s10803-006-0280-1.
Granpeesheh, D., Dixon, D. R., Tarbox, J., Kaplan, A. M., & Wilke, A. E. (2009). The effects of age and treatment intensity on behavioral intervention outcomes for children with autism spectrum disorders. *Research in Autism Spectrum Disorders, 3*(4), 1014–1022. https://doi.org/10.1016/j.rasd.2009.06.007.
Hayward, D., Eikeseth, S., Gale, C., & Morgan, S. (2009). Assessing progress during treatment for young children with autism receiving intensive behavioural interventions. *Autism, 13*(6), 613–633. https://doi.org/10.1177/1362361309340029.
Hume, K., Boyd, B., McBee, M., Coman, D., Gutierrez, A., Shaw, E. … Odom, S. (2011). Assessing implementation of comprehensive treatment models for young children with ASD: Reliability and validity of two measures. *Research in Autism Spectrum Disorders, 5*(4), 1430–1440. https://doi.org/10.1016/j.rasd.2011.02.002.
Lincoln, A. J., Allen, M. H., & Kilman, A. (1995). The assessment and interpretation of intellectual abilities in people with autism. In E. Schopler & G. B. Mesibov (Eds.), *Learning and cognition in autism* (pp. 89–117). New York: Springer.
Lord, C., Risi, S., Lambrecht, L., Cook, E. Jr., Leventhal, B., DiLavore, P., … Rutter, M. (2000). The autism diagnostic observation schedule—generic: A standard measure of social and communication deficits associated with the spectrum of autism. *Journal of Autism and Developmental Disorders, 30*(3), 205–223. https://doi.org/10.1023/a:1005592401947.
Lord, C., Rutter, M., DiLavore, P. C., & Risi, S. (2002). *Autism diagnostic observation schedule manual*. Los Angeles, CA: Western Psychological Services.
Lord, C., Rutter, M., DiLavore, P. C., Risi, S., Gotham, K., & Bishop, S. L. (2012). *Autism diagnostic observation schedule: ADOS-2*. CA: Western Psychological Services.
Lord, C., Rutter, M., & Le Couteur, A. (1994). Autism diagnostic interview-revised: A revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorders, 24*(5), 659–685. https://doi.org/10.1007/BF02172145.
Mayes, S. D., & Calhoun, S. L. (2003). Analysis of WISC-III, Stanford-Binet: IV, and academic achievement test scores in children with autism. *Journal of Autism and Developmental Disorders, 33*(3), 329–341. https://doi.org/10.1023/A:1024462719081.
Mullen, E. M. (1995). *Mullen scales of early learning manual*. Circle Pines, MN: American Guidance Service.
Paynter, J. M., Riley, E. P., Beamish, W., Scott, J. G., & Heussler, H. S. (2015). Brief report: An evaluation of an Australian autism-specific, early intervention programme. *International Journal of Special Education, 30*(2), 13–19.
Perry, A., Cummings, A., Geier, J. D., Freeman, N. L., Hughes, S., Managhan, T., … Williams, J. (2011). Predictors of outcome for children receiving intensive behavioral intervention in a large, community-based program. *Research in Autism Spectrum Disorders, 5*(1), 592–603. https://doi.org/10.1016/j.rasd.2010.07.003.
Prior, M., Roberts, J. M. A., Rodger, S., & Williams, K. (2011). *A review of the research to identify the most effective models of practice in early intervention of children with autism spectrum disorders*. Australian Government Department of Families, Housing, Community Services and Indigenous Affairs, Australia.
Productivity Commission. (2011). *Disability care and support (Report no. 54)*. Canberra: Productivity Commission.
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. (2013). Early Start Denver Model. In F. R. Volkmar (Ed.), *Encyclodedia of autism spectrum disorders*. New York: Springer Publishing.
Rogers, S. J., & Dawson, G. (2010). *Early Start Denver Model for young children with autism: Promoting language, learning, and engagement*. New York: The Gilford Press.
Rogers, S. J., Dawson, G., & Vismara, L. A. (2012). *An early start for your child with autism: Using everyday activities to help kids connect, communicate, and learn*. New York: The Guilford Press.
Rutter, M., Bailey, A., & Lord, C. (2003). *Social communication questionnaire (SCQ)*. Los Angeles, CA: Western Psychological Services.
Sallows, G. O., & Graupner, T. D. (2005). Intensive behavioral treatment for children with autism: Four-year outcome and predictors. *American Journal on Mental Retardation, 110*(6), 417–438. https://doi.org/10.1352/0895-8017(2005)110[417:IBTFCW]2.0.CO;2

Schopler, E. (1994). A statewide program for the Treatment and Education of Autistic and related Communication Handicapped Children (TEACCH). *Psychoses and Pervasive Developmental Disorders, 3*, 91–103.

Schreibman, L., Dawson, G., Stahmer, A. C., et al. (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.

Smith, T., & Iadarola, S. (2015). Evidence base update for autism spectrum disorder. *Journal of Clinical Child and Adolescent Psychology, 44*(6), 897–922. https://doi.org/10.1080/15374416.2015.1077448.

Smith, T., Groen, A. D., & Wynn, J. W. (2000). Randomized trial of intensive early intervention for children with pervasive developmental disorder. *American Journal of Mental Retardation, 105*(4), 269–285. https://doi.org/10.1352/0895-8017(2000)105<0269:RTOIEI>2.0.CO;2

Starr, E. M., Popovic, S., & McCall, B. P. (2016). Supporting children with autism spectrum disorder at primary school: Are the promises of early intervention maintained? *Current Developmental Disorders Reports, 3*(1), 46–56. https://doi.org/10.1007/s40474-016-0069-7.

Vivanti, G., Duncan, E., Dawson, G., & Rogers, S. J. (2017). *Implementing the group-based Early Start Denver Model for preschoolers with autism*. New York: Springer.

Vivanti, G., Manzi, B., Benvenuto, A., Battan, B., & Curatolo, P. (2011). An Italian prospective study on autism treatment: The earlier, the better?. *Autism*. https://doi.org/10.4172/2165-7890.1000102.

Vivanti, G., Paynter, J., Duncan, E., Fothergill, H., Dissanayake, C., & Rogers, S. J. (2014). Feasibility and effectiveness of the Early Start Denver Model implemented in a group-based community childcare setting. *Journal of Autism and Developmental Disorders, 44*(12), 3140–3153. https://doi.org/10.1007/s10803-014-2168-9.

Warren, Z., McPheeters, M. L., Sathe, N., Foss-Feig, J. H., Glasser, A., & Veenstra-VanderWeele, J. (2011). A systematic review of early intensive intervention for autism spectrum disorders. *Pediatrics, 127*(5), 1303–1311. https://doi.org/10.1542/peds.2011-0426.

Wechsler, D. (1999). *Wechsler abbreviated scale of intelligence*. San Antonio, TX: The Psychological Corporation.

Wechsler, D. (2011). *Wechsler abbreviated scale of intelligence* (2nd Edn.). San Antonio, TX: Pearson.