

ORIGINAL ARTICLE

Improving social functioning and challenging behaviors in adolescents with ASD and significant ID: A randomized pilot feasibility trial of reciprocal imitation training in a residential setting

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ABSTRACT

There is a lack of effective social interventions for youths with ASD and co-morbid intellectual disability (ID). A previous single-case design study indicated that reciprocal imitation training (RIT) may improve social interaction and challenging behavior in this population. The current pilot study examined the feasibility of conducting an RCT to investigate the effectiveness of RIT for improving social functioning and challenging behaviors in 20 adolescents with ASD and severe ID in a residential program. The assessment protocol was feasible. RIT was well-tolerated by the adolescents and implemented with fidelity by teaching staff. Preliminary findings indicate that treatment had moderate to large effects on social functioning and challenging behavior, with mixed findings for imitation skills. A larger RCT of RIT for this population is feasible and warranted.

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Introduction

Social impairment is a hallmark feature of autism spectrum disorder (ASD)¹. Deficits in social behaviors emerge by the end of the first year, and are one of the earliest identifiable symptoms of the disorder^{2,3}. Studies examining the course of ASD symptoms over the lifespan suggest that socialization skills often improve less than other adaptive skills, such as daily living skills and communication⁴, and most adolescents and adults with ASD continue to show significant social difficulties⁵.

Individuals with ASD and co-morbid intellectual disability (ID) are at particular risk of social problems^{6,7}, with the greatest social impairment observed in individuals with severe to profound ID⁸. In these individuals, social abilities show little improvement from childhood to adulthood and may actually worsen over time⁸. For example, in a follow-up of the Camberwell cohort, two-thirds of individuals with autism and ID who were observed to be passive in their social interactions during childhood were found to be aloof in adolescence, indicating a decline in sociability⁸.

In adulthood, social abilities are closely related to quality of life^{9,10} and self-determination¹⁰ in individuals' ASD and ID. In the follow-up of the Camberwell cohort in adulthood, the current level of social impairment, particularly being socially aloof, was highly predictive of poor or very poor outcomes as defined by skills, work, residential placement, and caregiver-rated quality of life⁹. In addition, numerous studies have found that social deficits are closely associated with the presence of challenging behavior in individuals with ASD and ID¹¹. The direction of this relationship is unclear¹²; however, there is preliminary evidence that increasing social interaction can lead to improvements in challenging

behavior¹³. This finding suggests that social interventions may have collateral effects on challenging behaviors. Indeed, it has been suggested that social skills training should be an essential ingredient of programs aimed at reducing high intensity challenging behaviors in individuals with severe ID^{12,14}.

These studies highlight the need for strategies to enhance positive social interactions with others in adolescents and adults with ASD and ID. This need is particularly pronounced for individuals who are served in specialized residential programs designed to provide the highest levels of support. The vast majority of these individuals present with extremely challenging behaviors that significantly limit their social interactions¹⁵. Additionally, while residential programs range in the degree of social opportunity, some research suggests that they provide fewer opportunities for social interaction than non-residential settings¹⁶, which may also restrict social behavior over time. Within residential care, individuals with ASD and ID are less likely to engage in positive social behaviors, such as sharing interests, smiling, playing, and communicating using gestures, than their peers with ID only¹⁷. They are also more likely to exhibit extremely challenging behaviors, which are related to the presence of negative social behaviors¹¹ and can further limit their social interactions¹⁵. This suggests that specialized social interventions may be necessary for this population^{17,18}. However, residential staff members often have limited training in specialized treatments for ASD¹⁹. Thus, social interventions that can be implemented in residential settings by community providers are a high priority.

Despite substantial growth in social interventions for younger children with ASD, social interventions for adolescents and adults remain very limited²⁰. Those that have been developed for older individuals have been designed almost

exclusively for individuals without ID or with well-developed verbal skills²¹. A recent comprehensive review of social interventions for adolescents and adults with ASD and severe ID concluded that there are currently no established social interventions for this population²². Thus, there is a strong need for the development and evaluation of social interventions for these individuals.

A developmental perspective suggests that techniques that promote social interaction in younger children with ASD would likely also benefit older individuals who are functioning at a similar developmental level^{22,23}. One early social intervention that may be successful for promoting social interaction in older individuals with ASD and severe ID is *Reciprocal Imitation Training* (RIT)²⁴. RIT is a naturalistic developmental-behavioral intervention that targets social interaction via engagement in extended bouts of reciprocal imitation. Reciprocal or mutual imitation, in which two partners alternate between imitating and being imitated by the other, is a key social process that begins in infancy and is thought to facilitate the development of more advanced social communication skills^{25–27} and positive social interactions²⁸. Mutual imitation that occurs between the infant and caregiver during face-to-face interactions supports the development of self-other representations and social understanding²⁹. In toddlerhood, reciprocal imitation between peers facilitates the development of coordinated social actions³⁰, and being imitated by others increases social liking across development³¹.

Children with ASD, particularly those with ID, have significant deficits in imitation³² and imitation recognition³³. These deficits disrupt their ability to engage in reciprocal imitation and are thought to impair the development of more advanced social interaction skills^{25,27,34}. In addition, deficits in generalized imitation impair the acquisition of new skills via observational learning³⁵. Although the majority of this work has been conducted with young children with ASD, there is also evidence that these behaviors are important for social development among older children with ASD and ID. For example, imitation ability in early adolescence was a strong predictor of social skills five years later in individuals with ASD and severe ID³⁶. RIT targets these skills to help children with autism engage in extended bouts of reciprocal imitation as a means to enhance their social interaction, as well as to build a generalized imitation repertoire.

RIT has been shown to increase spontaneous imitation, joint attention, and social-emotional functioning in 2–4-year-old children with ASD when implemented by providers for 3 hours per week^{37–39}. RIT is simple and easy to learn, and has been successfully taught to parents and school-age siblings of children with ASD^{40,41}, making it ideal for use by community providers in residential programs who have limited specialty training in ASD interventions.

To examine whether RIT could promote social interaction in older individuals with ASD and severe ID, we conducted a single-case design study across four adolescents with ASD and severe to profound ID⁴². Treatment was provided by teachers at a full-time residential program for

adolescents and adults with developmental disabilities. All adolescents demonstrated improvement in their imitation skills in response to 2–6, 20-minute sessions per week of RIT implemented over 10 weeks. Improvements were also noted in joint engagement and self-stimulatory behavior for a subset of the adolescents. Furthermore, naïve observers rated the adolescents as exhibiting more appropriate social behavior and less challenging behavior during late treatment sessions than early treatment sessions. Teachers at the center were able to implement the intervention with fidelity, and rated the intervention as highly acceptable, indicating that RIT can be feasibly implemented by staff in a residential treatment setting.

These data suggest that RIT is a promising approach for targeting social functioning in adolescents with ASD and severe ID, and support the further investigation using a “gold standard” treatment design and standardized outcome measures. Pilot studies, in which the feasibility of key study components is evaluated, enhance the likelihood of success of randomized controlled trials (RCTs)^{43,44}. Thus, the goal of this pilot study was to evaluate the feasibility of conducting an RCT of RIT in adolescents with ASD and severe ID living in a residential program.

Primary outcomes included metrics of: (1) the feasibility of the assessment protocol, including a preliminary analysis of the psychometric properties of two imitation assessments when used with adolescents¹; and (2) the feasibility of the intervention protocol, including adolescent treatment participation and fidelity of implementation of the treatment by teachers. Secondary outcomes included a preliminary analysis of the effect of RIT on social functioning, challenging behaviors, and imitation.

Method

Participants

Twenty adolescents with ASD and severe ID between 12 and 20 years enrolled in the study. One adolescent in the control group discontinued participation due to escalating aggression toward staff. Adolescents were diagnosed with ASD and ID prior to study enrollment by the staff psychologist using DSM-IV-TR criteria, the *Autism Diagnostic Observation Schedule-Generic* (ADOS-G)⁴⁵, and standardized assessments of intellectual and adaptive functioning (see Table 1 for participant characteristics). All but one adolescent had adaptive skills that were consistent with a DSM-5 severity level of “severe”, with the final adolescent having adaptive skills consistent with a moderate level of ID severity. Adolescents varied in their level of functional communication. Two adolescents communicated using simple sentences, four communicated using phrases or single words, and the remaining adolescents were nonverbal and used augmentative communication (e.g., picture exchange communication system (PECS), Proloquo2go). All adolescents needed ongoing support in their self-care and vocational tasks. All adolescents had

¹Although several imitation assessments have been developed for young children with ASD and/or ID [52,61,62], none have been examined with older individuals with ASD and severe ID.

Table 1. Descriptive data for treatment and control groups at pre- and post-treatment.

	Treatment		Control	
	Pre (n = 10) M (SD)	Post (n = 10) M (SD)	Pre (n = 9) M (SD)	Post (n = 9) M (SD)
Gender	9 males, 1 female		7 males, 2 females	
Ethnicity	9 majority, 1 minority		7 majority, 2 minority	
Chronological Age	16.26 (3.15)		16.90 (2.53)	
IQ ^a	48.50 (13.42)		47.43 (8.48)	
Adaptive Behavior Composite ^b	43.70 (9.50)		40.88 (6.92)	
Autism Severity ^c	18.67 (1.66)		18.75 (3.69)	
MESSIER	148.80 (21.11)	157.80 (19.01)	136.11 (13.77)	138.11 (19.21)
ABC-R	48.50 (23.01)	37.50 (17.17)	48.89 (18.49)	56.11 (21.94)
UIA	26.42 (23.95)	39.31 (33.11)	22.32 (21.14)	24.59 (23.53)
MIS ^d	69.66 (30.48)	71.68 (34.61)	49.69 (29.86)	54.09 (33.53)

^aWAIS-IV, Binet-5, Leiter-R, CTONI-2; Untestable = 2 Control Group, 1 Treatment Group; Missing data = 1 Control Group.

^bVineland Adaptive Behavior Scales; Missing data = 1 Control Group.

^cADOS-G (Social + Communication); Missing data = 1 Control Group, 1 Treatment Group.

^dUntestable = 1 Control Group, 1 Treatment Group.

a history of significant aggression and/or other challenging behavior that prevented them from being cared for in the family home, and a number of the adolescents had additional medical complications (e.g., seizure disorder, health concerns related to obesity, gastrointestinal problems). Thus, adolescents were on one or more psychotropic and/or seizure medications throughout their participation in the study. In addition, each student was on a positive behavior support plan and participated in a vigorous exercise program to address challenging behavior.

Residential program

All adolescents were full-time residents at an approved Residential/School program for children and adults with complex and multiple disabilities. Students receive classroom-based instruction from 9:00–2:15, with a staffing ratio of 6.1 students to 3.5 staff members. The classroom curriculum is developmental and functionally based, and includes the use of direct instruction, naturalistic teaching strategies, daily schedules and environmental organization strategies, functional communication training, story-based interventions, and self-regulation strategies. Outside of the classroom, students participate in farm-based pre-vocational and vocational tasks and a moderate/vigorous exercise program involving various adaptive physical education and vocational activities aimed at producing sustained elevated heart for a minimum of two, 30-minute periods per day. Students live in 6-person residential units where they receive support in self-care and household chores. The program includes support from psychiatry, gastroenterology, nutrition, special education, psychology, behavior analysis, adaptive physical education, physical therapy, occupational therapy, and speech therapy. Students who engage

in aggressive or highly inappropriate behaviors are on individual positive behavior support plans designed by the staff psychologist and implemented regularly throughout the day. PBS plans use a function-based approach and often target communication as part of the plan. All staff members who interact with the residents receive ongoing training in evidence-based practices and the program's individualized curriculum.

Design and procedure

Adolescents were enrolled in two cohorts of 10. Cohorts were selected based on the location of the students' housing units such that members of each cohort were living and receiving instruction in the same part of the campus. The protocol was implemented with one cohort at a time to facilitate data collection. Measures of IQ, adaptive functioning, and autism symptomatology (ADOS) were obtained from record review. Outcome measures were administered over several weeks at pre-treatment for each cohort. After pre-treatment assessment, adolescents were stratified by age and adaptive skills within a cohort and then randomly assigned to the treatment or control group. Adolescents in the treatment group received, on average, two, 10-minute sessions of RIT per day, 3 days per week for five months and adolescents in the control group received an equivalent number of one-to-one treatment sessions targeting current instructional goals. Post-treatment assessment was conducted over several weeks following treatment completion to examine the effect of treatment on social functioning, challenging behaviors, and imitation.

Outcome measures

Social skills

The staff psychologist interviewed a direct care staff member who worked closely with each student using the *Matson Evaluation of Social Skills for Individuals with Severe Retardation* (MESSIER)⁴⁶. Both the staff psychologist and direct care providers were kept blind to the adolescents' group assignment. The MESSIER is an 85-item rating scale designed to assess strengths and weaknesses in social skills in individuals with severe to profound ID. The MESSIER has strong reliability and validity and is effective for monitoring treatment response in adolescents and adults with ASD and severe ID⁴⁶. The MESSIER has items that measure positive and negative skills which resolve into 6 factors. Sample items include: (1) turns head in the direction of the caregiver; (2) smiles in response to positive statements; (3) likes to hold hands with others; (4) prefers to be alone; and (5) disrupts activities of others. To create an overall measure of social functioning, the negative items were reversed scored, and all items were summed, with higher scores indicative of better social functioning (more positive skills and fewer negative skills)⁴⁷.

Challenging behavior

The *Aberrant Behaviour Checklist-Residential* (ABC-R)⁴⁸ was completed by the staff psychologist for each student. The staff

psychologist was kept blind to group assignment. The ABC-R is a symptom checklist for assessing problem behaviors of children and adults with ID ages 6–54 who live in a residential facility. Extensive psychometric assessment of the ABC-R has indicated that the ABC-R has good reliability and validity and is effective for monitoring treatment response in children and adults with severe ID, including those with ASD⁴⁹. The summary score was used as a measure of challenging behaviors⁵⁰.

Imitation skills

Two imitation assessments originally designed for use with young children with ASD were administered by the adolescents' teacher (cohort 1) or the staff supervisor (cohort 2). The *Unstructured Imitation Assessment* (UIA)⁵¹ assesses spontaneous imitation of actions with objects and gestures in an unstructured, free-play setting. It includes 10 object and 10 gesture imitation tasks. Three trials of each task are presented without explicit instruction to imitate, and periods of contingent imitation by the examiner are conducted between tasks. In this way, it resembles RIT. However, no prompting or reinforcement for correct responding is provided. The *Motor Imitation Scale* (MIS)⁵² assesses imitation in a structured, elicited context. It includes eight object and eight gesture imitation tasks. Three trials of each task are presented, with explicit instruction to imitate for each (e.g., "You do it").

For both measures, responses are scored on a 3-point scale: a "2" is recorded for exact imitation, a "1" for an emerging response, and a "0" is recorded for no imitation, and the best response for each trial is recorded. The total scores were converted to a percent of maximum possible score by dividing the adolescent's total score by the highest possible score that could be obtained for the tasks that were administered. Reliability was calculated by two independent observers on 33% of adolescents. Cohen's Kappa collapsed across items and participants was 0.79 for the UIA and 0.76 for the MIS.

Group assignment

Adolescents in each cohort were stratified by age (early adolescence: 12–15 years; late adolescence: 16–20 years) and paired with another member in the same age category based on adaptive functioning on the *Vineland Adaptive Behavior Scales, 2nd Edition*⁵³. One member from each pair was randomly assigned to the treatment or control group by a coin flip. Adolescents continued to receive their existing educational programming, behavior plans, and medication management.

Treatment group

The treatment group received 1:1 instruction in RIT. Intervention was conducted in a secluded environment (e.g., empty classroom, lounge) with just the student and therapist present. Five pairs of play/leisure materials were used in each session. Materials were selected based on the students' preferences and could include toys (e.g., slinkies, koosh balls, action figures), sport equipment, musical instruments, or art materials. Materials were varied across sessions

so that each adolescent was exposed to a variety of high interest materials.

RIT uses several naturalistic techniques to teach imitation skills. To promote imitation recognition and reciprocity, the teacher contingently imitated the adolescent's verbal and non-verbal behavior, described the adolescent's actions using simplified language, and expanded the adolescent's utterances. To teach imitation, the teacher modeled an action paired with a verbal marker, once a minute on average, with the duplicate of the object the adolescent was currently attending to or a gesture related to the adolescent's play. The verbal marker described the action (e.g., "Vroom, vroom" while pushing a car), but did not give explicit instruction to imitate or complete the action. Actions were modeled up to three times. If the adolescent did not imitate the action within 10 seconds of the third model, the teacher physically guided the adolescent to complete the action. The teacher praised the adolescent for imitation and returned to using contingent imitation and describing the adolescent's actions. The majority of sessions were conducted during play/leisure activities. A portion of each adolescent's sessions were conducted during functional routines (e.g., folding laundry, setting the table, putting away dishes). When implemented during functional routines, the teacher used the imitation training procedure to present each step in the functional chore (e.g., if the student was setting the table, the teacher would model putting the plate on the table with a verbal marker up to three times, followed by physical guidance if necessary). When appropriate for the task, the teacher would also imitate the students' behavior and described the student's actions (e.g., if the student was folding laundry, the teacher would fold similar clothes at the same time). Inappropriate behaviors during session were minimal and were addressed using redirection.

Control group

The control group received a similar number of sessions of 1:1 instruction on seated academic tasks identified in their individualized treatment plan. Academic tasks typically involved direct instruction in academic concepts (e.g., counting, sorting) that could support the functional farming activities that were part of the student's program (e.g., collecting eggs, picking fruit). Instruction typically used pictures or other visual stimuli and focused on 1:1 correspondence, matching, sorting, pre-reading, and number recognition, depending on the student's individual goals. Although instruction did not use specific prompt-fading procedures or explicit teaching sequences, the students were required to respond often, and received high rates of reinforcement. When the individualized treatment plan lacked a supplementary academic lesson for that week, control group adolescents engaged in structured games with a staff member (e.g., Uno, Connect 4). All treatment sessions were conducted in a secluded environment (e.g., empty classroom, lounge). Inappropriate behaviors during session were minimal and were addressed using redirection.

Teacher training

Treatment was provided by 8 teacher support staff at the residential program. These teachers did not provide direct

instruction or supervision to the students outside of treatment sessions, although they were present at the facility and frequently ran into the students on campus. Teachers conducted treatment sessions for both groups, with each teacher working with 2–5 adolescents. Each teacher had a bachelor's degree in an education-related field and had received training in therapeutic approaches while employed at the center. All teachers were female and had worked at the facility for a minimum of 5 years. Training and supervision in RIT was provided onsite by the third author who was a supervisor at the center and had previously established fidelity in RIT. Initial training in RIT lasted two weeks and consisted of a didactic session covering the goals and procedures of RIT and review and discussion of videos of RIT sessions with young children and the four adolescents who participated in the Ingersoll et al. (2013) study. Following this initial training, teachers participated in daily role plays with each other, while receiving feedback on their use of the RIT strategies from the third author until they met fidelity on the RIT fidelity checklist⁵⁴. All teachers met fidelity during role plays prior to beginning work with study participants. The first and second authors in consultation with the third author provided feedback to the teachers during their initial implementation of the intervention with study participants based on video recordings of intervention sessions until they met fidelity on the RIT fidelity checklist.

Fidelity of implementation

After teachers met fidelity of implementation for both conditions, six subsequent treatment sessions for each participant were randomly selected and scored by the research staff for fidelity. RIT sessions were scored using the RIT fidelity checklist. Control group sessions were scored using a study checklist that included 1:1 interaction, working on a task, task-related materials present, adult makes bid to student at least every 1–2 minutes, adult does not imitate actions/movements, and adult does not imitate vocalizations. Interrater reliability for the fidelity checklists was calculated on 33% of these sessions using intraclass correlation coefficients (ICCs). ICCs were .96 and .82 for fidelity of the RIT sessions and control sessions respectively.

Social validity

Teachers were asked to describe their experience using RIT with the students with whom they worked using an open-ended questionnaire developed for this study. Of specific interest were comments indicating perceived changes in imitation, socialization, or challenging behavior in participants' day-to-day behavior. Specific probes included: (1) Did you notice any changes in the child(ren) you worked with then you saw them outside of the RIT sessions? If yes, please give specific examples of what you noticed changed. (2) Did other employees working with the children who received RIT make comments to you about changes they noticed in the child? If so, please give specific example of what they reported changed. Teachers were also asked to discuss challenges with the

implementation of RIT or the research protocol with the research team throughout the study.

Results

Feasibility of the assessment protocol

The assessment protocol called for all outcome measures to be administered by a blinded staff member familiar with the adolescents. While this was feasible for the informant-report measures (MESSIER and ABC-R), it was not feasible for the observational assessments (UIA and MIS) due to competing staff demands. Thus, the imitation measures for cohort 1 were administered by the teachers who worked with the adolescents and, for cohort 2, the third author who was a staff supervisor at the center and was not blind to group assignment.

A preliminary analysis of the imitation measures was conducted to assess their feasibility as measures of imitation in this population. During pre-testing with the first few adolescents it was found that longer administration periods (>10 minutes) were associated with significant agitation. Thus, the number of trials for each task of the UIA and MIS was reduced from 3 to 2 and the amount of contingent imitation between tasks on the UIA was reduced to decrease the overall length of administration. Even with these modifications, administration was somewhat challenging, particularly for the MIS. Two adolescents (1 treatment, 1 control) were not administered the MIS at one time point due to non-compliance with testing. For a number of adolescents, one or more trials or tasks were not administered on the UIA (1 treatment, 2 control) or MIS (7 treatment, 4 control) at pre- or post-testing due to increasing agitation that required administration to be cut short. If a trial or task was not administered at one time point, the same trial or task from the opposite time point was removed from analysis to ensure that the pre- and post-administrations were comparable for each adolescent.

Cronbach's alphas for each measure were .89 (pre) and .94 (post) for the UIA and .95 (pre) and .94 (post) for the MIS, suggesting excellent internal reliability for both measures. Pearson's r correlations between pre- and post-assessments were .85 for the UIA and .86 for the MIS, both p s < .001, suggesting consistency over time. We examined the correlation between the imitation measures and the other outcome measures to evaluate convergent and discriminant validity. We hypothesized that the imitation measures would be positively correlated with each other and with the MESSIER, a measure of social skills, but not necessarily related to the ABC-R, a measure of challenging behavior. As expected, the adolescents' performance on the UIA and MIS were positively correlated, $r(19) = .72$, $p < .001$, and both imitation measures were positively correlated with the MESSIER (UIA: $r(19) = .53$, $p < .05$; MIS: $r(19) = .56$, $p < .05$). Neither imitation measure was correlated with the ABC-R (UIA: $r(19) = -.21$, $n.s.$; MIS: $r(19) = .01$, $n.s.$). These preliminary analyses suggest that the basic psychometric properties of the UIA and MIS are upheld in this population, although the lack of blinded administration is a shortcoming. These data indicate that these measures are appropriate for assessing imitation skills in adolescents with

ASD and severe ID, but may require additional modifications to increase compliance with testing.

Feasibility of the intervention protocol

The original intervention protocol called for 20-minute sessions, 5 days per week. Prior to beginning treatment, this protocol was modified based on feedback from teachers that it was not feasible given the structure of the program. Residents were treated almost exclusively in group settings and were unfamiliar with sustained one-on-one interactions with staff. Thus, teachers reported concerns about the adolescents becoming agitated and/or aggressive if sessions were a full 20 minutes. In addition, teachers indicated that 5 days per week of implementation was not feasible given student home visits and other staff responsibilities. Thus, the protocol was modified so that each adolescent received 2, 10-minute sessions per day, 2–3 days per week. Staff indicated that the modified protocol was feasible and it was implemented as intended excluding times when the adolescents were ill or on a home visit. However, inconsistent tracking of completed sessions prevented an examination of the exact number or length of sessions that each adolescent received, as well as the specific number of sessions that involved academic tasks vs. structured games for the control group.

Nineteen of 20 adolescents completed the intervention protocol. One adolescent in the control group was withdrawn from the study after several weeks due to escalating aggression toward staff members. RIT was well-tolerated by the adolescents in the treatment group, with the exception of one adolescent. This young man would often tell the teacher that he wanted to be finished with the session (at which point the session was terminated), suggesting that he found the intervention unpleasant.

Average teacher fidelity ratings were 91.21% (range: 90.37–100%) for the RIT group and 95.78% (range: 90.37–100%) for the control group. These data indicate that the teachers were able to implement the intervention protocols with fidelity. However, several teachers did not consistently meet fidelity in RIT until a few weeks into treatment.

Preliminary outcomes

Analytic strategy

Data were examined for normality. All continuous data, with the exception of the MIS and UIA, were normally distributed. Parametric tests were used when data were normally distributed and the equivalent non-parametric tests were used when data were not normally distributed; chi square tests were used for categorical data. First, we examined whether there were differences between groups on any of the developmental and demographic characteristics or the outcomes measures at pre-treatment using independent t-tests, Mann Whitney U tests, and chi square tests as appropriate. Next, we used independent t-tests (MESSIER, ABC-R) and Mann Whitney U tests (MIS, UIA) to analyze group differences on the outcome measures at post-treatment. Finally, we examined whether either group made significant change from pre- to post-treatment on the outcome measures using paired

sampling t-tests (MESSIER, ABC-R) and Wilcoxon signed rank tests (MIS, UIA). Given that this study was not powered to detect statistically significant group differences, effect sizes (Cohen's d) are presented and interpreted, and all findings should be considered preliminary. For Cohen's d , an effect size of .20 is considered small, .50 is considered moderate, and .80 and above is considered large.

Pre-treatment characteristics

Participant pre-treatment characteristics are presented in Table 1. There were no statistically significant differences at pre-treatment between groups on any of the demographic, developmental, or outcome variables (see Table 2). Effect sizes for the outcome measures at pre-treatment were calculated by group. There was no effect of group on the ABC-R ($d = .02$) or the UIA ($d = .18$); however, there was a moderate effect of group on the MESSIER ($d = .60$) and the MIS ($d = .66$); both of which were higher in the treatment group.

Group differences at post-treatment

At post-treatment, the treatment group was rated as exhibiting statistically significantly better social functioning on the MESSIER than the control group, $t(17) = 2.24, p = .04$. The effect size for the MESSIER was $d = 1.03$, indicating a large effect. The treatment group was also rated as exhibiting marginally statistically significantly less challenging behavior at post-treatment than the control group, $t(17) = -2.07, p = .05$, with a large effect ($d = .95$). There were no significant group differences for the UIA, $t(17) = -1.10, n.s.$, or the MIS, $t(15) = -1.25, n.s.$; however, a moderate effect size favoring the treatment group was found for both (UIA: $d = .51$; MIS: $d = .52$).

Change from pre- to post-treatment by group

The treatment group demonstrated statistically significant gains in social functioning on the MESSIER from pre- to post-treatment, $t(9) = -2.40, p = .04$ (see Table 3). The treatment group also demonstrated a marginally statistically significant decrease in challenging behavior on the ABC-R, $t(9) = 2.22, p = .05$ and statistically significant gains in imitation skills on the UIA, $z = -1.96, p = .05$. Effect sizes for the pre-post difference for the treatment group were in the moderate-to-large range for these assessments (MESSIER: $d = .76$; ABC-R: $d = .70$; UIA: $d = .75$). No significant changes were observed on the MIS for the treatment

Table 2. Group differences on demographic, developmental, and outcome measures at pre- and post-treatment.

	Pre		Post	
	Test Statistic	p-Value	Test Statistic	p-Value
Gender ^a	.53	.47		
Ethnicity ^a	.53	.47		
Chronological Age ^b	-.48	.63		
IQ ^b	.18	.86		
Adaptive Behavior ^b	.70	.49		
Autism Severity ^b	-.06	.95		
MESSIER ^b	1.53	.14	2.24	.04
ABC-R ^b	-.04	.97	-2.07	.05
UIA ^c	-.20	.84	-1.10	.27
MIS ^c	-1.49	.14	-1.25	.21

^aChi-square statistic.

^bt-Value.

^cz-Score.

Table 3. Changes on outcome measures from pre- to post-treatment for the treatment and control groups.

	Treatment		Control	
	Test Statistic	p-Value	Test Statistic	p-Value
MESSIER ^a	-2.40	.04	-.46	.66
ABC-R ^a	2.22	.05	-1.18	.27
UIA ^b	-1.96	.05	-.63	.53
MIS ^b	-.25	.80	-.17	.73

^at-Value.^bz-Score.

group, $t(7) = -.25$, *n.s.*. The control group did not demonstrate significant changes on any of the outcome measures from pre- to post-treatment.

Social validity

Teachers described a number of perceived benefits of RIT on the participants' lives at the residential center. In particular, teachers noted increases in their student's social responsiveness (increased initiations, eye contact, awareness of peers) and functional skills (vocational activities, self-care, leisure skills). Teachers also noted their own and their student's general enjoyment of the sessions. Teachers noted some challenges with the use of RIT with specific students, as well as implementation of some aspects of the research protocol, particularly as it related to recording sessions. See Table 4.

Table 4. Teachers' qualitative comments about RIT.

Perceived Benefits of RIT
<i>Sociability</i>
[Student] definitely initiated with me more whenever he saw me during the day, and the staff at his residence reported that he always returned in a good mood from our sessions.
I didn't see the student outside of RIT often but when I did, he would come up to me and look me in the eye. When I said hi to him he would imitate the "h" sound.
... both children treated with RIT would go out of their way to greet me on a pathway and in communal areas! I also observed one of the children during lunchtime at school and he was significantly more aware of his peers around him.
RIT was great for [Student]. It was so much fun to work with him, and he seemed to love coming to his sessions.
<i>Challenging Behavior</i>
The residential staff said he was easier to work with for the rest of the day. We have seen a reduction in behaviors.
<i>Functional Skills</i>
We really worked on setting the table as our functional routine. By the end of RIT, he was able to do this with a lot less prompting in his residence (without me being there!).
He also participated in a step by step meal prep with less prompting than usual.
The staff all recognized a change in the child's ability to manipulate a leisure item and increase eye-contact.
Other staff members in the residential house noted that he was making more eye contact as well as imitating movements to complete vocational activities with less prompting.
Perceived Challenges of RIT
I don't think that RIT was the best fit for [Student]. He would often get frustrated by it, and would always want to know how much longer it was going to last. I saw some of the sessions with the other residents, and it seemed to go more smoothly for them.
[Student] was difficult to work with because of aggressive behaviors related to OCD. This made RIT more difficult, because the imitation made him head butt. But [Student] really seemed to like our time together, and would come up to me whenever he saw me during the day.
The intervention itself was easy to learn, but it was hard to videotape the sessions.

Discussion

The pilot data support the feasibility of conducting an RCT to evaluate the effectiveness of RIT with adolescents with ASD and significant ID in a residential setting, and provide preliminary support for the positive impact of the intervention on social functioning and challenging behavior. Both the assessment and intervention protocols were feasible, although a number of modifications to the original protocols had to be made in order for the study to be implemented in a community setting with this highly impacted population.

The pilot data suggest that the UIA and MIS were appropriate for use with adolescents with ASD and severe ID, with adequate internal consistency, consistency over time, and convergent and discriminate validity, and thus are appropriate for measuring these skills in this population. At the same, administration was much more challenging; it was necessary to reduce number of trials for each task, and for some adolescents, administration needed to be discontinued early due to agitation. Similar negative behaviors have been observed during administration with younger children as well. However, given that adolescents are much larger and more powerful than young children, concerns about aggression during testing for this population are greater. Thus, it appears that these assessments may need some additional modifications in their administration, particularly if they are to be administered by community providers. Possible modifications might include fewer trials and tasks, administration across several days, embedding the imitation tasks in on-going activities, and a dense schedule of reinforcement contingent on participation but not performance.

In order to be feasible, the original intervention protocol had to be modified in terms of the frequency and length of sessions. Without these modifications, we would not have been able to achieve buy in from the staff. These modifications reflect the challenges of providing one-to-one intervention to significantly affected adolescents in a community-based program, and it is clear that, without them, the study could not have been successfully carried out. The final protocol was considered feasible by program staff, making it likely to be transportable to other residential programs with similar staffing structures. At the same time, the modifications resulted in a substantially lower dose of intervention than in previous RIT studies with young children with ASD (1 h per week vs. 3 h per week), and even than in the original single-case study of RIT in adolescents with severe ID. It is not yet clear what the optimal dosage of RIT is for improving social outcomes for children or adolescents, or whether there is a minimum dosage below which RIT is no longer efficacious. Thus, the feasibility of implementation by community programs must be considered alongside information on optimal or necessary intensity. To this end, future studies should examine dosage-response curves for various outcome measures.

The overall participant retention to the treatment protocol was high, with only one adolescent (in the control group) having to discontinue due to significant aggression. The participants in the RIT group tolerated the intervention well, with the exception of one adolescent. This adolescent was the highest functioning participant in the study. He had an ID in the moderate range and functional language abilities. Additionally, his imitation skills at pre-treatment were adequately developed (UIA = .60; MIS = .88).

In contrast, the adolescents with the lowest cognitive abilities appeared to find the intervention the most enjoyable, with several of them actively seeking out their teacher for interaction once the intervention had begun. This observation suggests that RIT may be most appropriate for those adolescents who are most developmentally similar to the young children for whom it was originally designed. Additional research that can determine the optimal developmental age for individuals to benefit from RIT would be important.

Teachers were able to implement RIT with fidelity, although several did not consistently meet fidelity until a few weeks into treatment. Unlike our previous studies of RIT, initial training of the teachers was provided by the staff supervisor at the center (who had met fidelity herself during a previous training) rather than by the intervention developer. This is a limitation of this study, and suggests that a more structured training protocol may be necessary to help residential staff implement RIT with fidelity in a timely manner.

The outcome data suggest that there was a large effect of treatment on the adolescents' social functioning. Adolescents in the treatment group demonstrated significant improvement on blinded ratings of their social skills from pre- to post-treatment, while adolescents in the control group showed no improvement in social skills over the course of the study, despite receiving a similar number of 1:1 sessions with a teacher. The lack of improvement in social skills for the control group is consistent with previous findings indicating little natural improvement in social skills over time in individuals with ASD and severe ID⁸, and suggests that specific intervention strategies, rather than time in interaction with others, may be necessary for improving social functioning in this population.

There was also a large effect of treatment on challenging behaviors, with the adolescents in the treatment group demonstrating decreases in challenging behaviors from pre- to post-treatment, and the control group demonstrating non-significant increases. Decreases in one type of challenging behavior (stereotypy) were also observed in our previous single-case study, providing additional support for the ability of RIT to improve these behaviors in adolescents with ASD and severe ID. Although the mechanism of effect is not yet clear, it is hypothesized that RIT reduces challenging behavior by either promoting increased social interaction with others or increased engagement with play materials. Research that can examine exactly how RIT impacts challenging behaviors in this population would be very informative.

The findings regarding the effect of the treatment on imitation skills were mixed, but promising. The treatment group demonstrated a significant increase in their imitation skills on the UIA from pre- to post-treatment, suggesting a positive effect of RIT on spontaneous imitation. However, group differences were not significant at post-treatment; thus these results must be interpreted cautiously. In contrast, there was no effect of treatment on imitation performance on the MIS. RIT directly targets reciprocal imitation. The UIA measures spontaneous imitation within a similar context, while the MIS measures elicited imitation in a more structured context. Thus the fact that improvements in the treatment group were observed on the UIA, but not the MIS might suggest that the adolescents were able to generalize their skills to a highly similar context, but not a more dissimilar context. Pre-treatment UIA scores were significantly lower than MIS scores,

and several of the adolescents in the treatment group were near ceiling on the MIS at pre-treatment. Thus, an alternative explanation is that there was more room for improvement on the UIA than the MIS. Given the limitations of the imitation data as well as the fact that the assessments were administered by staff members who were not blind to the students' group assignment, further research is needed prior to concluding that RIT can improve imitation skills in adolescents with ASD and severe ID. Future research should also examine the extent to which improvement in social functioning and/or challenging behaviors are mediated by changes in imitation, a proposed mechanism of action of RIT⁵⁵.

Teachers were asked to discuss their experience using RIT with their student(s). Teachers described a number of positive changes in the students' day-to-day lives that they attributed to RIT. In particular, they gave examples of their student making social initiations to them outside of RIT sessions, as well as requiring less prompting to complete functional tasks in their residence and vocational settings. Several teachers reported that other staff noticed these positive changes as well. These qualitative data provide some support for the clinical significance of the findings by demonstrating perceived improvements in socialization in the students' day-to-day lives. Teachers also indicated that they used RIT with other residents who were not in the study, suggesting the potential for sustained implementation. At the same time, teachers reported challenges using RIT with specific students, underscoring the fact that RIT may not be appropriate for students with higher cognitive levels. They also indicated challenges with data collection (e.g., recording sessions). These qualitative data were helpful in developing a preliminary understanding of the social validity of the intervention⁵⁶. However, they were limited in scope. Future research should include quantitative teacher ratings of treatment acceptability, such as the Treatment Acceptability Rating Form-Revised (TARF-R)⁵⁷. It would also be important to include formal assessment of treatment acceptability from the students. This could be done through the application of the concurrent-chains procedure or other choice measures or observation of student affect during intervention⁵⁸.

There are several limitations to this pilot study that must be acknowledged. First, we did not control for the use of multiple t-tests, and there were pre-treatment differences on some of the outcome measures that, although not significantly different, may have influenced the results. Given the pilot nature of the study, we were not powered to detect significant differences, and thus did not use a more conservative approach such as analysis of covariance. Second, we used composite scores for the MESSIER and ABC-R as our primary outcome measures in the analyses. Given the small sample size, we felt that this was a more conservative approach, although we acknowledge that these measures are designed to be analyzed at the level of the individual subscales⁵⁹. In addition, although we observed moderate to large effect sizes for some of our outcome variables, we acknowledge the interpretation of effect sizes in small samples can be problematic⁶⁰. Taken together, our findings regarding the effect of RIT on student outcomes should be interpreted very cautiously. Future research that includes an appropriately powered sample size, more conservative statistical analyses, and the use of individual subscales of the MESSIER and ABC-R is needed to confirm these preliminary findings.

Second, although both groups received a similar number of 1:1 treatment sessions, the RIT sessions were typically longer. This occurred because control group sessions ended when the academic tasks were complete, while the RIT sessions ended after roughly 10 minutes. In future work, greater care will need to be given to the development of a control condition that is better matched for length, but that remains ecologically valid (i.e., approximates what students would be exposed to naturally in their program). In addition, although the intervention protocol was feasible for staff at the residential center, it was challenging for staff to implement some aspects of the research protocol (e.g., recording all sessions). This was due primarily to competing demands for staff time. For this reason, future research on RIT and other interventions conducted in a residential setting would strongly benefit from having a fulltime research associate on staff at the program.

Finally, our qualitative data suggest that the teachers who implemented RIT perceived that it resulted in improvements in the students' social and functional skills, and challenging behavior that were present in their daily lives. However, we did not have direct observations of generalization of these behaviors in other environments. We originally planned to videotape the students in their residences to assess for generalization. However, we were unable to do so since we did not have permission for other students to appear on camera. Given this constraint, future research could use semi-structured role plays of daily routines with small groups of study participants and their direct care staff.

In summary, this pilot study supports the feasibility of implementing an RCT of RIT within a residential program for adolescents with ASD and severe ID, and finds preliminary support for benefits of the intervention on social functioning and challenging behavior. These data suggest that a fully powered RCT with a longer follow-up period is warranted. If successful, it would provide a much needed social intervention for older individuals with ASD and severe ID, and would support the extension of similar naturalistic developmental-behavioral interventions for young children with ASD to this population.

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Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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