



Feasibility and initial outcomes of the social ABCs parent-mediated intervention for autistic toddlers in Israel: A pilot single-arm study

Tanya Nitzan^{a,b,*}, Tamar Matz Vaisman^{c,1}, Tamar David^c, Michal Ilan^{a,b,d}, Michal Faroy^{b,d}, Anya Michaelovski^{b,e}, Dikla Zigdon^d, Gal Meiri^{b,d}, Ilan Dinstein^{a,b}, Judah Koller^c

^a Psychology Department, Ben Gurion University, Beer Sheva, Israel

^b Azrieli National Centre for Autism and Neurodevelopment Research, Ben Gurion University of the Negev, Beer Sheva, Israel

^c Seymour Fox School of Education, Hebrew University of Jerusalem, Jerusalem, Israel

^d Pre-School Psychiatry Unit, Soroka University Medical Center, Beer Sheva, Israel

^e Zusman Child Development Center, Soroka University Medical Center, Beer Sheva, Israel

ARTICLE INFO

Keywords:

Autism
Parent-mediated intervention
Pilot feasibility
Early intervention
PRT
NDBI
Social ABCs

ABSTRACT

The Social ABCs is a parent-mediated Naturalistic Developmental Behavioral Intervention (NDBI) that promotes early verbal communication and affect sharing emphasizing child-led learning within natural routines. Here we conducted a six-week pilot single-arm study of the Social ABCs program with 17 autistic toddlers (19–39 months) and their parents in Israel, employing pre- and post-intervention assessments including language, social communication, and parenting stress measures. Results demonstrated significant gains in expressive and receptive vocabulary, improved social communication reduced social withdrawal, and enhanced parent-child interaction quality, with high parental satisfaction and engagement. No significant changes were observed in autism symptom severity or developmental scores. These findings suggest that the Social ABCs is a feasible, promising early intervention for autistic toddlers in Israel. Larger controlled trials are needed to confirm efficacy and assess long-term impact.

1. Introduction

Naturalistic Developmental Behavioral Interventions (NDBIs) combine developmental science with Applied Behavior Analysis (ABA), embedding child-led learning into everyday routines (Crank et al., 2021; Schreibman et al., 2015). Parent-mediated NDBIs, in which caregivers learn to use intervention strategies during daily interactions, have been shown to improve social communication and language in autistic children while also supporting family engagement (Kasari et al., 2014; Vivanti & Zhong, 2020). These approaches are cost-effective and scalable, though meta-analyses indicate they primarily enhance targeted, proximal skills rather than broader outcomes like adaptive functioning (Crank et al., 2021; Vivanti & Zhong, 2020).

The Social ABCs is a parent-mediated NDBI for toddlers (12–36 months) showing early signs of autism. Grounded in Pivotal

* Corresponding author at: Psychology Department, Ben Gurion University, Beer Sheva, Israel.

E-mail address: tanyan@post.bgu.ac.il (T. Nitzan).

¹ These authors contributed equally to this study.

<https://doi.org/10.1016/j.reia.2026.202906>

Received 11 September 2025; Received in revised form 16 March 2026; Accepted 16 March 2026

3050-6565/© 2026 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Response Treatment (PRT; Koegel & Koegel, 2006), it targets early functional verbal communication and affect sharing by coaching parents to integrate strategies into routines (e.g., meals, playtime). Studies conducted by the team who developed the program demonstrated gains in vocabulary, social communication, parental fidelity, and reduced stress (Brian et al., 2016, 2022, 2024).

Parent-mediated NDBIs have been implemented across diverse global contexts using a range of delivery models, including clinic-based programs, home-based coaching, and telehealth or hybrid formats. Across these settings, studies consistently report improvements in proximal child outcomes such as social communication and early language, as well as gains in caregiver implementation and engagement (Brian et al., 2016, 2022, 2024; Kasari et al., 2014; Vivanti & Zhong, 2020). Implementation work has emphasized the importance of distinguishing between core intervention components that preserve theoretical and procedural fidelity and peripheral elements that can be adapted to align with local service systems and family contexts. In the present study, adaptation was limited to systematic translation and contextual tailoring of materials for Hebrew-speaking families, while core intervention components, terminology, and the group-based coaching structure were intentionally preserved.

Given rising autism prevalence in Israel (Dinstein et al., 2024), and a shortage of early-intervention professionals (Ferman & Segal, 2024), timely access to services remains limited. Although an autism diagnosis grants entry to public supports, long waiting lists for speech-language therapy (Ferman & Segal, 2024), and the scarcity of Hebrew-language programs available for immediate use create a gap during a critical developmental window. Brief, parent-delivered interventions therefore represent a practical approach to expanding early access. This pilot study examined the feasibility and preliminary effectiveness of the Social ABCs with Hebrew-speaking families. We focused on distal outcomes: child social communication, vocabulary, adaptive functioning, aberrant behavior, and parenting stress, and hypothesized that the intervention would be feasible, engage parents, and lead to measurable improvements in both child and parent outcomes.

2. Methods

2.1. Design

This single-arm, pre-post pilot study evaluated the feasibility and preliminary outcomes of the Social ABCs, a parent-mediated intervention for autistic toddlers. The study was registered at ClinicalTrials.gov (NCT07025603). Without a control group, allocation ratio was not applicable. No major changes were made to the design or eligibility criteria after trial initiation; only minor procedural adjustments (e.g., flexible scheduling) supported family needs without altering the intervention protocol. This design enabled examination of implementation, parent and child outcomes, and within-subject change in a naturalistic setting. Emphasis was placed on feasibility and initial impact to inform future trials.

Ethical approval was obtained from the Helsinki Committee at Soroka Medical Center (SOR-20-0363) and the Ethics Committees of the Seymour Fox School of Education at the Hebrew University of Jerusalem (HUJI) and the Psychology Department at Ben-Gurion University (BGU).

2.2. Participants

Seventeen autistic toddlers and their parents completed the study. Recruitment occurred at two sites: BGU and HUJI, through multiple channels: at BGU, families were referred by diagnostic teams (psychologists, neurologists, psychiatrists) following an autism diagnosis; at HUJI, parents were drawn from prior studies or responded to social media ads. Some families joined after hearing about the program from participating parents. Aside from higher ADOS-2 SA-CSS scores (reflecting greater social-affect symptoms) and slightly lower verbal abilities among BGU participants, no significant site differences emerged (Table 1).

Inclusion criteria: (a) autism diagnosis by DSM-5 criteria via independent assessments from both a psychologist and physician (child psychiatrist, developmental pediatrician, or neurologist); (b) diagnosis before 30 months; (c) full-term birth (>36 weeks, >2500 g). Exclusion criteria: (a) known neurological/genetic conditions or severe sensory/motor impairments; (b) attendance at a

Table 1
Pre-intervention characteristics of participants by recruitment site (BGU vs. HUJI).

Variable Measures	BGU (n = 11) Mean (SD)	HUJI (n = 6)	t (df)	p-value	Cohen's d
Age at intervention (Months)	28.45 (6.14)	25.67 (4.68)	t(15) = 0.96	0.35	
Sex % boys	90.9	100			
Visit numbers	8.09 (1.38)	9.00 (0.00)	t(10) = -2.19	0.05*	-0.81 (large)
Maternal education (Years)	14.91 (3.36)	18.50 (3.78)	t(15) = -2.02	0.06	
Verbal ability*	2.91 (1.22)	1.67 (1.21)	t(15) = 2.01	0.06	
ADOS-2 SA-CSS*	8.36 (1.63)	5.67 (1.86)	t(15) = 3.11	0.01*	1.58 (large)
ADOS-2 RRB-CSS*	7.91 (1.58)	6.83 (1.72)	t(15) = 1.30	0.21	
ADOS-2 CSS*	8.36 (1.69)	6.83 (2.23)	t(15) = 1.60	0.13	
Cognitive score	67.73 (22.40)	71.50 (19.04)	t(15) = -0.35	0.73	

* Lower scores on ADOS-2 and verbal ability indicating lower symptom severity and better verbal ability. BGU Ben Gurion University of the Negev; HUJI Hebrew University of Jerusalem; ADOS-2 SA-CSS Autism Diagnostic Observation Schedule 2nd edition Social Affect calibrated severity scores; ADOS-2 RRB-CSS Autism Diagnostic Observation Schedule 2nd edition Restricted and Repetitive Behavior calibrated severity scores.

special-education kindergarten; (c) participation in another parent-mediated intervention. These exclusion criteria were selected to reduce heterogeneity that could confound interpretation in a small pilot feasibility study and to align with the Social ABCs target population and delivery assumptions.

2.3. Intervention

Families received Social ABCs coaching from three trained coaches, all graduate students with extensive autism experience who completed formal Social ABCs training provided by the Canadian program developers, including direct instruction, guided practice, and ongoing remote supervision. One coach met fidelity with three families; two others with two families each. With developer guidance, all materials were translated into Hebrew by bilingual speech-language clinicians with near-native proficiency in both languages. A bilingual member of the original development team reviewed the initial translation, after which the materials were back-translated into English by the developer team, to ensure accuracy and conceptual equivalence. The back-translation was then reviewed by Prof. Brian, one of the program developers. No cultural contextual modifications were required beyond language adaptation, and all core components, terminology, and examples were retained. Eligible families attended an in-person meeting to provide consent, receive the manual, and review the schedule. Baseline assessments were arranged, and questionnaires were completed online (Qualtrics; <https://www.qualtrics.com>) or on paper.

The six-week group protocol (Brian et al., 2022) included weekly remote group sessions conducted via the Zoom video conferencing platform (<https://zoom.us>) with 2–4 families participating per cycle, introducing strategies (≈ 1.5 h), in which one or two manual modules were introduced using program-developed translated slides. In addition, in-person coaching sessions were delivered individually, with one parent–child dyad per session in clinical settings (≈ 1 – 1.5 h) that combined brief parent discussion with supported practice using the strategies. Individual coaching occurred twice weekly during weeks 1–3 and once weekly during weeks 4–6, for a total of 15 sessions. Parents received live feedback, completed a satisfaction survey at the final session, and returned for post-intervention assessments six weeks later (See full protocol on NIH website: NCT07025603).

2.4. Measures

All measures were administered at baseline and six weeks post-intervention, except for the satisfaction questionnaire, which was completed after the final session.

2.4.1. Child measures

Autism symptoms were assessed with the Autism Diagnostic Observation Schedule, Second Edition (ADOS-2; Lord et al., 2012), a standardized, clinician-administered observational measure. The ADOS-2 consists of multiple modules (each containing 20–30 scored items) using clinician-coded ordinal scores (0–3); algorithm totals produce Social Affect (SA) and Restricted, Repetitive Behaviors (RRB) domain scores, which are converted to calibrated severity scores (CSS; range 1–10). Six ADOS-2 items (e.g., pointing, gesturing, initiation of joint attention) were combined to create a joint attention (JA) score (0–17; higher = poorer JA). Spoken language was coded via ADOS-2 item A1, harmonized across modules using an 8-point scale (Visser et al., 2017).

Developmental level was assessed with the *Mullen Scales of Early Learning* (MSEL; Mullen, 1995), a clinician-administered developmental battery consisting of four domains (Visual Reception, Fine Motor, Receptive Language, Expressive Language) composed of structured tasks rather than discrete Likert-style items. Scores include T-scores (mean = 50, SD = 10), age equivalents, and the Early Learning Composite (mean = 100, SD = 15).

Adaptive functioning was measured via parent-report Adaptive Behavior Assessment System - II (ABAS-II; Harrison & Oakland, 2000). The ABAS-II contains 232–241 items (depending on age band), rated on a 4-point frequency scale (0–3). Raw scores are aggregated into skill areas and then standardized into scaled scores (mean = 10, SD = 3) and composite standard scores (mean = 100, SD = 15).

Behavioral challenges were rated with the *Aberrant Behavior Checklist* (ABC; Aman et al., 1985), a 58-item caregiver-report instrument with items rated on a 4-point scale (0 = not at all to 3 = severe). The Social Withdrawal subscale used in RCI analyses demonstrates $\alpha = .86$ – $.94$ and test–retest $r = .86$.

Receptive and expressive vocabulary were captured using the *Hebrew CDI* (HCDI; Gendler-Shalev & Dromi, 2021; Maital et al., 2000). Depending on form, the HCDI includes approximately 400 vocabulary checklist items, marked by parents as “understands” or “understands and says”. Scores range from 0 to the total number of words on the form. Psychometric properties are excellent, with $\alpha = .95$ – $.98$ and test–retest $r = .93$ for expressive vocabulary and $r = .94$ for receptive vocabulary.

Early social-communication skills via the Communication and Symbolic Behavior Scales Developmental Profile (CSBS-DP; Wetherby & Prizant, 2002). The CSBS-DP Caregiver Questionnaire includes 40 items rated on a 5-point frequency scale; the Behavior Sample is a clinician-administered structured observation with 20 items. Composites include Social, Speech, and Symbolic domains, as well as a Total Score. Score ranges vary by subscale (raw and norm-referenced standard scores). Psychometric reliability is strong: Social Composite $\alpha = .88$ – $.92$, Speech Composite $\alpha = .83$ – $.91$, Total Score $\alpha = .89$ – $.94$; test–retest reliability $r = .77$ for the Social Composite, $r = .79$ for the Speech Composite, and $r = .87$ for the Total Score (Wetherby & Allen, Cleary, et al., 2002).

2.4.2. Parent measures

Parent stress was assessed with the *Parenting Stress Index–Short Form* (PSI-SF; Abidin, 1995), a 36-item parent-report measure comprising three subscales: Parental Distress, Parent-Child Dysfunctional Interaction, and Difficult Child - rated on a 5-point Likert

scale. Internal consistency for the PSI-SF subscales ranges from $\alpha = .80-.87$, consistent with published estimates, and test–retest reliability ranges from $r = .68-.75$ (Haskett et al., 2006). For RCI analyses, the reliability coefficient for the Parent–Child Dysfunctional Interaction subscale was set to $r = .715$.

Intervention satisfaction was evaluated with the 7-item *Social ABCs Satisfaction Questionnaire* (Brian et al., 2016), rated on a 5-point scale assessing perceived helpfulness of the intervention.

2.5. Statistical analysis

Analyses were conducted in R (4.0.3). The final analysis included $N = 17$ participants. Data were complete for the ABC and PSI measures ($N = 17$). For other measures (HCIDI, ABAS, CSBS-DP, and ADOS-2), one participant had missing data at either the pre- or post-intervention time point. Cognitive scores were missing for two participants at pre-intervention and three at post-intervention. Importantly, missingness was not consistent across time points for the same individuals; therefore, rather than excluding participants with incomplete data, Random Forest multiple imputation (20 iterations) was employed. This approach allowed for the retention of the full pilot sample ($N = 17$) in the longitudinal analysis, as reflected by the degrees of freedom ($df = 16$) reported in Table 2. Independent-sample t -tests compared baseline child characteristics between recruitment sites (BGU, HUJI), with effect sizes (Cohen’s d) interpreted as small (.20), medium (.50), or large (.80) (Cohen, 1988). Paired-sample t -tests assessed pre–post changes for continuous outcomes, with within-subject effect sizes reported as Cohen’s d_z for paired comparisons, along with 95% confidence intervals, following recommendations by Lakens (2013). Significance was set at $p < .05$ (two-tailed). Reliable Change Indices (RCIs) were computed for key measures (Jacobson & Truax, 1992), using the formula: $RCI = \frac{X_{post} - X_{pre}}{SE_{diff}}$, $S_{diff} = \sqrt{2 \times SD_{pre} \sqrt{1 - r}}$, where r is the published test–retest reliability coefficient for each measure. We used the conventional RCI threshold ($p < .05$) to maintain a conservative and comparable approach, although alternative thresholds have been suggested for populations with limited expected change (Blampied, 2022). Participants with $RCI \geq \pm 1.96$ were classified as showing significant improvement or deterioration. Percentages of participants meeting RCI criteria are reported descriptively to characterize individual-level change and are not interpreted as an effect size or as a substitute for magnitude-based estimates.

3. Results

3.1. Screening/eligibility

A total of 47 families were initially identified as potential candidates. Fifteen did not meet inclusion criteria: ten were already

Table 2
Outcome measures for intervention completers pre-intervention and post-intervention ($N = 17$).

	Pre-Intervention		Post-Intervention		t	df	p -value	Cohen’s d_z [95% CI]	RCI
	M	SD	M	SD					
ADOS-SA	7.38	2.19	6.75	2.08	-1.4	16	0.182	-0.34 [-0.83, 0.16]	
ADOS-RRB	7.69	1.58	8.38	1.45	1.9	16	0.077.	0.46 [-0.04, 0.96]	
ADOS-CSS	7.94	1.98	7.62	1.82	-0.86	16	0.401	-0.21 [-0.69, 0.28]	
JA score	10.29	3.96	8.88	3.72	-1.82	16	0.088	-0.44 [-0.94, 0.06]	
Cognitive score	69.06	11.23	68.06	10.48	-0.26	16	0.8	-0.06 [-0.54, 0.42]	
ABAS-GAC	71.88	12.88	73.25	14.88	0.5	16	0.621	0.12 [-0.36, 0.60]	
ABAS-Conceptual	76.56	13.25	78.81	12.07	0.86	16	0.404	0.21 [-0.28, 0.69]	
ABAS-Social	76.06	14.53	77.44	14.77	0.38	16	0.710	0.09 [-0.39, 0.57]	
ABAS-Practical	72.19	13.49	72.31	15.81	0.05	16	0.964	0.01 [-0.47, 0.49]	
ABC Irritability	7.29	8.06	5.82	4.48	-1.02	16	0.324	-0.25 [-0.73, 0.24]	
ABC Social Withdrawal	8.53	8.49	4.53	4.26	-2.42	16	0.028*	-0.59 [-1.10, -0.06]	-0.89
ABC Stereotypic behavior	3.59	3.45	3.59	3.68	0.0	16	1.000	0.00 [-0.48, 0.48]	
ABC Hyperactivity	12.41	9.91	10.18	7.44	-1.15	16	0.266	-0.28 [-0.77, 0.21]	
ABC Inappropriate speech	2.18	2.6	2.71	2.57	0.61	16	0.552	0.15 [-0.33, 0.63]	
HCIDI expressive	71.73	108.18	136.8	143.31	4.11	16	0.001*	1.00 [0.40, 1.57]	1.47
HCIDI receptive	211.13	192.42	389.07	289.6	3.94	16	0.001*	0.96 [0.37, 1.52]	2.38
PSI Parental distress	26.53	8.65	24.24	6.58	-1.15	16	0.266	-0.28 [-0.77, 0.21]	
PSI Parent-Child Dysfunctional Interaction	23.35	5.29	20.24	4.38	-3.25	16	0.005*	-0.79 [-1.33, -0.23]	-0.78
PSI Difficult Child	27.82	9.29	26.88	9.29	-0.66	16	0.516	-0.16 [-0.64, 0.32]	
PSI total score	77.71	19.88	71.35	16.5	-1.78	16	0.093.	-0.43 [-0.93, 0.07]	
CSBS-DP Social Composite	14.33	4.56	17.07	4.38	2.9	16	0.012*	0.70 [0.16, 1.23]	0.88
CSBS-DP Speech Composite	6.33	1.5	7.0	1.46	2.2	16	0.045*	0.53 [0.02, 1.04]	0.68
CSBS-DP Symbolic Composite	9.47	4.5	10.2	3.69	0.71	16	0.486	0.17 [-0.31, 0.65]	
CSBS-DP-total score	30.13	8.77	34.27	7.89	2.24	16	0.042*	0.54 [0.03, 1.05]	0.80

ADOS-2 SA-CSS, Autism Diagnostic Observation Schedule 2nd edition Social Affect calibrated severity scores; ADOS-2 RRB-CSS Autism Diagnostic Observation Schedule 2nd edition Restricted and Repetitive Behavior calibrated severity scores; JA Joint Attention; ABAS Adaptive Behavior Assessment System; GAC general adaptive behavior composite score; ABC Aberrant Behavior Checklist; HCIDI The Hebrew Communicative Development Inventory; PSI Parenting Stress Index; CSBS-DP Communication and Symbolic Behavior Scales Developmental Profile.

enrolled in specialized educational placements at the time of referral, four were participating in an overlapping parent-training program (one of whom was also born preterm), and one was excluded because the parents were not Hebrew-speaking, the required language of intervention. An additional twelve families declined participation: seven due to excessive treatment burden, three due to difficulties attending in-person sessions, one family could not be reached, and one declined for an unspecified reason (Fig. 1).

3.2. Feasibility and acceptability

Seventeen of 20 families (85%) completed the intervention; three withdrew for personal reasons. Among completers, 88% attended ≥ 14 of 15 sessions, with no intervention-related concerns reported (Fig. 1). Parents expressed high satisfaction ($M = 33.1/35$, $SD = 2.8$), with 44% rating the program at the maximum score.

3.3. Child outcomes

Paired-sample *t*-tests showed significant gains in language and social-communication skills (Table 2). Expressive vocabulary (HCDI) rose by 90.7% ($t(16) = 4.11$, $p = .001$, $d_z = 1.00$), and receptive vocabulary by 84.3% ($t(16) = 3.94$, $p = .001$, $d_z = 0.96$), both representing large effect sizes. CSBS-DP Social, Speech, and Total scores also improved significantly ($p \leq .045$), with the Social Composite showing a medium-to-large effect ($d_z = 0.70$), suggesting a meaningful practical benefit for the participants' daily interactions. Additionally, ABC Social Withdrawal scores declined significantly ($t(16) = 2.42$, $p = .028$, $d_z = -0.59$).

Beyond these significant improvements, an examination of effect sizes reveals "non-negligible" trends (Cohen, 1988) in other clinical domains. JA scores showed a medium effect size toward reduction ($d_z = -0.44$, $p = .088$), suggesting a meaningful clinical improvement in behaviours related to JA. Conversely, ADOS-RRB scores showed a medium effect size in the direction of increased symptoms ($d_z = 0.46$, $p = .077$). While not statistically significant, this trend in RRB might reflect an increased parental awareness of specific repetitive behaviors following the intervention. In contrast, measures of more stable traits showed negligible effect sizes, including ADOS-2 Social Affect ($d_z = -0.34$), adaptive behavior (ABAS; d_z range: 0.01–0.21), and cognitive scores ($d_z = -0.06$). These results are consistent with the nature of these assessments; cognitive and adaptive behavior (ABAS) scores are generally not expected to show significant shifts over such a brief intervention period. Similarly, the ADOS-2 is widely recognized as a diagnostic tool that is less sensitive to subtle clinical changes over short-term durations.

3.4. Parental outcomes

The Parent-Child Dysfunctional Interaction (PCDI) subscale of the PSI improved significantly ($t(16) = -3.25$, $p = .005$, $d_z = -0.79$), representing a large effect size. While other PSI subscales did not reach statistical significance, the PSI Total Score yielded a medium effect size ($d_z = -0.43$, $p = .093$), indicating a clinical trend toward reduced overall parental distress, a key goal of this parent-mediated intervention.

Overall, the Social ABCs demonstrated high feasibility and acceptability, with meaningful vocabulary and parent-child interaction

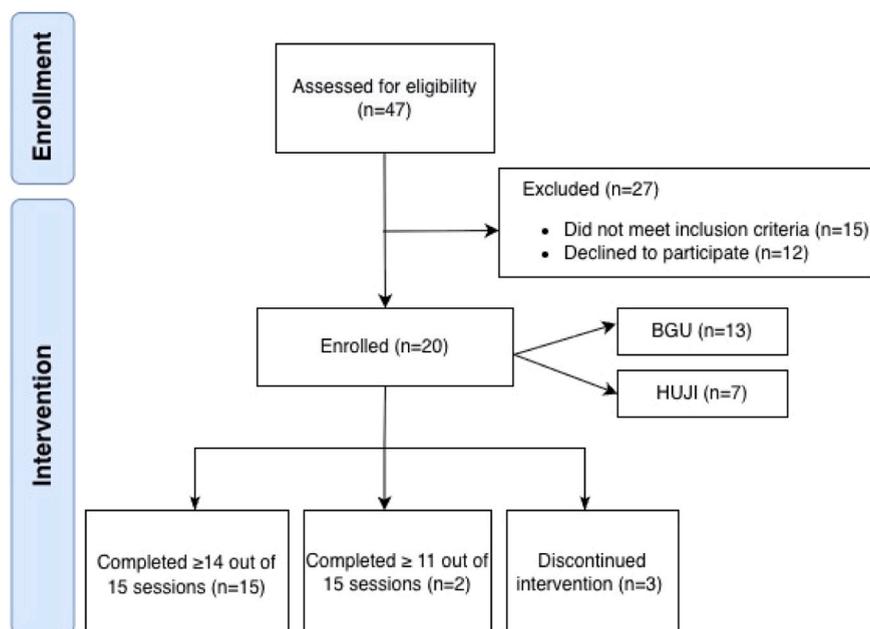


Fig. 1. CONSORT flow diagram of participants. Ben Gurion University of the Negev (BGU); Hebrew University of Jerusalem, Israel (HUJI).

gains and reductions in social withdrawal, warranting further investigation in larger controlled trials.

4. Discussion

This pilot study provides preliminary feasibility under the present eligibility criteria that the Social ABCs is a feasible, promising early intervention for autistic toddlers in Israel and potential benefits of the group-based Social ABCs program for Hebrew-speaking families of autistic toddlers. Findings showed high parent satisfaction, strong participation, and improvements in child vocabulary, social-communication skills, and parent-child interaction.

Feasibility findings were generally positive. Enrollment and retention were high (85% completion), consistent with prior Social ABCs studies (Brian et al., 2016, 2022). Although inclusion criteria were intentionally narrow to minimize confounding from concurrent intensive therapies, families who met criteria showed strong engagement. Parents rated the program as highly helpful, consistent with previous work demonstrating strong parental motivation for participating in parent-mediated interventions (Pickard et al., 2016; Trembath et al., 2019). suggesting strong engagement, likely supported by the hybrid format combining online group sessions with in-person coaching. Coach training was successfully delivered with developer supervision, suggesting that the model can be transferred to local providers. Together, these indicators support the feasibility of implementing Social ABCs in Hebrew-speaking community settings and inform the design of future, larger trials

Significant vocabulary gains and CSBS-DP improvements were observed. These findings align with prior NDBI research (Brian et al., 2016; Vivanti & Zhong, 2020). JA scores showed a moderate within-subject reduction ($d_z = -0.44$, 95% CI [-0.93, 0.05]), although the confidence interval included zero, indicating that a definitive effect cannot be established in this pilot sample. Though ADOS-2 scores showed no significant change, this may reflect measurement insensitivity to subtle behavioral shifts, supporting calls for more sensitive observational tools (e.g., BOSCC) (Carruthers et al., 2021; Grzadzinski et al., 2020). In this study, a significant decrease was observed only on the Parent-Child Dysfunctional Interaction (PCDI) subscale of the PSI, while other parenting stress domains (Parental Distress, Difficult Child) showed no change. This suggests that the parent-child interaction quality, a core target of NDBIs, showed greatest improvement. Improvements in moment-to-moment engagement may reflect behavioral changes that enhance family functioning and lay the groundwork for broader developmental gains over time. Although parent-mediated interventions can temporarily increase stress as parents learn new strategies (Brian et al., 2022), these findings highlight that even without reductions in overall stress, strengthening parent-child interactions can yield meaningful change for families (McConachie et al., 2015).

4.1. Limitations

This pilot study had several limitations. The small, uncontrolled design and reliance on self-reported measures limit the strength and generalizability of the findings. Crucially, while our outcome measures were collected at a 6-week post-intervention assessment point, the study lacked a long-term follow-up to assess the sustained durability of effects months after the conclusion of the program. The single-arm, pre-post design limits causal inference and does not control for threats such as regression to the mean or nonspecific intervention effects. Multiple-baseline single-case research designs offer a methodologically stronger alternative for early-stage intervention research by allowing staggered intervention onset and repeated measurement across participants to strengthen internal validity. In the present implementation, the fixed six-week cohort structure and group-based Zoom sessions, combined with co-ordinated in-person coaching, precluded the use of a true multiple-baseline design. Future trials could incorporate multiple-baseline or hybrid SCRD-group designs with more frequent repeated measurement to strengthen causal inference while preserving the ecological validity of community-based, group-delivered service models (McLay et al., 2021).

Eligibility criteria were intentionally narrow to reduce heterogeneity in this preliminary phase, highlighting the need for future studies with broader inclusion and more rigorous designs. Parent implementation fidelity was not formally assessed, limiting conclusions about the extent to which caregiver strategy use mediated intervention effects. Social validity was measured only through a brief parent satisfaction questionnaire, providing limited insight into caregivers' experiences and acceptability of the program. Future research should include larger randomized controlled trials (RCTs), blinded outcome assessments, formal measures of parent implementation fidelity, additional social validity methods (e.g., interviews), and longer-term follow-up to evaluate sustained impacts and potential developmental gains over time.

Beyond these methodological constraints, several systemic challenges for wider implementation in Israel must be addressed. While the hybrid delivery model is efficient, the inclusion of face-to-face sessions imposes logistical demands on Israel's strained public healthcare and child development centers. Furthermore, large-scale implementation would require a robust infrastructure for professional training and ongoing mentorship to ensure model fidelity, a significant undertaking given the current shortage of specialized clinicians in the public sector. Additionally, while digital literacy is generally high in Israel, the "digital divide" remains a concern for specific underserved populations. Ensuring universal access to stable internet and hardware is essential for the equitable delivery of such remote-access interventions. Future research should pilot this program within community service settings to identify sustainable pathways for integration into the Israeli public health system.

4.2. Implications

Despite these limitations, within the current eligibility criteria, this pilot study provides preliminary support that the Social ABCs may be a scalable, promising parent-mediated intervention to address early communication delays in autistic toddlers in Israel. Its group-based format and hybrid delivery model (online and in-person) offer a practical option for systems facing long wait times for

services. Training community providers to deliver programs like Social ABCs could close critical service gaps, offering families an early, accessible support following diagnosis and potentially improving developmental trajectories during a crucial window for intervention.

CRedit authorship contribution statement

Michal Ilan: Writing – review & editing, Investigation. **Michal Faroy:** Writing – review & editing, Investigation. **Analya Michaelovski:** Writing – review & editing, Investigation. **Dikla Zigdon:** Writing – review & editing, Investigation. **Gal Meiri:** Writing – review & editing, Supervision, Resources, Investigation. **Ilan Dinstein:** Writing – review & editing, Supervision, Resources, Methodology, Funding acquisition, Conceptualization. **Judah Koller:** Writing – review & editing, Supervision, Resources, Methodology, Funding acquisition, Conceptualization. **Tanya Nitzan:** Writing – original draft, Visualization, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Tamar Matz Vaisman:** Writing – original draft, Validation, Methodology, Investigation, Data curation, Conceptualization. **Tamar David:** Writing – review & editing, Investigation.

Authors contributions

TN and TMV jointly led the delivery of the intervention, conducted the literature review, interpreted the findings, and co-wrote the manuscript. TN performed the data analysis and contributed to methodology and data curation. TMV also contributed to data curation and validation. TD supported the delivery of the intervention. MI participated in data collection. MF, AM, and DZ contributed to participant recruitment. GM coordinated participant recruitment, provided resources, supervised the project, and contributed to manuscript review and editing. ID and JK were involved throughout the research process, including conceptualization, methodology, resources, supervision, study design, and manuscript preparation. All authors reviewed and approved the manuscript.

Ethical approval

The study received ethical approval from the Helsinki Committee at Soroka Medical Center (approval number: SOR-20-0363). Additional approval was granted by the Ethics Committee at the Seymour Fox School of Education, Hebrew University of Jerusalem (HUJI), and the Psychology Department at Ben-Gurion University of the Negev (BGU). The study was retrospectively registered at ClinicalTrials.gov (Identifier: NCT07025603).

Funding

Funding was received from the Canadian Friends of the Hebrew University.

Declaration of Competing Interest

The authors declare no competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors thank the participating families, as well as the students and staff of the Autism Child and Family Lab and the Azrieli National Centre for Autism and Neurodevelopment Research. We thank Dr. Jessica Brian and her team at Holland Bloorview Rehabilitation Center for their guidance on the Social ABCs program, and Dr. Jonathan Leef for his help translating the questionnaires.

Data Availability

Data will be made available on request.

References

- Abidin, R.R. (1995). *Parenting stress index manual* (3rd ed.). Psychological Assessment Resources.
- Aman, M. G., Singh, N. N., Stewart, A. W., & Field, C. (1985). The aberrant behavior checklist: A behavior rating scale for the assessment of treatment effects. *American Journal of Mental Deficiency, 89*(5), 485–491.
- Blampied, N. M. (2022). Reliable change and the reliable change index: Still useful after all these years? *The Cognitive Behaviour Therapist, 15*, Article e50. <https://doi.org/10.1017/S1754470X22000484>
- Brian, J., Dowds, E. M., Bernardi, K., Velho, A., Kantawalla, M., & de Souza, N. (2024). Transporting and implementing a caregiver-mediated intervention for toddlers with autism in Goa, India: Evidence from the social ABCs. *Frontiers in Rehabilitation Sciences, 5*(February), 1–12. <https://doi.org/10.3389/frsc.2024.1214009>
- Brian, J., Smith, I. M., Zwaigenbaum, L., Roberts, W., & Bryson, S. E. (2016). The social ABCs caregiver-mediated intervention for toddlers with autism spectrum disorder: Feasibility, acceptability, and evidence of promise from a multisite study. *Autism Research, 9*(8), 899–912. <https://doi.org/10.1002/aur.1582>
- Brian, J., Solish, A., Dowds, E., Roth, I., Bernardi, K., Perry, K., Daoud, S., Jilderda, S., MacWilliam, S., Smith, I. M., Zwaigenbaum, L., & Bryson, S. (2022). Going Mobile™—increasing the reach of parent-mediated intervention for toddlers with ASD via group-based and virtual delivery. *Journal of Autism and Developmental Disorders, 52*(12), 5207–5220. <https://doi.org/10.1007/s10803-022-05554-7>

- Carruthers, S., Charman, T., El Hawi, N., Kim, Y. A., Randle, R., Lord, C., Pickles, A., Green, J., Aldred, C., Barrett, B., Barron, S., Beggs, K., Blazey, L., Bourne, K., Byford, S., Collino, J., Cutress, A., Harrop, C., Houghton, T., & White, L. (2021). Utility of the autism diagnostic observation schedule and the brief observation of social and communication change for measuring outcomes for a parent-mediated early autism intervention. *Autism Research, 14*(2), 411–425. <https://doi.org/10.1002/aur.2449>
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.
- Crank, J. E., Sandbank, M., Dunham, K., Crowley, S., Bottema-Beutel, K., Feldman, J., & Woynaroski, T. G. (2021). Understanding the effects of naturalistic developmental behavioral interventions: A project AIM meta-analysis. *Autism Research, 14*(4), 817–834. <https://doi.org/10.1002/aur.2471>
- Dinstein, I., Solomon, S., Zats, M., Shusel, R., Lottner, R., Gershon, B. B., Meiri, G., Menashe, I., & Shmueli, D. (2024). Large increase in ASD prevalence in Israel between 2017 and 2021. *Autism Research, 17*(2), 410–418. <https://doi.org/10.1002/aur.3085>
- Ferman, S., & Segal, O. (2024). The face of autism in Israel. *Neuropsychiatric Disease and Treatment, 20*, 1677–1692. <https://doi.org/10.2147/ndt.s466420>
- Gendler-Shalev, H., & Dromi, E. (2021). The Hebrew word communication development inventory (MB-CDI): Lexical development growth curves. *Journal of Child Language, 1–17*. <https://doi.org/10.1017/S0305000921000179>
- Grzadzinski, R., Janvier, D., & Kim, S. H. (2020). Recent developments in treatment outcome measures for young children with autism spectrum disorder (ASD). *Seminars in Pediatric Neurology, 34*(Cidd), Article 100806. <https://doi.org/10.1016/j.spen.2020.100806>
- Harrison, P. L., & Oakland, T. (2000). *Adaptive behavior assessment system*. TX: Psychological Corporation San Antonio.
- Haskett, M. E., Ahern, L. S., Ward, C. S., & Allaire, J. C. (2006). Factor structure and validity of the parenting stress index-short form. *Journal of Clinical Child & Adolescent Psychology, 35*(2), 302–312. https://doi.org/10.1207/s15374424jccp3502_14
- Jacobson, N. S., & Truax, P. (1992). Clinical significance: A statistical approach to defining meaningful change in psychotherapy research. *Journal of Consulting and Clinical Psychology, 59*(1), 12–19. <https://doi.org/10.1037/0022-006X.59.1.12>
- Kasari, C., Lawton, K., Shih, W., Barker, T. V., Landa, R., Lord, C., Orlich, F., King, B., Wetherby, A., & Senturk, D. (2014). Caregiver-mediated intervention for low-resourced preschoolers with autism: An RCT. *Pediatrics, 134*(1), 72–79. <https://doi.org/10.1542/peds.2013-3229>
- Koegel, R. L., & Koegel, L. K. (2006). *Pivotal response treatments for autism: Communication, social, & academic development*. Paul H. Brookes Publishing Co.
- Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: A practical primer for t-tests and ANOVAs. *Frontiers in Psychology, 4*. <https://doi.org/10.3389/fpsyg.2013.00863>
- Lord, C., Rutter, M., Di Lavore, P., Risi, S., Gotham, K., & Bishop, S. (2012). *Autism and diagnostic observation schedule, Second Edition (ADOS-2) Manual (Part I): Modules 1-4*.
- Maital, S. L., Dromi, E., Sagi, A., & Bornstein, M. H. (2000). The Hebrew communicative development inventory: Language specific properties and cross-linguistic generalizations. *Journal of Child Language, 27*(1), 43–67. <https://doi.org/10.1017/S0305000999004006>
- McConachie, H., Parr, J. R., Glod, M., Hanratty, J., Livingstone, N., Oono, I. P., Robalino, S., Baird, G., Beresford, B., Charman, T., Garland, D., Green, J., Gringras, P., Jones, G., Law, J., Le Couteur, A. S., Macdonald, G., McColl, E. M., Morris, C., ... Williams, K. (2015). Systematic review of tools to measure outcomes for young children with autism spectrum disorder. *Health Technology Assessment, 19*(41), 1–538. <https://doi.org/10.3310/hta19410>
- McLay, L., France, K., Blampied, N., Van Deurs, J., Hunter, J., Knight, J., Hastie, B., Carnett, A., Woodford, E., Gibbs, R., & Lang, R. (2021). Function-based behavioral interventions for sleep problems in children and adolescents with autism: Summary of 41 clinical cases. *Journal of Autism and Developmental Disorders, 51*(2), 418–432. <https://doi.org/10.1007/s10803-020-04548-7>
- Mullen, E. M. (1995). *Mullen scales of early learning*. Pines, MN: AGS Circle.
- Pickard, K. E., Wainer, A. L., Bailey, K. M., & Ingersoll, B. R. (2016). A mixed-method evaluation of the feasibility and acceptability of a telehealth-based parent-mediated intervention for children with autism spectrum disorder. *Autism, 20*(7), 845–855. <https://doi.org/10.1177/1362361315614496>
- 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>
- Trembath, D., Gurm, M., Scheerer, N. E., Trevisan, D. A., Paynter, J., Bohadana, G., Roberts, J., & Iarocci, G. (2019). Systematic review of factors that may influence the outcomes and generalizability of parent-mediated interventions for young children with autism spectrum disorder. *Autism Research, 12*(9), 1304–1321. <https://doi.org/10.1002/aur.2168>
- Visser, J. C., Rommelse, N. N. J., Lappenschaar, M., Servatius-Oosterling, I. J., Greven, C. U., & Buitelaar, J. K. (2017). Variation in the early trajectories of autism symptoms is related to the development of language, cognition, and behavior problems. *Journal of the American Academy of Child and Adolescent Psychiatry, 56*(8), 659–668. <https://doi.org/10.1016/j.jaac.2017.05.022>
- Vivanti, G., & Zhong, H. N. (2020). Naturalistic developmental behavioral interventions for children with autism. In F. R. Volkmar (Ed.), *Clinical guide to early interventions for children with autism* (pp. 93–130). Springer International Publishing. https://doi.org/10.1007/978-3-030-41160-2_6
- Wetherby, A.M., Allen, L., Cleary, J., Kublin, K., & Goldstein, H. (2002). *Validity and reliability of the communication and symbolic behavior scales developmental profile with very young children*.
- Wetherby, A. M., & Prizant, B. M. (2002). *Communication and symbolic behavior scales: Developmental profile*. Paul H Brookes Publishing Co.