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Journal article

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Journal of Autism and Developmental Disorders

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Manuscript Number:	JADD-D-20-00326R3
Full Title:	Can I learn to play? Randomized Control Trial to assess effectiveness of a peer-mediated intervention to improve play in children with Autism Spectrum Disorder
Article Type:	Article
Keywords:	Autism; Play; Intervention; video modeling
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Funding Information:	
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Response to Reviewers:	Thank you for your comments and additional review. We have amended as recommended to the manuscript and responded in more detail to each of the comments in the attached supplementary material table.

Can I learn to play? Randomized Control Trial to assess effectiveness of a peer-mediated intervention to improve play in children with Autism Spectrum Disorder

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Can I learn to play? Randomized Control Trial to Assess Effectiveness of a Peer-Mediated
Intervention to Improve Play in Children with Autism Spectrum Disorder

Abstract

Play is often used in interventions to improve social outcomes for children with Autism Spectrum Disorders (ASD). Play is a primary occupation of childhood and, therefore, an important outcome of intervention. The Ultimate Guide to Play, Language and Friendship (PLF) is a peer-mediated intervention for 6- to 11-year-old children with ASD. A total of 68 dyads were randomized to either a 10-week treatment first or waitlist control group. Results revealed a significant moderate intervention effect from pre- to post-intervention, which was maintained to the 3-month follow-up clinic session and generalized to the home environment. The findings support that the PLF intervention can be used to positively improve play in 6- to 11-year-old children with ASD.

Keywords: autism, play, intervention, video modeling

Introduction

Play is essential for social development and the primary occupation of childhood (Smith, 1980). Play is frequently used as a medium to deliver intervention to improve other developmental areas such as social skills and language; however, play as an independent outcome is often neglected and not reported (Smith, 1980). Children with ASD have difficulty playing with peers (MacDonald et al., 2009) and are frequently observed to have fixed interests, concrete and repetitive behaviours, reduced symbolic quality, lack of flexibility and impaired social skills that impact their play (MacDonald et al., 2009).

Social play interactions become more complex across middle childhood (between 6 to 12 years of age) as children develop their language skills and individual interests (Del Giudice, 2014). Difficulty with peer social play in middle childhood influences other areas of life, including reduced engagement in school activities, difficulties developing and maintaining friendships and developing social anxiety. This can lead to social withdrawal, isolation and feelings of loneliness (Zeedyk, Cohen, Eisenhower, & Blacher, 2016). As a result, both girls and boys with ASD have higher rates of social exclusion in middle childhood than younger children with ASD or their typically developing (TD) same-aged peers (Dean et al., 2014). While TD boys tend to play organized games and girls maintain joint engagement, moving fluidly from one activity to another, boys with ASD tend to play alone and girls with ASD tend to maintain close proximity to peers but remove themselves periodically from the game (Dean et al., 2017; Dean et al., 2014).

Given the importance and benefits of play in middle childhood, interventions need to target social play and peer interactions to meet the demands of the increasingly complex contexts and skills required for successful engagement (Del Giudice, 2014). Interventions to improve play outcomes for children with ASD have been developed with a variety of different

approaches, including social stories, coaching of the child with ASD, teacher training and parent education and demonstrated, on average, a small effect size [REDACTED]

Previous play interventions for children with ASD have focused on lower level social skills outcomes, such as joint attention or initiating interactions with peers (Bass & Mulick, 2007; Kasari et al., 2006). Although these outcomes are important enablers of play, they do not represent the complexity of sustained play performance with a peer. Furthermore, the majority of these play interventions are for younger children and require significant intervention hours common in early intervention but difficult to engage in during middle childhood while also attending school (Kasari et al., 2015; [REDACTED]). [REDACTED] specifically recommended The Ultimate Guide to Play, Language and Friendship (PLF) - a play intervention with demonstrated moderate effectiveness for children with Attention Deficit Hyperactivity Disorder (ADHD) - be investigated with children with ASD. Children with ASD and children with ADHD share some commonalities in their play difficulties, specifically, difficulty playing with peers, interpersonal empathy and antisocial behaviours ([REDACTED]; MacDonald et al., 2009). However, despite those commonalities there are distinct differences: Children with ADHD are more likely to experience high levels of peer rejection because of their negative behaviors. By contrast, children with ASD are less likely to display prosocial behaviors and therefore appear as if they do not care about social interactions (Mikami, Miller, & Lerner, 2019). Due to these differences, it is not known if the PLF would be an effective intervention for children with ASD.

The PLF is a complex psychosocial intervention that includes upskilling the child with ASD through peer-modeling, video-modeling and both clinic and home components. The adaptation of the intervention approach for children with ASD is supported in literature as video-modeling and peer-modeling have demonstrated effectiveness to improve play for

children with ASD (Corbett et al., 2016; Kasari et al., 2006; [REDACTED]). Video-modeling is a promising intervention technique with emerging evidence for children with ASD (McCoy, Holloway, Healy, Rispoli, & Neely, 2016). A systematic review of video-modeling reported on seven single case study designs for children with high functioning autism demonstrated moderate effect size (median non-overlap of all pairs (NAP): 0.84; McCoy et al., 2016; Parker & Vannest, 2009).

Similarly, use of peers or siblings as agents of the intervention leads to positive skill acquisition for the child with ASD (Chan et al., 2009; Shivers & Plavnick, 2015). Peer-mediated interventions have demonstrated social validity and effectiveness in improving social outcomes for children with ASD (Chan et al., 2009). Chan et al. (2009) reviewed 42 studies, 21 of which required that peers initiate social interaction with the child with ASD and five studies engaged in more robust interventions of pivotal response training. Although the PLF is not based on pivotal response training, the peers are required to engage in a similarly comprehensive role.

Previous reviews have recommended interventions for children with ASD be tested using randomized control trial (RCT) design (Reichow & Volkmar, 2010) and for more robust research to investigate interventions for children with ASD involving play (Tanner, Hand, O'toole, & Lane, 2015). The Medical Research Council of the United Kingdom recommended the development and testing of complex interventions be completed in stages (Campbell et al., 2000; Craig et al., 2008). These stages include testing the intervention components in a feasibility study before conducting an RCT to determine effectiveness of the intervention. In an earlier study completed on the PLF for children with ASD, we confirmed the treatment intensity, recruitment rates and outcome measures were feasible to complete this RCT [REDACTED]. The aim of this RCT was

to examine the effectiveness of the PLF for improving the social play skills of children with ASD in peer-to-peer interactions. Specifically, we asked the following research questions:

1. Was the PLF effective in improving play performance for children with ASD aged 6 to 11 years?
2. Did the intervention effects remain at a 3-month follow-up?
3. Did the intervention effects generalize from the clinic to the home environment?
4. Were there any individual participant or dyad factors that moderated the intervention effects?

Methods

The trial protocol was registered with the Australia New Zealand Clinical Trials Registry (ACTRN12615000008527; Universal Trial Number: U1111-1165-2708). Prior to initiation of the trial, a feasibility study was completed and the necessary sample size of 68 dyads was calculated using a moderate effect size and G*Star Power (Faul et al., 2007). The Consolidated Standards of Reporting Trials (CONSORT) 2010 guidelines for evidence-based reporting of RCTs were used to report this trial (Schulz et al., 2010).

Trial design.

This RCT was a single site, two-group parallel trial. Participants were randomly assigned to an intervention-first or waitlist control-first group. The intervention-first group received the 10-week PLF play-based intervention. The control-first group received no treatment for 10-weeks, after which they returned to the clinic for a post-control assessment and then engaged in the PLF for 10-weeks. Follow-up clinic and home appointments were conducted 3-months following the completion of the PLF for each participant.

This trial was approved [REDACTED] Human Research Ethics Committee (approval number: [REDACTED]) prior to participant recruitment. All informed consent and assent

procedures were approved by the ethics committee. Children provided verbal assent or written consent after the researcher explained their involvement as part of this research. Parents also provided informed written and verbal consent on behalf of their children.

Participants.

Participants were children with ASD (N = 71) who each invited a known, TD peer (see Table 1 for participant demographics). One family enrolled three children with ASD, and one family enrolled two children with ASD. One intervention-first participant dropped out after 8 sessions and two control-first participants dropped out before their post-control wait-list period and assessment was completed due to family illness, reducing the sample size to 68. A further 2 participants did not complete the intervention, bringing the total number who completed the intervention to 66. See Figure 1 for the participant flow diagram.

To be included in the study, children with ASD needed to be between 6 and 12 years with a diagnosis of ASD made by a pediatrician or psychiatrist, using recognised diagnostic procedures such as the American Psychiatric Association's Diagnostic and Statistical Manual 4th edition or 5th edition (American Psychiatric Association, 2013). The diagnostic report was sighted by the treating therapist and they confirmed it did not include a diagnosis of any intellectual disability. Children were included if they presented with common co-morbid conditions (i.e., ADHD, anxiety) and were excluded if they were diagnosed with other major developmental disorders (i.e., intellectual disability) or did not attend mainstream school. Children continued to take any medication prescribed. Participating families did not have outgoing expenses related to participation in the program, excluding travel costs to and from the clinic.

Screening measures.

The Expressive Vocabulary Test, Second Edition (EVT-2; Williams, 2007) and Test for Auditory Comprehension of Language, Fourth Edition (TACL-4; Carrow-Woolfolk, 2014) were individually administered to each child and peer prior to the initial assessment to confirm eligibility to participate in the trial. An EVT-2 standard score ≥ 70 , and a TACL-4 Elaborated Sentences and Phrases scaled score ≥ 4 were required to ensure participants did not have language difficulties that might reduce comprehension of intervention concepts. The EVT-2 is a norm-referenced measure of expressive vocabulary and word retrieval. The EVT-2 has good internal consistency (0.94) and test-retest reliability (0.94-0.97). The TACL-4 is a reliable and valid tool for measuring receptive language ability (coefficient α range between 0.94 and 0.96).

The parent-rated Conners Comprehensive Behavior Rating Scales (CCBRS; Conners, Pitkanen, & Rzepa, 2011) was used as a baseline measure to confirm if children with ASD presented with behavior ratings consistent with ASD at study entry (i.e., scoring above the clinical cut-off on the Autistic or Aspergers disorder subscales, T-scores > 70) and to identify any potential clinically significant characteristics in the peers. The CCBRS is a reliable and valid tool: Cronbach's α 0.67 to 0.97, test—retest reliability coefficient 0.56 to 0.96 ($p < 0.001$), inter-rater reliability coefficients 0.50 to 0.89 ($p < 0.001$), and mean classification accuracy of 78%.

Procedure.

Recruitment.

Participants were recruited using convenience sampling. A recruitment flyer was distributed to therapeutic services and three ASD parent support groups across metropolitan [REDACTED]. The flyer was also distributed through professional networks of the researchers and

the [REDACTED]. Participants were recruited from January 2016 to April 2017 and follow-up data were collected by October 2017. The trial was stopped when 68 dyads had been recruited. Parents of 102 children with ASD contacted the project; 71 of those met the inclusion criteria (see Figure 1). All assessments were booked outside of school hours and clinic sessions were conducted at [REDACTED] Clinic, which were equipped with toys, including a small sand pit, figurines, train set, NerfTM guns, dress-ups, a tent, tunnel, balls and miscellaneous turn-taking games, such as UNOTM cards. Home sessions were conducted at the participants' primary residence. An Occupational Therapist and a Speech Pathologist trained in the intervention and assessments completed all intervention and assessment sessions with the children.

The clinic play assessments involved recording each dyad playing for 15 minutes using two wall-mounted video cameras with motion sensor capabilities (three clinic assessment videos for the intervention first group, four for the control-first group). The home play assessment was recorded by one of the therapists who was familiar to the children, using a handheld camera and toys available in the home. Where possible this was the same therapist that completed the intervention with the children.

Measures.

The Test of Playfulness (ToP [REDACTED]) was the primary outcome measure used to examine the children's play skills in peer interactions in the clinic and home. The ToP is a 28-item instrument, suitable for children aged 6 months to 18 years that requires observational scoring by trained raters. Examples of items include 'is actively engaged – extent', 'engages in social play – skill', and 'supports play of others – skill'. Each item is rated on a 4-point (0-3) scale reflecting extent, intensity or skillfulness of the play performance. A total score is indicative of overall playfulness and play performance, with

1 higher scores indicating better play performance. The ToP has excellent inter-rater reliability
2 (96% of raters meet Rasch model expectations), moderate test-retest reliability (intraclass
3 correlation 0.67; Brentnall et al., 2008), good construct validity with 93% of items reflecting
4 a unidimensional construct of playfulness and 98% of people fit Rasch expectations [REDACTED]
5 [REDACTED]

6
7 The ToP was developed from a theoretical model of playfulness which describes
8 how it manifests as a disposition in all individuals, regardless if the individual is typically
9 developing or not. The ToP has been found to be useful in differentiating play difficulties in
10 children with different diagnostic categories, including being clinically useful in
11 understanding the play of children with ASD ([REDACTED])
12 [REDACTED]
13 [REDACTED].

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15 Using the ToP, each participant's video recorded play sessions were scored by the same
16 independent rater, who was trained and calibrated. The ToP rater was not aware of any
17 aspects of the study, including the purpose of the study, assessment time-point, participant's
18 group allocation, diagnosis, age or relationship. Video and participant codes were de-
19 identified, renamed and randomly allocated for scoring to minimize the possibility of the rater
20 identifying a pattern. The rater scored all 611 play assessment sessions. As part of the
21 calibration process, the rater's ToP ratings had been compared with hundreds of other raters
22 in a large database ($N > 3,000$). The rater's scores were considered reliable as her goodness-
23 of-fit statistics were within an acceptable range ($MnSq < 1.4$; standardised value ≤ 2 ; Bond &
24 Fox, 2007). The rater was calibrated using a combination of videos of children who are
25 typically developing and children with neurodevelopmental disorders, including children with
26 ASD. The rater involved in this study has extensive experience in rating both children who
27 are typically developing and children with ASD and has been involved as a blinded rater in
28 previous studies.

Child, parent and teacher report measures.

The Piers-Harris 2 (Internal consistency: Cronbach's $\alpha = 0.91$, test-retest reliability: 0.69-0.96; Piers & Herzberg, 2002); the Home and Community Social Behaviour Scales (HCSBS; internal consistency: Cronbach's $\alpha = 0.96$ for social competence and 0.98 for antisocial behavior, test-retest reliability: 0.82-0.91; Merrell & Caldarella, 2002) and the Parenting Relationship Questionnaire (PRQ; Median coefficient α reliabilities for norm groups in this study = 0.85, median test-retest reliability: 0.81; Kamphaus & Reynolds, 2006) were used as secondary outcome measures with children and parents. All three measures were administered at pre-control period assessment time, pre-intervention, post-intervention and at 3-months following intervention. The School Social Behavior Scales (SSBS; internal consistency Cronbach's $\alpha = 0.91$ for social competence and 0.98 for antisocial behavior, test-retest reliability: 0.68-0.82; Merrell, 2002) was used with teachers and administered at pre- and post-intervention only.

Randomization.

When parents enrolled in the study, a baseline assessment was scheduled over the phone. Only information regarding the inclusion criteria and the assessment date and time were collected prior to randomisation. As recruitment was expected to be sporadic, randomization was conducted with a block size of multiples of two. Simple randomization by an independent researcher using a random number generator was used to assign one of each dyad to each group (Haahr, 2016). Once assigned by the independent researcher, participants and parents were informed of their allocation following the screening and initial assessment by their treating therapist.

Intervention: The Ultimate Guide to Play, Language and Friendship.

The PLF intervention was based on [REDACTED] model for a play-based intervention for children with ADHD. The model built on [REDACTED] and was subsequently adapted for children with ASD from an intervention for children with ADHD [REDACTED]. The intervention included three components: pre-clinic, clinic and post-clinic (see Figure 2). The weekly, 1-hour clinic intervention sessions were conducted over 10 weeks, with pre-clinic videos created before each session and a home play session facilitated by the parents of the child with ASD between clinic sessions. Each week the clinic was set up in the same way with the same variety of toy options laid out around the edge of the room. This set up supported child-led play and familiarity with options which supported the children to make their own choices about what to play with and how to play, as well as encouraging creative uses of the toys as they became more familiar with them.

The PLF intervention components included peer-modeling, video-modeling, therapist-modeling, home resources and play sessions facilitated by parents. Although both the intervention delivered to children with ADHD and the PLF shared these intervention components, the way they were used was individualized to the needs of the children. Specifically, the PLF included additional chapters in the home resources (on play and technology; having a friend over to play and playing with my brother or sister) and there was more focus on social language and initiating play interactions during video modeling with the children with ASD.

Peer-modeling.

Peers were TD children (a familiar friend or sibling) aged between 6 and 12 years. See Table 1 for more details. The non-sibling peers included school friends, family friends, neighbors or

siblings of other friends with ASD. Peers did not have a diagnosis of ASD or any other developmental disorder and were identified by parents to demonstrate stronger social play skills than the child with ASD. Further information on the peers has been reported in a separate paper [REDACTED]

Video-modeling.

Video-modeling will be used throughout the manuscript to refer to both self-video feedback and video feedforward, except where otherwise stated (Dowrick, 2012). Each week the therapist would review the play session from the previous week and extract short snippets of video to create an individualized video for each dyad. The therapist conducted a 20-minute video-modeling session with the dyad and attending parents prior to the play session in weeks 2 to 10 and before each follow-up session. Self-video feedback consisted of short snippets of the dyad's play from the previous week that the therapist had identified as either desirable (green play) or undesirable play (red play). *Green play* was explained to the dyad to mean, "When everyone is having fun playing together, like a green traffic light, green play means we can keep going." Conversely, *red play* was explained to the dyad to mean "When someone is not having fun playing together, like a red traffic light, red play means we need to stop and think about why we are not having fun." The dyad was provided with multiple video examples of both *green play* and *red play* and they had the opportunity to problem solve and explain why these play transactions were either *green play* or *red play* throughout the 10-week program. The prompts of *green play* and *red play* were given both during video modelling sessions, as well as during play sessions to either promote positive play transactions (green play) or to inhibit negative play transactions (red play).

The dyad was supported by the therapist to identify potential ways to change "red play" into "green play" or continue behaviours that maintained "green play." Easy-to-remember visual

prompts were provided as video feedforward following each snippet. For example, a short snippet of the child with ASD saying yes to their peer's shared idea of "Do you want to play with the trains?" would be identified as "green play" and the prompts of "Share ideas" and "Say yes to ideas" would be reinforced. Likewise, a short snippet of the child with ASD ignoring their peer's initiations to play and continuing to play with their preferred toy (dress ups) when the peer shares their idea of "Do you want to play with the trains?" would be identified by the therapist as "red play" and the prompts of "Respond" and "Say yes to ideas" would be provided. As the children demonstrate their understanding of these concepts, more nuanced prompts could be provided. For example, "Say yes to ideas" could evolve to "Share ideas," "Add ideas to make it fun for you" and "Put two ideas together to make it fun for everyone." All these video-modeling prompts promote a balance of sharing control of the play and enable playfulness in both the child with ASD and their typically developing peer. Each video-modeling session concluded with video feedforward and a reminder of prompts to remember when playing in the playroom.

Therapist-modeling.

The therapists were an experienced occupational therapist (OT) and speech pathologist (SP) who had previously completed the PLF intervention with children in the feasibility study ([REDACTED]). Following video-modeling, the dyad and the therapist entered the clinic playroom and engaged in child-led, social and cooperative play for approximately 30 minutes (depending on the dyad, the interaction within the playroom and time to complete video-modeling). The therapist roles included modeling pro-social behaviours, prompting for "green play" behaviors and, when necessary, negotiating or making playroom changes. Modeling this play behavior supported children to understand how to share control and read and respond to play cues. The therapist role as an additional playmate and model of "green

1 play” behaviors also encouraged both children to initiate and extend play, by encouraging
2 them to choose what they wanted to play, add ideas to make it more fun for them and come
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4 up with new ways of playing with the same play materials and toys. Once “green play” had
5
6 been established, the therapist withdrew to allow the children to play without adult
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8 intervention.
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11 ***Parent support using home resources.***

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13 Home resources included a manual with 11 chapters and PLF DVD with corresponding
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15 episodes on different play topics. Examples of topics included ‘How to start and keep
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17 playing’, ‘Taking the perspective of another’, and ‘Let’s try something different’. Parents
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19 facilitated the children’s watching the DVD episode and facilitated a guided question and
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21 answer session with the children to facilitate understanding of the Red and “green play”
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23 demonstrated in the DVD. After watching the DVD, parents facilitated a short play session
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25 with the same playmate at home.
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32 ***Tailoring.***

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34 As the intervention is a child-led play intervention, the above intervention components were
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36 personalised to each child based on their play in the clinic and discussions with parents.
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38 Specifically, the play performance for each dyad was reviewed each week by their treating
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40 therapist and individual learning opportunities were chosen for their video-modeling sessions,
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42 for example, choosing a snippet of the child with ASD ignoring their peer and only wanting
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44 to play with the train set on their own. This play would be identified as “red play” and this
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46 child would be encouraged with a prompt of “Play Together”. Another video snippet of when
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48 he was playing with his peer would be shown and identified as “green play” to demonstrate
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50 the difference and self-modeling of the desired play behaviour. Likewise, the therapist-
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52 modeling in the playroom would highlight play enablers specific to that child, for example,
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1 choosing more structured turn taking game ideas to help encourage interactions between the
2 dyad. Therapist involvement was graded for each dyad and reduced in later weeks to allow
3 for increased independence in facilitating “green play” and changing “red play” into “green
4 play” between the dyad. Parents observed the sessions via video monitor in an adjacent room.
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10 Therapists and parents discussed observed behaviors and the focus for the following week
11 during home-based play opportunities. Each week, the therapist prescribed an individual
12 chapter for each dyad based on playroom observations and discussions with parents.
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16 ***Modifications.***

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20 Three dyads (4%) completed only 8 of the 10 sessions due to illness and availability of both
21 children; their results were screened for outliers. Three TD peers repeated the intervention
22 with a second child with autism. Three peers who dropped out were replaced with three new
23 peers to allow the child with ASD to complete the 10 sessions. Instead of watching the DVD
24 episodes as part of their home sessions two dyads (3%) watched their personalized
25 intervention video from each week as their parents reported difficulty engaging them with the
26 DVD episodes. The parents watched the DVD episodes and read the manual and looked for
27 ways to apply the lessons to their own child’s play.
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40 **Statistical methods.**

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43 We converted ordinal ToP item ratings to interval level measure scores for each participant
44 for all assessment time points using Rasch analysis in Winsteps (Version 3.92.0; Linacre,
45 2007). We used IBM SPSS Statistics (version 25, IBM Corp., 2017) to perform all analyses
46 of participant demographics, screening and outcome measure data. The primary analysis was
47 intention-to-treat and dyads who completed less than the 10-week protocol were screened for
48 person-fit statistics. Significance was set at $p < 0.05$. Cohen’s d effect sizes were calculated
49 and interpreted as follows: 0.2 = small effect size, 0.5 = medium effect size, 0.8 = large effect
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size (Cohen, 1988). As this investigation is restricted to a small number of planned comparisons and the results of the individual t -tests with exact p -values are reported, and with consideration to avoid the likelihood of type 2 errors, we did not apply Bonferroni (or other similar) adjustments for type 1 errors (Armstrong, 2014).

Effectiveness of the intervention.

To determine if the PLF was effective, we compared scores of the intervention first group with the wait-list control group. We calculated change scores for ToP, Piers-Harris, HCSBS and PRQ scores by deducting pre-intervention from post-intervention for intervention-first participants and pre-control from post-control scores for wait-list control participants. The means of the change scores from each group were then compared using an independent samples t -test. Mean scores for SSBS pre-intervention and post-intervention for all participants were compared using a paired samples t -test.

We combined the scores for all participants who completed the intervention on the ToP and other measures data at pre-intervention, post-intervention and follow-up. Subsequent analyses were completed on the combined data. We completed paired samples t -tests for the ToP and calculated the effect size for pre-to post-intervention.

Maintenance and generalization of intervention effects.

To answer the question, did the intervention effects maintain to a 3-month follow-up and generalize to the home environment, we conducted a one-way repeated measures ANOVA to compare the effect of the timing of the assessment (pre-interventions, post-intervention, follow-up clinic and follow-up home) on the ToP Measure score. Pairwise comparisons of ToP scores between the different time points were obtained from this analysis.

Although it was also obtained from the ANOVA, we used a paired samples t -test to explicitly compare means of ToP follow-up clinic and home scores to assess if play was generalized

from the clinic to the home environment at the end of the investigation. A mean difference score was calculated by deducting clinic follow-up scores from home follow-up scores.

Individual and dyad factors influencing intervention effects.

Further analysis was completed to identify if there were any factors that moderated the intervention effects. The following independent variables were investigated: age and gender of the child with ASD and therapist profession; their scores from the EVT-2, TACL-4, and CCBRS screeners; pre-intervention reports of the HCSBS, PRQ, Piers-Harris, and SSBS. Dyad variables of playmate relationship; gender difference; and age difference between the dyad were also investigated. Univariate analysis was completed to screen for any significant effects on the dependent variable (i.e., ToP Measure scores) for the child with ASD. We used linear mixed models to assess the effect of the five significant variables that were identified from univariate analysis. Variables examined were time (i.e., pre-, post-, follow-up), TACL-4 score, peer relationship (sibling or non-sibling peer), gender of child with autism, and therapist profession (other dyad and individual variables, e.g. age of the child with autism, were not examined further as they did not influence intervention effects). Conditional R^2 analysis was then completed and a hierarchical linear regression was run to better understand the factors that influenced outcomes. The change in R^2 is a way to evaluate how much predictive power was added to the factor (i.e., pre-intervention ToP score) by the addition of another variable (e.g., gender).

Results

We reviewed ToP measure scores for participants who attended fewer than 10 sessions ($n = 3$) and those with TACL-4 scores at inclusion cut off (i.e., 4; $n = 7$). Data from 4 participants were considered outliers because their ToP person-fit statistics did not fit Rasch expectations (mean square value < 1 , standard score ± 2) and were excluded from further analysis. We

confirmed the remaining data were normally distributed using Shapiro-Wilkes tests.

Demographic and screening data for the intervention first and control first groups are reported in Table 1 and Table 2.

Effectiveness of the intervention

The 10-week PLF intervention demonstrated a moderate positive effect on the play for children with ASD aged 6 to 11 years. The overall change in play performance for children in the intervention-first group was significantly greater than the change in the wait-list control group ($t(63) = 2.471, p = 0.016, d = 0.61$). There was a significant difference between the two groups on four of the six subscales (see Table 3) on the parent identified social emotional strengths and risky social behaviours at home and in the community. No significant change was identified for the child's self-concept or parents' perspective on the parent-child relationship. Teacher identified social emotional strengths and risky social behaviours at school demonstrated a significant difference for the social competence subscale ($t(20) = -2.29, p = 0.033$), but no significant difference for the antisocial behaviour subscale ($t(20) = 1.67, p = 0.111$).

Maintenance and generalization of intervention effects.

The repeated measures ANOVA showed that there was a significant increase in ToP scores over time for the children with ASD ($F(3,259) = 10.86, p < 0.0001$). The treatment effect of ToP data for pre- to post-intervention once all participants were included in the analysis was moderate (pre-intervention mean (SD) = 57.39 (13.4), post-intervention 64.10 (13.1), $d = 0.51$). Results indicate that treatment effects for play were maintained and slightly improved at the 3-month follow-up clinic appointment (*Cohen's* $d = 0.36$; see Table 4).

At 3-months follow-up, there was no significant difference ($p = 0.932$) between mean clinic [69.00 (14.44)] and home [69.27 (14.3)] ToP measure scores, indicating that play with the same peer generalized from the clinic to the home environment. This interpretation should be viewed with caution, as due to limited feasibility of scheduling availability of the dyad and therapist, no pre-intervention ToP scores were collected at home. No significant change was identified for the child's self-concept between post-intervention and follow-up: mean (SD) post-intervention = 49.59(9.98), mean (SD) follow-up clinic = 49.12 (12.45), ($t(57) = 0.412$, $p = 0.682$, $d = 0.04$).

Individual and dyad factors influencing intervention effects.

To understand the effect of the peer relationship, gender of child with ASD and therapist profession factors, TACL-4 and Pre-intervention ToP scores were compared for sibling or non-sibling relationships, male or female, and OT or SP respectively. Significant main effects of time, TACL-4 score, peer relationship, gender of child with ASD and therapist profession were present for ToP measure scores (see Table 5). There were significant differences in pre-intervention ToP scores between sibling and non-sibling peer groups [Sibling Mean(SD) = 53.40 (12.14); Non-sibling Mean(SD) = 60.98 (12.23); $t(61) = -2.431$, $p = 0.018$] and between male and female participants [Male Mean(SD) = 55.21 (12.54); Female Mean(SD) = 65.57 (9.95); $t(61) = -2.230$, $p = 0.029$]. There were also significant differences in both pre-intervention ToP and TACL-4 screening scores for the therapist profession groups [pre-intervention ToP: OT Mean(SD) = 53.45 (12.46); SP Mean(SD) = 60.13 (12.11); $t(61) = -2.148$, $p = 0.036$] and [TACL-4: OT Mean(SD) = 7.65 (2.45); SP Mean(SD) = 9.00 (1.89); $t(62) = -2.448$, $p = 0.017$].

The percentage of variability accounted for in the ToP pre- to post-intervention difference scores changed from 30.2% (for ToP pre-intervention scores only) to 35.5% (TACL-4 score), 35.9% (therapist allocation), 37.8% (gender) and remained the same (30.2%) for peer relationship. When the other factors of TACL-4 score; therapist allocation; gender and peer relationship were controlled for, only the pre-intervention ToP scores ($\beta = -0.549$; $p < 0.001$) influenced the ToP pre- to post-intervention difference scores. Therefore, children with ASD with lower play scores at pre-intervention improved more than those with higher play scores and for every 1-unit decrease in pre-intervention ToP measure score, the difference from pre- to post intervention increased by 0.55 units.

Discussion

This investigation demonstrated the effectiveness of the PLF to improve play in children with ASD. The moderate effect size from pre- to post-intervention is larger than the average small effect size calculated in a systematic review for play interventions for children with ASD (██████████). The effects of the intervention on play performance were maintained 3-months following the completion of the intervention and generalized to the home of the child with ASD. Parents reported a significant improvement in social competence and decrease in anti-social behaviours, while teachers reported a significant increase in social competence at school but no significant change in anti-social behaviours. These results support the benefits of the PLF and adds to a field in need of robust research –effective interventions to improve social play in primary school aged children with ASD (Reichow & Volkmar, 2010; Wong et al., 2015).

Effectiveness of the intervention.

The individualized intervention approach used in the PLF is similar to other effective play interventions for children with ASD that focused on identifying and developing individual

play skills, as opposed to having predetermined play skills or curriculum (Kasari et al., 2006;

██████████). The individualization of the PLF was enabled by two intervention components: video-modeling and peer-modeling. As the video feedback sessions targeted children with ASD and their playmates, both children were supported and upskilled in their play performance. Involving both children in video-modeling discussions facilitated improvement in the peer interaction and allowed for increased social complexity of the play between them.

Peer-modeling was important to this intervention as it helped create an authentic social and natural play environment. The peer-modeling facilitated child led play and natural interaction with the child with ASD. Both the PLF and pivotal response training requires more robust engagement by the peer and their ability to support prolonged interactions beyond just initiating. The use of the same peer in the PLF is important in developing these comprehensive and supportive skills in the peer.

Another important mechanism of using the same peer throughout the intervention is providing a consistent and supportive social environment for the child with ASD. As the child with ASD is already familiar with the peer, whether they be a sibling, friend from school or other known peer, this allows for a supportive and familiar social environment from the beginning of the intervention. The PLF intervention approach of using the same peer to support the child with ASD has the advantages of building play performance from one week to the next and increasing the play repertoire and complexity of the interaction between the dyad. Specifically, in the PLF the peers were supported by the therapist to expand play interactions with the child with ASD and both children were encouraged to use common phrases, such as “share ideas” or “say yes to ideas”, with their peer to support the interaction. The significant positive effect on parent and teacher reported social competence on both the HCSBS and the SSBS outcome measures may be associated with improved social play

performance (Reichow et al., 2013). This finding is in line with the link between play performance and social behaviors that has previously been established for TD children and children with ASD (Wolfberg, 2009). It is possible that educating parents on the importance of play, and specifically, how to identify and promote “green play” would influence the results; especially when coupled with a reduction in conflict with peers or siblings during play over the course of the intervention. It is particularly encouraging that teachers noted a positive change in the participants’ social competence, as school is a socially demanding environment where children with ASD experience social challenges, victimization and isolation (Rowley et al., 2012). Although scores from the feasibility study were approaching significance for improved parent child relationship and child self-concept measures ([REDACTED]); no significant changes were identified in this study. This may be due to the relatively stable nature of both these constructs.

Maintenance and generalization of intervention effects.

The inclusion of the same peer in the intervention likely contributed to maintenance and generalization of intervention effects. The play environment, both in the clinic and at home, included naturally occurring social play interactions between the dyad. The use of the same peer allowed a common experience and common language used between the dyad to describe the quality of the play experience. However, these results should be considered with caution as the child with ASD play performance was not assessed with untrained peers or in unfamiliar environments.

Developing a common language to describe play performance was unique to this intervention and enabled the children, parents and therapists to use a shared language across the different intervention environments of the clinic and home. In our study, dyads frequently took on a collaborative approach to try and achieve “green play”. Using the new common language, the

peer also supports the generalization of play performance across environments from the clinic to the home (Chan et al., 2009).

The additional support and practise within the home environment each week, facilitated by the parents, encouraged the continuation of learning and common language used within the program. The manual and DVD were used as tools by parents to provide structure and the same consistent use of language for the home play sessions. This common and simplified label to describe play performance in the moment and across contexts likely supported maintenance and generalization.

Individual and dyad factors influencing intervention effects.

The ToP scores predict changes as a result of the intervention, with participants with lower scores on the ToP improving more than children with higher scores. This is similar to findings for children with ADHD who completed an earlier version of the PLF over 8 sessions (). It is interesting to note that both peer relationship and gender had significantly different pre-intervention ToP scores; with non-sibling dyads playing better than sibling dyads and girls playing better than boys. The gender difference may be explained by earlier research that found that boys with autism tend to play alone and girls with autism come in and out of the social environment but maintain proximity to interaction (Dean et al., 2017).

Regression analysis identified that gender, peer relationship, therapist profession and pre-intervention auditory comprehension influenced outcomes, but were not predictive of the intervention outcome. Importantly, once pre-intervention play performance was controlled for, these factors demonstrated no significant impact on intervention outcomes. These findings are encouraging for the diversity of children who will benefit from the PLF. The

improved play performance for children with ASD was not limited by gender, whether you were playing with a friend or a sibling or what profession your allocated therapist was.

Family and clinic considerations.

The dosage of clinic sessions, coupled with a weekly focused home session facilitated by the parents, is important for the effectiveness of the PLF. This intervention dosage frequency is in line with other effective play interventions ranging from twice per week (Kasari et al., 2015) to daily (Kasari et al., 2006). Having multiple opportunities over time allowed for skill consolidation, improved play performance and mastery of more challenging pro-social behaviours (). Although the 20 hours was a considerable commitment for families, it is not as demanding as alternative effective play interventions of 40 hours over 10 4-hour sessions in a community setting (Corbett et al., 2016) or popular early intervention approaches such as Applied Behaviour Analysis that can be as high as 50 hours per week (Schwichtenberg & Poehlmann, 2007).

Having access to a peer that could commit to the intervention schedule was an important consideration for families. Common reasons for not engaging with the PLF included scheduling difficulties to commit to the intervention and not being able to find an appropriate peer. Parents of the child with ASD frequently chose a similar aged sibling as the TD peer for the intervention, allowing for convenience of completing the home modules. Although there was a significantly lower mean play performance at the pre-intervention assessment point for the children with ASD playing with a sibling than those playing with a non-sibling peer, parents opting to involve a sibling peer should be encouraged that the peer relationship did not influence outcomes significantly. This is comparable with another study utilizing siblings for intervention implementation that demonstrated positive skill acquisition for both the child with ASD and a sibling (Shivers & Plavnick, 2015). It is possible that the lower mean play

performance for sibling dyads when compared to non-sibling dyads was due to established play patterns within the relationship. However, the advantage of including siblings as a playmate in the intervention is that siblings offer a guaranteed long-term opportunity for social play and learning (Shivers & Plavnick, 2015).

The play environment is another important consideration. The clinic environment was designed to create a naturalistic play environment that promotes individual preferences and increased children's play repertoire. Specifically, careful consideration should be given to the choice of toys used in the playroom with more flexible, open-ended and pro-social toys that encourage interaction, build on what the children are familiar with, and have the properties to engage children at the start of the intervention (Wolfberg & Schuler, 2006).

Limitations.

There is a possibility that the rater may have some observer drift, however, as the rater was calibrated this is unlikely. Furthermore, the videos were scored in a random selection and the rater was not aware of the different time points, as such, any rater drift would have been random. Not all parents and teachers returned completed secondary outcome measures, thus reducing the statistical power of the secondary measures, which, in turn, could have resulted in some moderators not being identified. As there was no teacher report SSBS responses for the control period, we could not confirm if the change in participants scores was due to the intervention for that secondary measure. Although the intervention may have influenced pro-social behaviours at school, as it did with the parent report measure, we do not have the data to confirm that.

Implications for future research.

As peer mediators were an important intervention component, future research should evaluate the play performance and social characteristics of peers to determine if these factors influence

1 outcomes for the child with ASD. Furthermore, future research should investigate whether
2 the child with ASD is able to generalise skills learned in the intervention to untrained peers or
3 a larger group of children. Involving more playmates in the play transaction will allow for a
4 more dynamic social environment which would be more challenging for children with ASD.
5 Future investigation of adapting and testing the effectiveness of the PLF in improving play
6 with other populations is another important consideration.
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15 **Conclusion**

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17 This randomized control trial demonstrated the PLF was effective for improving the play
18 performance of children with ASD aged 6 to 12 years. Improvements in play performance
19 were maintained 3-months following the intervention and generalized to the home
20 environment. Pre-intervention play scores influenced the intervention effects, with children
21 with lower play scores improving more than those with higher play scores. These results
22 support complex interventions using peer-modeling, video-modeling, therapist-modeling and
23 home modules to support the development of play and pro-social behaviours in children with
24 ASD.
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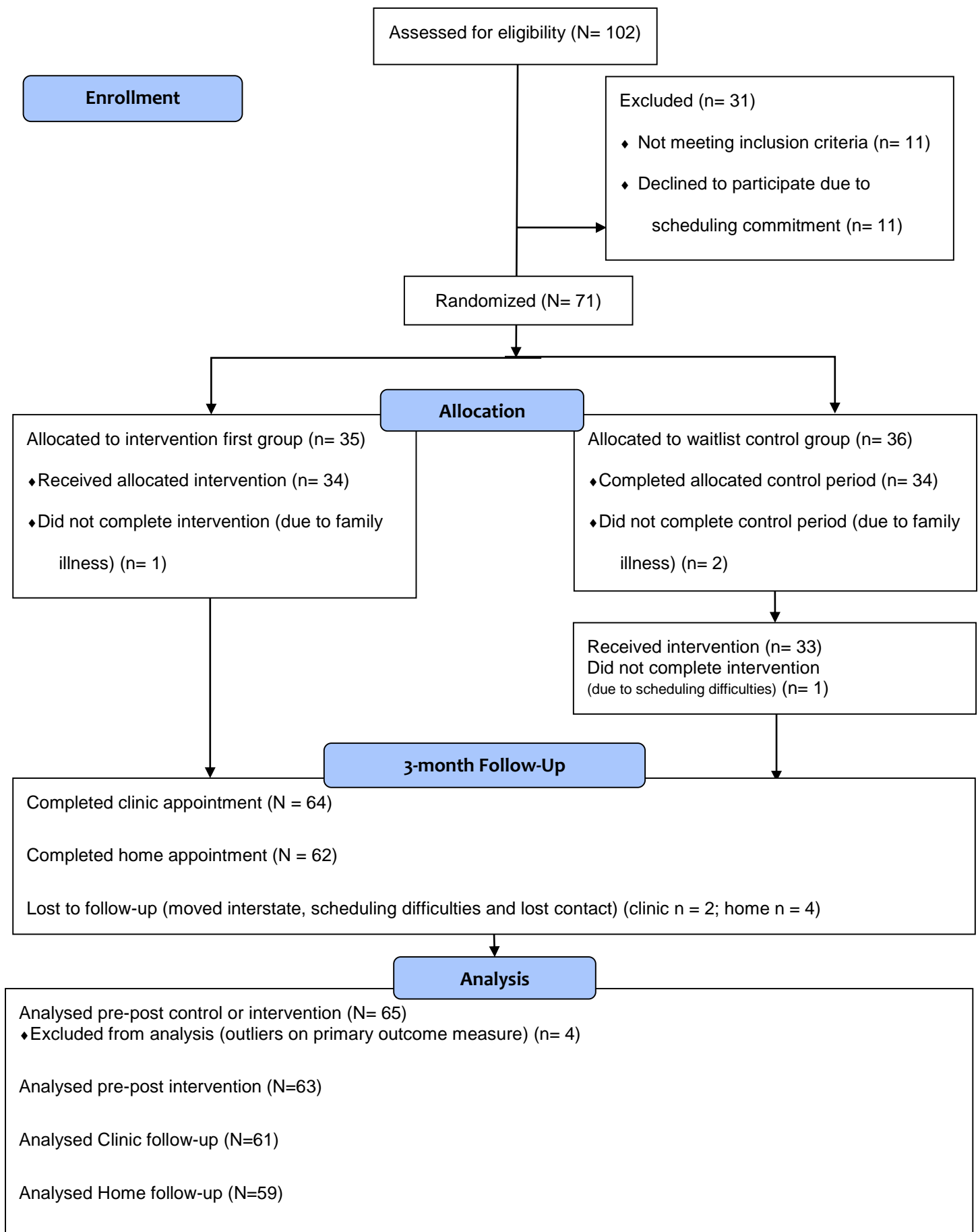


Figure 1 CONSORT flow chart

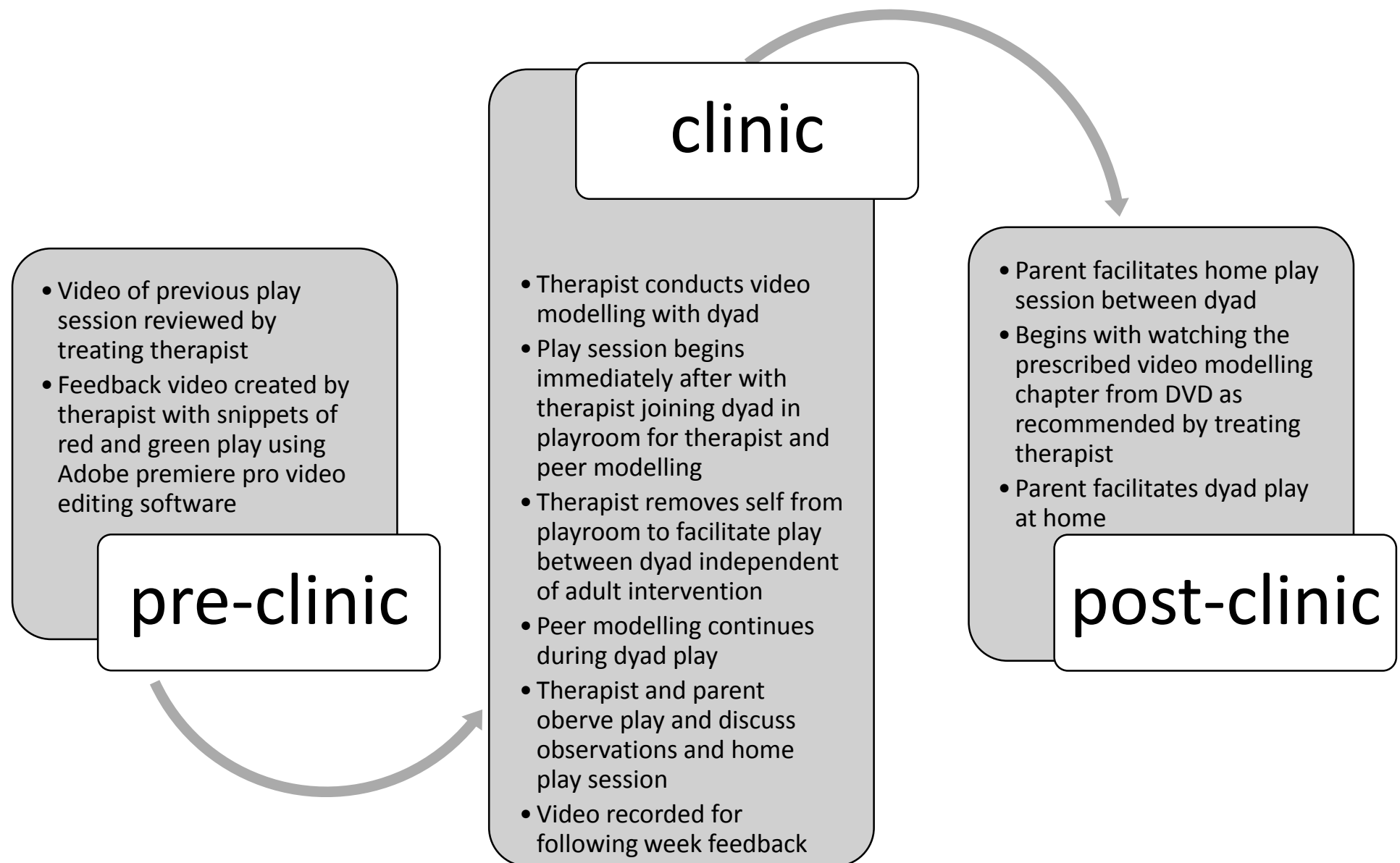


Figure 2. PLF Intervention components

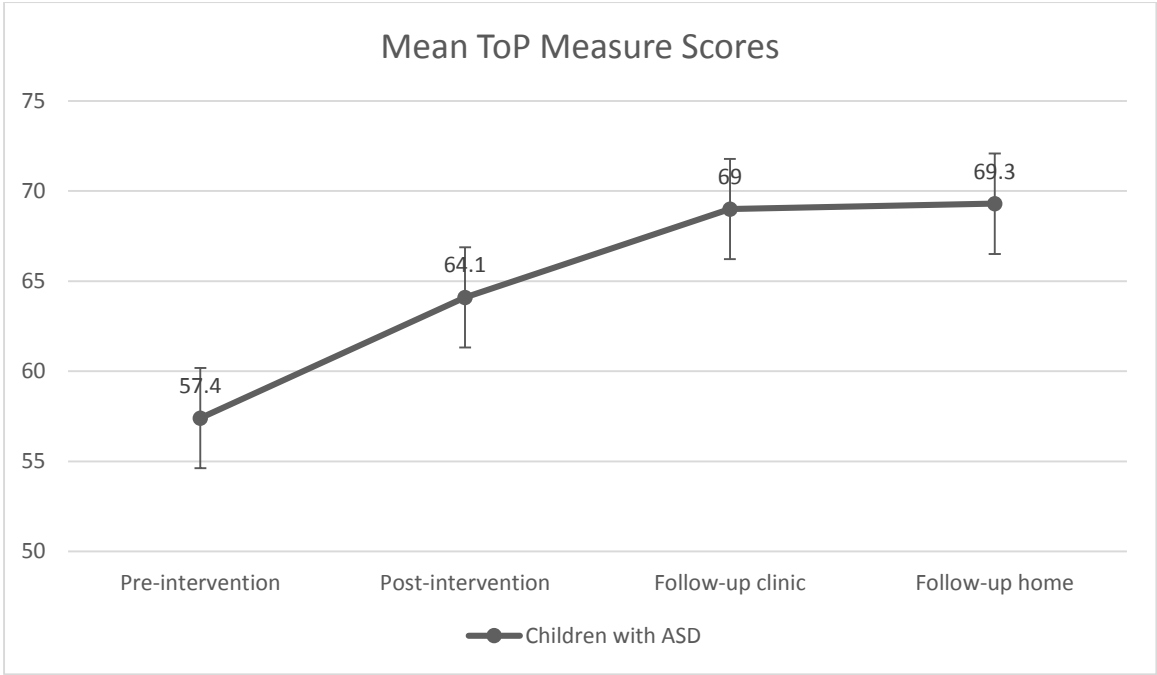


Figure 3. Mean ToP Measure Scores for children with ASD

Table 1 Participant demographics

Variables	Intervention-First	Control-First
Child Demographic Variables		
Age (years)	8.68 (1.43)	8.44 (1.37)
Gender (male)	30 (93.75%)	27 (81.81%)
Secondary diagnosis	12 (37.5%)	15 (45.45%)
English first language	31 (96.88%)	32 (96.97%)
Child Screening Measures		
CCBRS		
Autistic disorder	86.18 (7.52)	85.32 (7.45)
Aspergers disorder	81.43 (10.54)	78.86 (11.22)
ADHD (predominantly inattentive)	76.11 (11.12)	81.19 (8.99)
ADHD (predominantly hyperactive-impulsive)	74.04 (13.16)	69.96 (15.52)
Oppositional defiant disorder	71.43 (14.78)	74.36 (13.75)
Generalized anxiety disorder	75.31 (13.95)	79.61 (13.51)

Variables	Intervention-First	Control-First
EVT-2	102.72 (13.57)	103.53 (12.91)
TACL-4	8.22 (2.48)	8.39 (2.12)
Parent Demographic Variables		
Age (years)	42.34 (5.80)	40.29 (3.73)
Education after high school	25 (80.65%)	26 (81.25%)
Mother education after high school	23 (74.19%)	26 (81.25%)
Peer Demographic Variables		
Age	8.62(1.80)	8.08(1.43)
Gender (male)	15 (46.88%)	21 (63.64%)
Peer Screening Measures		
CCBRS		
Autistic disorder	50.36 (9.66)	55.14 (16.25)
Aspergers disorder	50.11 (8.94)	52.55 (12.35)
ADHD (predominantly inattentive)	58.29 (15.58)	58.59 (14.25)

Variables	Intervention-First	Control-First
ADHD (predominantly hyperactive-impulsive)	57.11 (14.24)	56.41 (14.37)
Oppositional defiant disorder	59.18 (14.18)	62.21 (12.39)
Generalized anxiety disorder	58.21 (12.59)	63.76 (15.31)
EVT-2	107.93 (13.09)	110.76 (10.91)
TACL-4	8.9 (1.49)	9.21 (1.95)

Note. CCBRS = Conners Comprehensive Behaviors Rating Scale (T-score ≥ 70 indicates clinical range); EVT-2 = Expressive Vocabulary Test, 2nd edition (standard score ≥ 70 was required as a screening measure for all participants to ensure they had vocabulary to participate in intervention components); TACL-4 = Test of Auditory Comprehension of Language 4th Edition (standard score ≥ 4 was required as a screening measure for all participants to ensure they had auditory comprehension to participate in intervention components).

Table 2 Dyad Variables

Variables	Intervention-First	Control-First
Occupational Therapist	19 (59.38%)	15 (45.45%)
Age difference (years)	-0.22 (1.92)	-0.46 (1.59)
Peer sibling	16 (50%)	21 (63.64%)
Peer same gender	17 (53.13%)	19 (57.58%)

Table 3 Intervention effects on ToP and child/parent report outcome measures

Measure	Mean change score (SD)					
	Treatment-First	Control-First	<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>
	Group	Group				
	(Post Intervention – Pre-intervention)	(Post-control – Pre-control)				
ToP Overall	9.72 (14.62)	1.18 (13.23)	2.47	63	0.016	0.61
Treatment <i>n</i> =32						
Control <i>n</i> =33						
Piers-Harris	2.94 (8.89)	2.13 (6.04)	0.41	60	0.680	0.11
Treatment <i>n</i> =32						
Control <i>n</i> =33						
HCSBS Treatment						
<i>n</i> =21						
Control <i>n</i> =21						
Social competence total	4.14 (6.22)	-0.48 (5.57)	2.53	40	0.015	0.78
Anti-social behaviour total	3.24 (6.38)	-1.48 (6.16)	2.44	40	0.019	0.75
PRQ						
Treatment <i>n</i> =20						

Measure	Mean change score (SD)					
	Treatment-First	Control-First	<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>
	Group	Group				
	(Post Intervention – Pre-intervention)	(Post-control – Pre-control)				
Control <i>n</i> =17						
Attachment	-0.75 (6.49)	-1.47 (12.80)	0.22	35	0.826	0.07
Communication	-0.40 (6.40)	1.47 (9.93)	-0.69	35	0.494	-0.96
Discipline Practices	3.45 (5.28)	-0.24 (8.94)	1.55	35	0.129	0.50
Involvement	-0.45 (6.90)	0.88 (8.63)	-0.52	35	0.605	-0.17
Parenting	1.30 (6.52)	-1.06 (8.98)	0.92	35	0.362	0.30
Confidence						
Satisfaction with school	0.80 (6.65)	-0.35 (11.17)	0.38	35	0.700	0.13
Relational Frustration	-0.55 (5.97)	-2.18 (9.21)	0.65	35	0.522	0.21

Note. ToP = Test of Playfulness; HCSBS = Home and Community Social Behavior Scales;
PRQ = Parent Relationship Questionnaire

	Mean (SE)*	95% CI		P-values for pairwise comparisons		
					Timing	
Timing		Lower	Upper	Post	Follow (clinic)	Follow (home)
Pre	57.39 (1.66)	54.12	60.66	0.0006	<0.0001	<0.0001
Post	64.00 (1.67)	60.71	67.29		0.0154	0.0130
Follow Up (clinic)	68.77 (1.71)	65.52	72.36			0.9315
Follow Up (home)	68.94 (1.73)	65.82	72.71			

Note. ToP = Test of Playfulness; SE = Standard Error; CI = Confidence Interval

* These means are the Least Squares Means obtained from the ANOVA model

Table 5 Factors influencing intervention effects on ToP outcomes

Fixed Factor	ToP Measure score		
	Mean (SE)	F	P
Time		18.78	<0.001
Pre	59.48 (2.098)		
Post	67.68 (2.098)		
Follow Up (Clinic)	71.40 (2.114)		
Non-sibling (n = 26)	69.69 (2.154)		
Therapist		10.91	0.002
OT (n = 34)	62.78 (1.881)		
SP (n = 29)	69.60 (2.194)		
Gender		14.37	<0.001
Male (n = 55)	60.46 (1.335)		
Female (n = 8)	71.83 (2.977)		
TACL-4		2.52	0.016
<i>Note.</i> ToP = Test of Playfulness; TACL-4 = Test of Auditory Comprehension of Language 4th Edition; OT = occupational therapist; SP = speech pathologist			

Author note

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The authors would like to acknowledge the School of Occupational Therapy and Social Work, Curtin University, who kindly donated the costs involved with installation of the camera equipment and creating "The Ultimate Guide to Play" DVD.

The authors would like to acknowledge the contribution of an Australian Government Research Training Program Scholarship in supporting this research.

The authors would also like to acknowledge Dr Richard Parsons for his assistance with the statistical analysis and Dr Lauren Parsons for her assistance with administering the intervention and data collection.

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Authors' declaration of authorship contribution;

The authors of this manuscripts affirm that they made a significant contribution to the conception, design, analysis, or interpretation of data; participated in drafting the manuscript or reviewing and/or revising it for intellectual content; approved the final version of the manuscript; agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CK conceived of the study and participated in all stages of the study, data collection, analysis and drafting the manuscript; RC participated in all stages of the study including design, analysis, interpreting results and helped to draft the manuscript; AJ participated in all stages of the study including design, interpreting results and helped to draft the manuscript; SWG participated in its design, interpretation of results and helped to draft the manuscript; AB participated in the design, interpretation of results and helped to draft the manuscript.

Funding statement;

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Conflict of interest statement;

The authors report no conflict of interest.

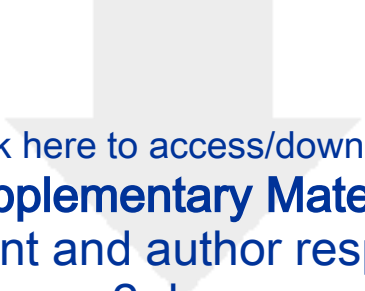
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Supplementary Material

Reviewer comment and author response table - Rev
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