



OPEN A single-blind active-control randomized controlled trial of group-based social competence intervention

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This study evaluated specific effects of a blinded randomized controlled trial of a group-based social skills intervention, Socio-Dramatic Affective-Relational Intervention (SDARI), against an active attention control (AC) intervention. Fifty-five autistic youth ($M_{age}=12.40$; $SD_{age}=2.92$; 73% boys) were randomly allocated to either the SDARI or the AC condition. Both interventions comprised 10 weekly sessions and were tightly matched for structure, participant age, IQ, and gender, such that the specific activities of SDARI were directly examined. Multimethod assessments at pre-, post-treatment, and 10-week follow-up included informant-reported social skills and autism-related behaviors, observer-rated spontaneous peer interaction, peer-rated friendships, and a metric of social information processing (the N170 event-related potential). Parent expectancy effect was also explored by examining perceived conditions by parents/caregivers, who were blinded to the condition assignment. Compared to the AC condition, the SDARI group evinced improvements in the N170 latency, rapid peer-liking, and reciprocal friendships at endpoint and follow-up. While the conditions did not differ on parent-reported social skills or autism-related behaviors, a parental expectancy effect was found where parent-rated social skills improvements were related to parents' perceived conditions. These results provide support for the efficacy of the specific SDARI activities on several objective, reliable outcomes of social functioning in autistic youth.

Keywords Autism spectrum disorder, Social skills intervention, Group-based social skills intervention, Randomized controlled trial

Group-based social skills interventions (GSSIs) are one of the primary intervention methods for improving core social competence challenges in school-aged and adolescent autistic youth^{1,2}. GSSIs have been shown to be both effective and efficacious for addressing social skills challenges in autism spectrum disorder (ASD)^{1–4}, with overall medium effects¹.

However, there are substantial and consistent methodological limitations that impact the reliability of this evidence. First, findings from GSSIs are often limited by reliance on highly subjective measures. For instance, it is often unclear whether parent-reported effects are due to parent expectancy and detection biases—that is, are they effectively a placebo effect⁵. It is thus important to use metrics that are less reliant on subjective perceptions of change, including neural constructs⁶ and observational methods⁷. For example, delayed latency of the N170 event-related potential indexed by electroencephalogram (EEG) to faces suggests atypical neural processing of social information, and exhibits robust evidence of being a promising biomarker for ASD^{8,9}. Preliminary evidence suggests that N170 latency may decrease following behavioral treatment designed to enhance social communication in autistic children, indicating its potential as a measure of treatment response for this population¹⁰. Also, direct observation of peer interactions in naturalistic settings captures authentic social dynamics among autistic youth¹¹. Similarly, examining peer-reported sociometric status assesses social outcomes within the context in which social relationships develop and function, and has been implemented in intervention settings^{12,13}. Second, few randomized controlled trials (RCTs) using active control have been conducted in this literature, and most have used “straw man” comparison conditions¹⁴. Third, no study to date

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in this literature has sought to blind invested primary outcome reporters (e.g., parents) to participant condition assignment. While this has often been attributed to the methodological difficulty of ethically precluding participant awareness of condition assignment in behavioral interventions¹⁵, it nonetheless means that no study in this literature has adhered to this in gold-standard RCT designs⁴. Fourth, GSSIs are highly susceptible to other nonspecific treatment effects, such as exposure to peers, time spent in group, therapist training, differences in the intervention space, and presence of a supportive environment, precluding the ability to identify whether any effects are *specific* to a particular GSSI – or are simply the result of these nonspecific effects. Fifth, analytic limitations abound, such as lack of utilization of statistical methods that account for nesting within groups¹⁶, as well as limited examination of generalization and maintenance of effects¹⁷. While all of these issues may be addressed via the use of a blinded active attention component-control (AC) RCT design¹⁸ with appropriate analytic considerations, all but two studies^{19,20} have done so to examine a GSSI for autistic youth.

The current study utilizes such an approach, thereby representing the most rigorous examination of the efficacy of GSSIs for ASD to date. This study examined the efficacy of Socio-Dramatic Affective-Relational Intervention (SDARI), which has shown evidence of effectiveness for improving social skills among autistic youth across several preliminary studies^{13,21–24}. For instance, the initial pilot study of 17 participants showed large effects on increasing assertion and decreasing social problems, with small effects on emotion recognition, with benefits maintained at 6-week follow-up²¹. A subsequent comparative study with another GSSI involving 13 participants found that SDARI was equally effective at promoting friendships, with SDARI participants showing decreased negative interactions and producing faster initial gains in social preference¹³. Additional studies demonstrated improvements in theory of mind, enhanced social knowledge, and better emotion recognition, particularly in community-based settings²³. Overall, research to date suggests SDARI improves both social communication and social cognition in autistic children, with different benefits emerging in laboratory versus community settings.

In particular, using rigorous experimental controls and examining long-term maintenance of effects, we investigated SDARI's impact on two key domains: (1) objective measures, including (1a) an EEG metric of social information processing, (1b) observer-rated social interactions, and (1c) peer-reported reciprocal friendships; and (2) assessment of parent-reported social skills while accounting for parent expectancy effects that often confound subjective measures.

Method

This trial was a randomized, single-blind, active-controlled study, with a 1:1 allocation ratio. This study was retrospectively registered on the Open Science Framework (OSF): <https://osf.io/v7zrb>.

Research participants

Fifty-five youth from a mid-Atlantic state ($M_{age}=12.40$, $SD_{age}=2.92$; 40 male, $IQ \geq 70$) participated in the current study from 2015 to 2017. Participants who met the recommended ASD cutoffs (scores ≥ 11) on the Social Communication Questionnaire²⁵ were eligible for an initial screening visit for this study. Participants were eligible to participate in this study if they (1) met criteria for ASD as confirmed by the gold-standard diagnostic assessment, the Autism Diagnostic Observation Schedule-Second Edition (ADOS-2)²⁶ assessed by research-reliable examiners; (2) between ages of 8–17; and (3) measured verbal and full-scale $IQ \geq 70$ based on an IQ evaluation via the Kaufman Brief Intelligence Test-Second Edition (KBIT-2)²⁷. Youth with significant medical or neurological illnesses that could impair participation were excluded from the study. Out of 100 youth assessed for eligibility, fourteen youth did not meet the inclusion criteria, and thirty-one participants declined enrollment, citing common barriers to participation in randomized controlled trials, including scheduling conflicts, transportation limitations, and time constraints. Written informed consent from a parent and/or legal guardian and assent from minors were obtained prior to any research activity. The current study sample has been described in other publications^{28,29}.

Procedures

The study was approved by the University Institutional Review Board, and all methods were conducted in accordance with relevant guidelines and regulations. Autistic youth participated in 1.5 h/week groups for 10 weeks. Each 10-week period is considered one “cycle” of intervention. There were 4 cycles in each condition (total of 8 groups). Interventions were implemented in a Psychology laboratory setting at a University. All group members were involved in the study, but participants were recruited individually from the surrounding communities and did not have known connections outside of intervention setting.

As is standard practice for SDARI, participants within a group were within 3 years of age of one another. We carefully considered developmental age and appropriateness of the groups, such that younger groups had participants aged 8–12 and older groups had participants 13 and older. This grouping approach was refined through years of implementation of SDARI, ensuring that participants were developmentally similar, facilitating more effective peer interactions, appropriate social challenges, and engagement in age-relevant activities. AC groups were also matched to a paired SDARI group on age (within 3 years), IQ, and gender. There were 2 groups of younger children (aged 8/9 to 11/12) and 2 groups of older children (aged 13/14 to 16/17) for each intervention condition.

Table 1 summarizes demographic characteristics of the sample as well as comparison between the two groups on key variables.

Interventions

The two interventions followed an identical structure, including unstructured time (break) for 20 min during the middle of each of the sessions. Both groups consisted of 6 to 9 participants.

Characteristic	Value			
	Total (N=55)	SDARI (n=28)	FACT (n=27)	Comparison Value (t or χ^2)
Age, mean (SD), y	12.40 (2.92)	12.73 (3.16)	12.06 (2.67)	0.85
Male	40 (73%)	20 (71%)	20 (74%)	0.05
Hispanic	4 (7%)	1 (2%)	3 (5%)	1.16
Race				
White	46 (84%)	26 (93%)	20 (74%)	4.43
Asian	3 (5%)	0 (0%)	3 (11%)	
More than one	6 (11%)	2 (7%)	4 (15%)	
SCQ	20.95 (4.77)	21.32 (4.47)	20.56 (5.11)	0.59
ADOS-2	7.56 (1.87)	7.86 (1.63)	7.26 (2.09)	1.18
KBIT-2	103.02 (16.08)	104.89 (14.28)	101.07 (17.82)	0.86
SSIS parent	75.64 (12.65)	77.54 (12.67)	73.67 (12.57)	1.14
SSIS self	95.84 (19.09)	99.07 (17.76)	92.48 (20.15)	1.28
N170 latency P7	184.42 (18.34)	186.96 (19.67)	181.77 (16.81)	1.03
N170 latency P8	187.25 (18.04)	183.78 (17.21)	190.85 (18.51)	1.44

Table 1. Baseline demographic and diagnostic characteristics (N=55). Note. SCQ=Social Communication Questionnaire; ADOS-2=ADOS-2=Autism Diagnostic Observation Schedule, Second Edition; KBIT-2=Kaufman Brief Intelligence Test, Second Edition; SSIS=Social Skills Improvement System. * $p < .05$. ** $p < .01$. *** $p < .001$.

Socio-Dramatic Affective-Relational intervention (SDARI)

SDARI is a group-based performance-based social skills intervention designed to provide participants the experience of successfully engaging in and learning a target social skill, with minimal didactic instruction or instrumental reinforcement of that skill. Detailed description of SDARI procedure have been previously described^{13,21,30}. SDARI has three main aspects: (1) SDARI utilizes affectively-motivating acting games adapted for this age group and population. Specifically, the SDARI manual contains more than 100 games that target specific goals of the day (e.g., perspective-taking or interpretation of body language), and clinicians and participants collaboratively choose games among the available games that align with the goals and are developmentally-appropriate for the participants in the group. For example, a group with younger participants may engage in cooperative play-based games, while a group with older adolescents participates in team challenges or improvisational games centered on real-world social scenarios that are relevant to adolescents. In the current study, the goals were consistent across cohorts and we assessed fidelity to these weekly curriculum and goals. (2) Clinicians promote strong relationships between participants, and between participants and clinicians, to support positive social reinforcement by fostering a supportive and enjoyable environment, facilitating structured and unstructured social interactions, encouraging collaborative problem-solving, and reinforcing positive peer engagement. (3) SDARI also uses strong motivators—such as noncompetitive physical activities, shared interests, and goal-oriented activities—to enhance social motivation and engagement.

Fun activities for children and teens (FACT)

The other intervention used structured recreational activities that are not necessarily inherently social (e.g. art projects). Similar to SDARI, FACT aimed to provide enriched environments for reinforcing peer interaction in the absence of explicit instruction. However, unlike the SDARI condition, there was no use of affectively-motivating acting games. The core program principles of FACT were as follows: (1) Use of recreational, motivational activities adapted for this age/population, (2) Positive social reinforcement through the use of activities, and (3) Use of strong age-appropriate motivators.

Comparisons of modules between the two conditions are described in Supplementary Material 1.

Therapists and treatment integrity

Both interventions were led by graduate-level and postdoctoral-level clinicians (three clinicians in each group), who received extensive training and weekly supervision by a PhD-level psychologist with 15 + years of experience. Notably, therapists received tightly-matched training (identical in length, materials, location, except for the core activities associated with conditions). To limit the potential impact of individual clinician or allegiance effects on obtained outcomes³¹, we systematically rotated clinicians between conditions throughout the study cycles to the extent possible. This rigorous, balanced approach ensured that no single clinician was predominantly associated with any particular condition.

Clinicians completed fidelity measures¹³ each week to ensure that curriculum content and staff behaviors are consistent across groups, and do not significantly deviate from, training materials of each condition. Fidelity was also monitored each week via staff discussion and session tape review by the supervisor to minimize intervention cross-contamination. Clinicians showed excellent manual fidelity (activities completed in the session were indicated in the treatment manual) in both conditions (SDARI=96.8%, FACT=97.0%; n.s.). Conceptual fidelity (how much intervention staff members adhered to performance-training principles) of SDARI approach was higher in SDARI (mean score out of 5, SDARI = 3.68 vs. FACT = 3.49, $p < .001$), indicating

that—as expected—while clinicians in both groups were equally adherent to the manualized elements of their respective interventions, SDARI clinicians endorsed greater adherence to the principles of SDARI.

Measures

EEG metric of social information processing

Participants completed the Diagnostic Analyses of Nonverbal Accuracy (DANVA-2)³², a measure of visual (facial) emotion recognition while EEG was simultaneously recorded. During the DANVA-2 facial emotion categorization task, participants viewed 48 color photographs of adult and child faces that ranged in emotional intensity (24 high- and 24 low-intensity) and emotional valence (12 happy, 12 sad, 12 angry, and 12 fearful). Each face was presented on the screen for a minimum of 1,000 ms and a maximum of 3,000 ms. Participants categorized the emotion of each face using a button box and their responses cued trial advancement. There was a 1,000 ms inter-trial interval during which a blank screen was presented. EEG data was recorded using a Brain Products 32-channel BrainVision actiCAP with active electrodes and amplified using an actiCHamp amplifier. The N170 latency was scored as the negative-going peak between 160 and 220 ms at electrode sites P7 and P8. Details of EEG data acquisition and reduction are described in Supplementary Material 3.

Observer-rated spontaneous peer interactions

Video recordings of sessions were used for observational coding of social interactions from unstructured play sessions each week within the SDARI and AC sessions, using a modified version of Social Interaction Observation Scale (SIOS)^{11,33}. SIOS is an observational measure to assess positive, negative, and low-level social interactions in autistic youth, where raters observe and rate a maximum of three characteristic behaviors within each 1-minute segment. In the current study, overall spontaneous peer interaction (across positive, negative, and low-level) was examined. Each session was double-coded by a team of research assistants who were naïve to study hypotheses and blinded to group conditions, chronology of videos, and the mean score between two coders was used in analyses to reduce measurement error. Additional details related to training, coding process, and reliability assessments are described in Supplementary Material 2.

Peer-reported reciprocal friendships

The peer-reported Sociometric interview was conducted after sessions 1, 5, and 10, regarding the peers within their group to assess friendship-making patterns and perceived acceptance by within-group peers (liking, disliking, desire to play again, and reciprocal friendship)³⁴. Questions were read aloud to participants by trained research assistants, and participants responded by pointing to the picture of the child they were nominating or saying the number on the Likert-type scale with visuals. To account for different group size, reciprocal friendships were calculated by considering the number of peers the participant nominated as a friend who also nominated them as a friend in return, then deriving a proportion score of the total number of participants in the group.

Parent-report social skills

At pre-test, post-test, and 10-week follow-up, participants and their parents completed the Social Skills Improvement System (SSIS)³⁵. The SSIS is a widely-used 46-item measure of overall frequency of social skills behavior. Social skills ratings were quantified using Social Skills Standard Scores. Parents also completed Social Responsiveness Scale-Second Edition (SRS-2)³⁶, which is a measure developed specifically to address the level of social skills related to autism in autistic youth. Additionally, parents reported the perceived condition at endpoint via a participant condition assignment questionnaire that asked in which condition that parents believed their child participated. To ensure that parents are blinded to treatment condition, this measure was administered to parents after all intervention sessions have been completed.

Randomization and blinding

After eligibility was determined and participants provided consent, participants were randomly assigned to SDARI or AC (see Fig. 1 for CONSORT Flow Diagram and Checklist). Randomization was accomplished via a random number generator, using assignment procedures corresponding to those used in previous randomized control studies, including those examining group social skills interventions for autistic youth^{37,38}. Participants and their caregivers were blinded to the randomization sequence and unaware of study hypotheses.

Statistical analysis

Generalized Estimating Equations (GEE)³⁹ were used to estimate effects of timepoints on change in dependent variables while accounting for nesting within groups. These models are appropriate for the present data structure, in which participants are nested within small groups, and group-level variation must be accounted for, but no group-level predictors are of interest. As all outcome measures were continuous variables, a normal distribution and identity link function were used. To determine the best-fitting model for the data, (1) we modeled timepoint as either a continuous or an ordinal variable in the model, and (2) ran independent, unstructured, and autoregressive correlation matrix structure models for each outcome measure. We compared the goodness of fit of the model using the quasi-likelihood information criterion (QIC). Significant effects using two-tailed tests were followed up using Fisher's least significant difference (LSD). Separate models were run for each outcome measure. If significant effects of timepoint*condition were found for an outcome measure, we probed the subscales to see if effects were also present. In all analyses, if the best-fitting model represented timepoint as an ordinal variable, we conducted *post-hoc* difference contrasts between timepoints, using LSD adjustment for multiple comparisons. Please contact the authors for inquiries regarding the fit comparisons across all tested models.

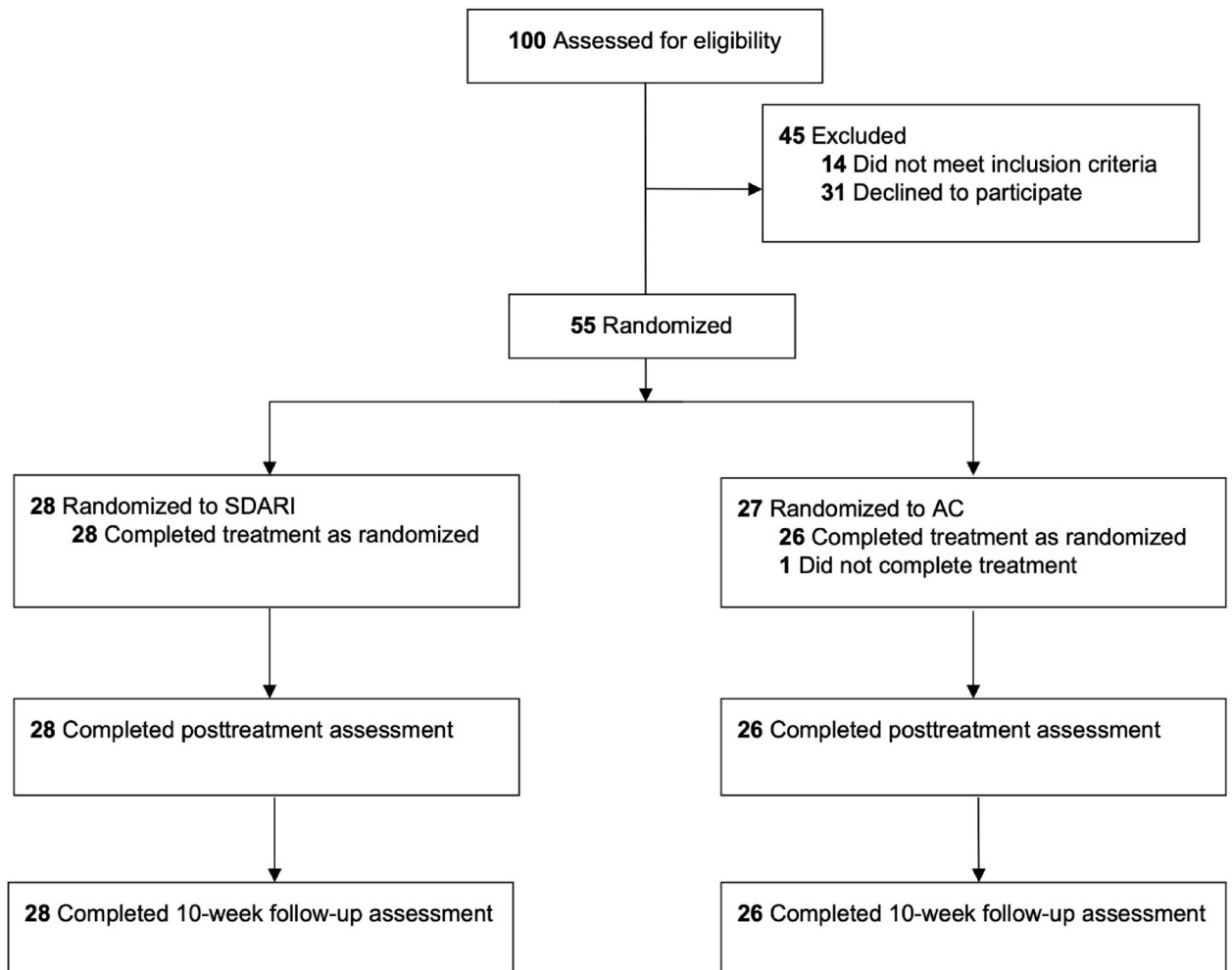


Fig. 1. CONSORT Flow Diagram.

We conducted an exploratory analysis examining parent expectancy effect by comparing SSIS-Parent scores and SRS-2 scores using perceived condition rather than actual condition.

Results

Sample characteristics and baseline information

Table 1 summarizes demographic information in SDARI and AC conditions, as well as means and standard deviations of primary outcome measures. There were no differences in demographic characteristics across conditions.

Outcomes

EEG metric of social information processing

The SDARI and AC conditions differed in their changes in N170 latency to faces (Wald's $X^2 = 6.00$, $p < .05$), where the SDARI group evinced accelerated N170 latency to faces (Fig. 2) over the course of the intervention, which remained at follow-up.

Observer-rated spontaneous peer interactions

As measured by the SIOS, differences were seen between conditions (Wald's $X^2 = 4.87$, $p < .05$), where greater amount of spontaneous peer interactions were observed during the earlier sessions in SDARI group (Wald's $X^2 = 35.87$, $p < .001$; Fig. 3A). In terms of specific interaction types, there were no significant differences between conditions for either negative or low-level interactions ($p > .15$), while positive peer interactions revealed marginal differences across conditions (Wald's $X^2 = 2.97$, $p = .085$), where a trend was observed for more positive peer interactions in SDARI group (Wald's $X^2 = 2.75$, $p < .10$).

Peer-reported reciprocal friendships

In comparison to the AC condition, SDARI led to improvements in peer sociometrics, specifically in reciprocal friendships (Wald's $X^2 = 6.52$, $p < .05$). SDARI participants evinced higher levels of reciprocated friendships after Session 1, whereas AC participants reached similar level of reciprocated friendships by Session 10 (Fig. 3B).

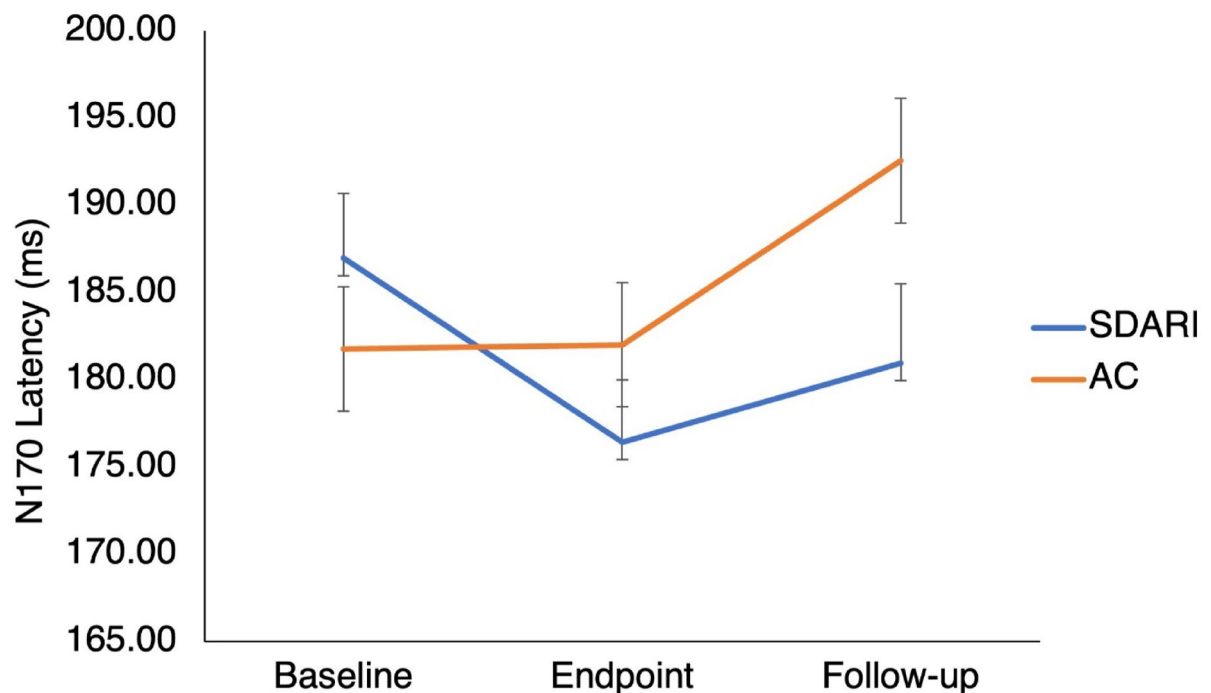


Fig. 2. Changes in N170 Event-related potential (ERP) latency to faces following Socio-Dramatic Affective Relational Intervention (SDARI) and Active Control (AC) at endpoint and follow-up.

Parent-reported social skills

There were no differences between actual conditions for both parent and self-reported SSIS or the SRS-2 ($p > .90$). However, in terms of exploratory analysis of parent expectancy effect, improvements on the SSIS-Parent were attributable to *perceived* condition (Wald's $X^2 = 6.256$, $p < .05$; Fig. 4). There were no differences between perceived conditions on the SRS-2 scores ($p = .69$).

Discussion

The present study is the one of the first single-blind randomized attention-controlled trials of a GSSI for autistic youth, and the first to explicitly control for *perceived* condition among informants and utilize a tightly-matched active control condition, representing a significant step forward in improving the evidence base in autism intervention research⁴⁰. Incorporating multi-informant measurement approaches, including neural and behavioral indices, results indicate SDARI-specific and durable improvements in the N170, a neural biomarker associated with ASD^{8,41}, as well as faster achievement of positive spontaneous peer interaction and reciprocal friendships. Utilizing the most rigorous methodology to date in the GSSI for ASD literature, these results indicate that this intervention evinces changes on multiple objective and reliable outcome metrics that are minimally subject to reporter bias.

SDARI has demonstrated positive effects on range of outcomes^{13,21,23}; however, it was previously unclear if these effects were due to activities specific to SDARI, nonspecific supportive elements, or expectancy effects – as is the case for all prior studies evaluating GSSI for autistic youth. In contrast, one major contribution of this study was to isolate – for the first time – a putative *active ingredient* of a specific GSSI for autistic youth by comparing it to a rigorous AC design that is tightly-matched and otherwise identical to the SDARI model. These results offer support for the efficacy of specific activities of this intervention, which focus on providing spontaneous social learning opportunities in the context of an enriched environment rather than providing explicit social knowledge. Autistic youth appear to have greater difficulty with actually carrying out social skills during interactions than acquiring explicit social knowledge^{42,43}, suggesting that this model may offer specific benefits for improving social skills in autistic youth. Relatively higher conceptual fidelity in SDARI in the current study, as well as in a prior RCT¹³, may represent that SDARI activities, compared to recreational activities of FACT or knowledge-based approaches, may align well with its core theoretical framework and intended mechanisms around using performance-based approaches, focus on relationship-building, and the use of strong age-appropriate motivators. Indeed, maintaining high fidelity to these core principles are in line with neurodiversity-affirming interventions focusing on authentic social connections and building social competence on their own terms, rather than enforcing neurotypical social norms that may pressure autistic individuals to mask autistic traits and approximate non-autistic behaviors^{43,44}. Specifically, SDARI activities support participants in navigating social interactions by leveraging their strengths and interests and by fostering environments that encourage and reinforce them.

This study also assessed the effects of SDARI on parent-reported variables identified to be relevant to social skills development, while addressing the question of parental expectancy. Results suggest that parent-report

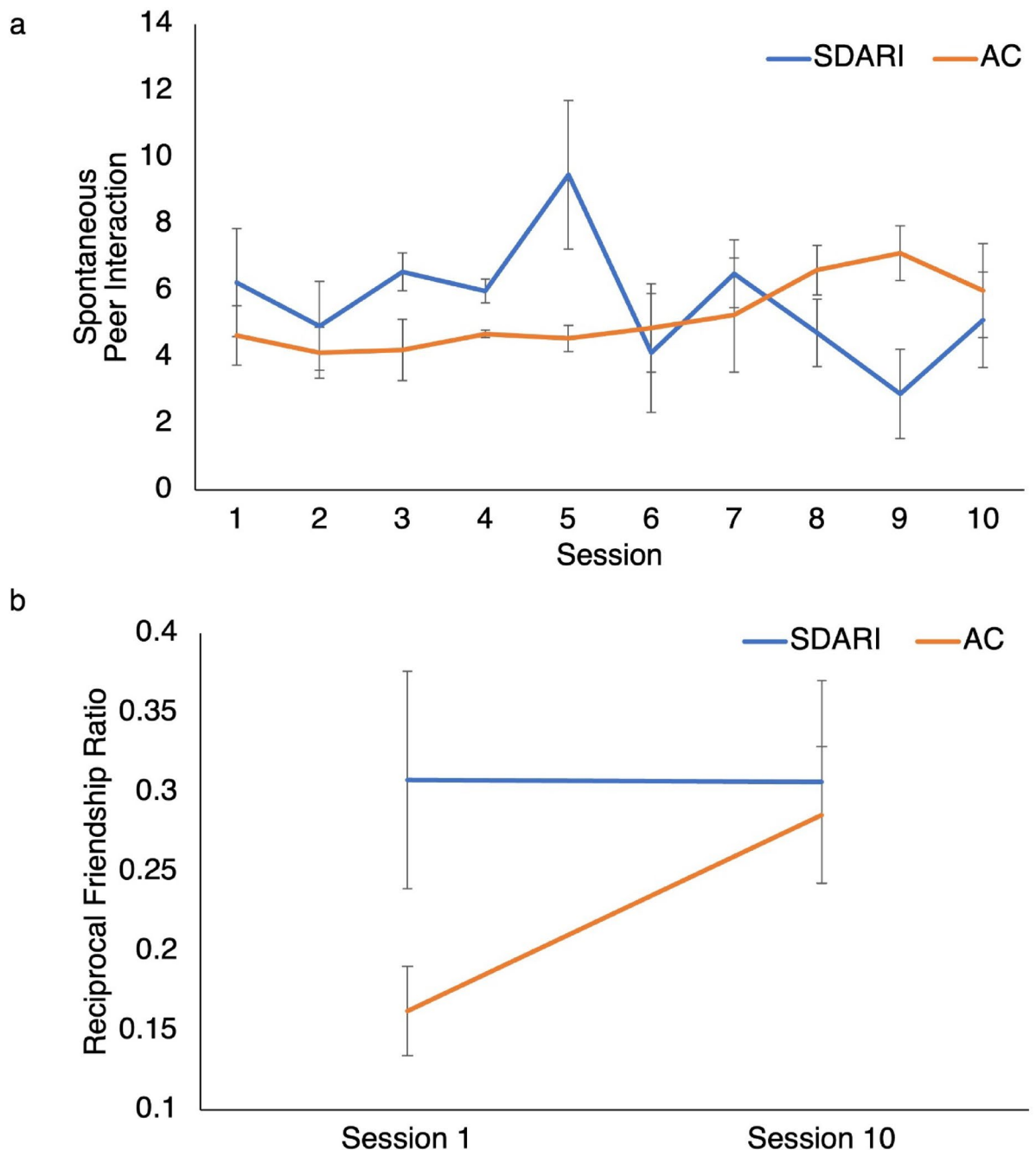


Fig. 3. (A) Mean levels of spontaneous peer interaction during unstructured break time across 10 sessions, and (B) peer sociometrics, specifically in reciprocal friendship ratio, after first session and last session of Socio-Dramatic Affective Relational Intervention (SDARI) and Active Control (AC). Error bars denote standard error.

effects were attributable to *expectations* of perceived condition, not SDARI-specific. The lack of group differences in parent-reported measures may reflect two possibilities. First, these measures might not be sensitive enough to detect the specific social and cognitive changes captured by objective assessments, or behavioral changes may take longer to manifest outside the intervention setting. Second, these results are in line with findings that revealed placebo-like response in caregiver ratings and how participation alone can reliably influence how caregivers perceive their children's behaviors⁵. Our results suggest that parents' expectations and hopes about the effects of a given intervention may account for more variance in reported changes than previously recognized. This highlights the need for caution regarding the use of parent-report as the sole outcome marker in treatment research without accounting for expectancy effects.

Considering the impact of expectancy effects on parent-reported outcomes, development of novel and objective markers of treatment progress is essential⁴⁵. Nonetheless, limited work has explored neural changes

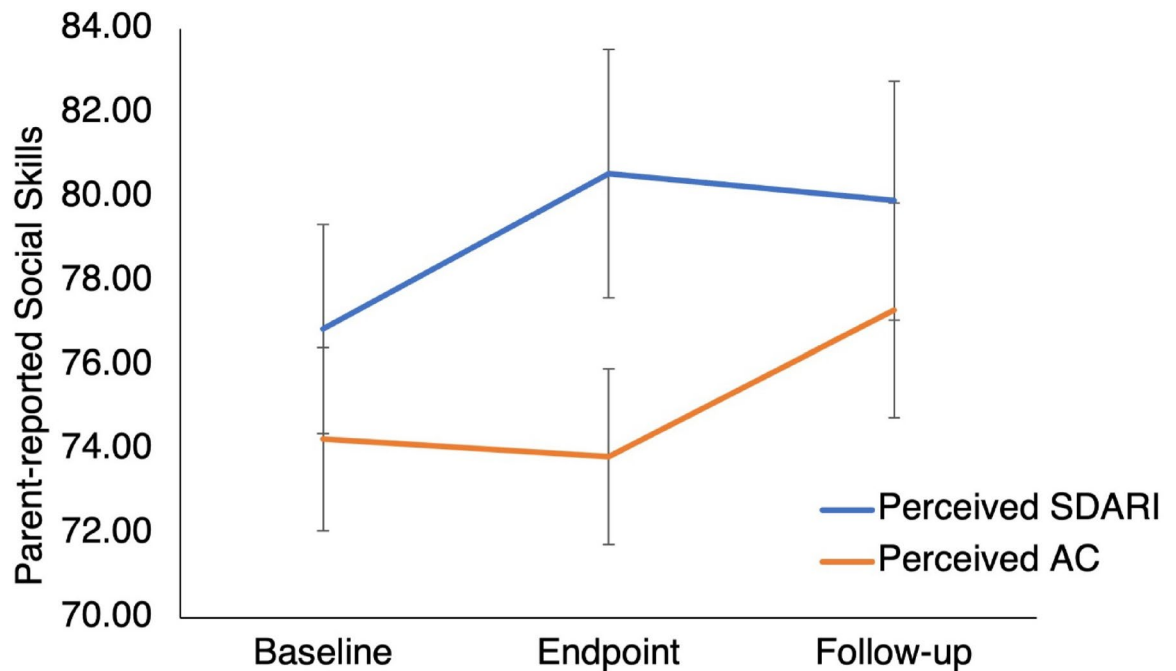


Fig. 4. Parent-report social skills scores by perceived condition, not actual condition, of Socio-Dramatic Affective Relational Intervention (SDARI) and Active Control (AC) at endpoint and follow-up.

in response to behavioral interventions for autistic⁴⁶. This study is among the first to show changes in relevant neural indices of social cognition, demonstrating their utility as outcome measures of interventions. It is possible that the latency of the N170 ERP may be a target engagement biomarker, which would indicate response of social brain circuitry from an intervention^{45,47}. Currently, there are no biomarker that can consistently predict treatment response in ASD clinical trials⁴⁸. Future work should examine whether the N170 may serve as a predictor of treatment response, thereby providing insights to clinicians for identifying who will most likely benefit from psychosocial intervention^{41,45}. Moreover, it would be important to understand how changes in N170 latency may be linked to other social outcomes. Existing literature suggests mixed associations between N170 and social functioning, highlighting the complexity of using early neural markers to predict real-world social competencies. Given these inconsistencies, future research should employ multi-level analyses—integrating neural, social cognitive, and ecological (behavioral and informant-reported) measures—to better capture the nuanced relationships between N170 and broader social abilities in autistic youth. Understanding how N170 responses relate to social outcomes will strengthen its potential utility as a biomarkers in clinical trials, both for participant selection and stratification, and for elucidating mechanisms of change⁴⁹.

It is also significant that SDARI group evinced increased reciprocal friendship, as many autistic youth have few or no reciprocated friends but report wanting them^{50,51}. Indeed, loneliness is a great concern among autistic youth⁵². Although many GSSIs focus on facilitating friendship-making outside the group, it is especially encouraging that participants in this study were able to increase friendship-making *within* group given the importance of having even one friend. Additionally, a growing body of literature on neurodiversity-affirming approaches highlights the unique importance of friendship-making *among* autistic individuals^{44,53,54}, with these results highlighting this as a feasible and critical outcome for this intervention.

Further, observed change in social behavior in unstructured social interaction over the course of the intervention represents an objective marker of change and may indicate real-time generalization of skills⁵⁴. Our findings from sociometrics and observed behaviors suggest that SDARI may be linked to rapid peer liking by facilitating social interaction during unstructured time from early in the intervention. One possible SDARI-specific mechanism involves naturalistic modeling of successful interactions that allow for performance-based learning approaches for autistic youth⁵⁵. Notably, these patterns were similarly found in a previous RCT, where more immediate interactions were shown in SDARI¹³. Taken together, these findings show initial benefits following the SDARI intervention, although these differences diminish over time. This aligns with research that positive first impressions can lead to increased social interaction and can play a role in shaping new friendships^{56,57}. Similarly, structured interventions like SDARI may help autistic individuals establish rapid peer connections. It will be important to consider how early social gains in SDARI can be sustained in real-world settings and whether additional supports, such as follow-up group sessions or school- or community-based interventions, can help promote more sustainable friendships.

Several limitations bear mentioning that also serve as fertile grounds for exploring future directions. First, the current RCT employed a 10-week version of an intervention originally designed as a more intensive summer program^{13,21,22}. Given our findings, future work should examine optimal dosing of this intervention to maximize benefits for autistic youth. Although we maintained three-year age ranges within groups and tailored engagement

methods to the participants' developmental levels, this age span may present challenges. For example, the difference between elementary and secondary school contexts may significantly impact social dynamics and peer relationships, even within a three-year range. This limitation in not fully accounting for age-related factors should be addressed in future research. Another potential limitation of this study is that intervention fidelity was based on self-reports from clinicians who rotated between two conditions, which may not accurately reflect inadvertent mixing of intervention approaches. Future research should incorporate observational coding of a subset of sessions by independent study personnel to corroborate fidelity assessments. In addition, changes in neural indices require more frequent sampling of EEG is warranted to parse out directionality of effects. Future work should employ designs to better elucidate what specific activities of SDARI may be responsible for their effects. The findings of the study also provide avenues for considering potential moderators of the intervention outcome to better understand for whom and under what conditions to maximize benefit from treatment.

The present study expands the GSSI literature by providing one of the first single-blind randomized attention-controlled trials of a GSSI for autistic youth, and the first to utilize a tightly-matched active control condition as well as control for *perceived* condition by informants. Using standardized observational, electrophysiological, parent-report, and sociometric measures, along with rigorously controlled active attention control design, the current study provides evidence for SDARI-specific effects that are not attributable to non-specific supportive elements. Results demonstrate specific effects on neural indices of social processing, sociometrics, and observed-rated social behavior, and demonstrate the utility of objective markers of treatment response. However, our findings also suggest that outcomes such as spontaneous peer interactions and reciprocal friendships may be accomplished – albeit more slowly – without SDARI activities in a supported group setting. Finally, our results raise caution regarding the use of parent-report as the sole outcome marker in treatment research without accounting for expectation effects. In sum, our results provide clear directions for future work in research and implementation of GSIs for autistic youth.

Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on a reasonable request.

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Author contributions

M.D.L. acquired funding for the study and supervised the study. E.K., T.E.R., and M.D.L. designed the study. E.K., T.E.R., C.M.K., A.H.G., and M.D.L. collected data. E.K. and M.D.L. analyzed the results. All authors wrote the manuscript text and E.K. prepared the figures and A.H.G. prepared the table. E.K. revised the manuscript based on reviewer feedback, and A.H.G. and M.D.L. provided input and edits. All authors reviewed and approved the manuscript.

Declarations

Competing interests

The authors declare no competing interests.

Additional information

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