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ORIGINAL PAPER

A Teacher-Facilitated Peer-Mediated Intervention to Support Interaction Between Students with and without Autism

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Abstract

Objectives Within the autism intervention literature, there is a need for research focused on training teachers to implement and monitor the use of evidence-based strategies in regular classroom settings. This study assessed the effects of a teacher facilitated peer-mediated intervention (PMI) on the cooperative play, initiations, and responses of three upper elementary students with autism and three typically developing peers attending a Title 1 school.

Methods Using a concurrent multiple probe across dyads design, we implemented a cascading coaching model and behavioral skills training (BST) package to teach one special educator to train peers in strategies to support and maintain play and interaction with their classmates with autism. Fidelity and social validity were assessed.

Results A functional relation between the intervention and cooperative play was demonstrated. Initiations increased for all peers. Participant initiations and responses increased but were variable, with substantial increases for two participants and modest increases for one participant. Peers implemented the support strategies with a high degree of fidelity, and the teacher accurately monitored peer strategy use and intervention effects. Feedback from the teacher, participants, and peers demonstrated a high level of social validity and satisfaction with the training procedures, intervention, and outcomes.

Conclusion A cascading coaching model using BST is a promising approach for training teachers to implement and monitor PMI in the natural classroom environment. Limitations and considerations for practice and future research are discussed.

Keywords Autism · Peer-mediated-intervention · Social interaction · Teacher training · Behavioral skills training

For children both with and without disabilities, play and peer interaction can influence learning and social development (Bishop & Curits, 2001). In school settings, children learn through play by interacting with peers, sharing in interests, and establishing friendships. Positive peer interactions and friendships in childhood can confer several benefits, including the development of prosocial skills, increased academic performance and school success, improved language skills, and enhanced quality of life (Carter et al., 2010; Rogers, 2000; Rotheram-Fuller et al., 2010; Rubin et al., 2009). Children with autism spectrum disorder (ASD), owing to difficulties with social communication (American Psychiatric Association, 2013), often demonstrate challenges with play and peer interactions. These social communication challenges can include difficulties initiating and maintaining interaction, engaging in play, and demonstrating conversational reciprocity (APA, 2013). In classroom settings in particular, research has indicated that children with ASD tend to have lower friendship qualities and are more socially isolated compared to their typically developing peers (Chamberlain et al., 2007). Notably, in the later elementary years, children with ASD may become even less involved in peer social relationships compared to those in younger grade levels, making intervention and support during this period of development especially important (Rotheram-Fuller et al., 2010).

Peer-meditated intervention (PMI) is an evidence-based practice shown to increase social interaction and play between children with ASD and their typically developing peers (Hume et al., 2021; Radley & Dart, 2022). In a

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peer-mediated approach, peers are trained to support interactions with children with ASD and are typically taught to model, prompt, or reinforce targeted social skills (Odom & Strain, 1984; Watkins et al., 2015). PMI research has a decades-long and rich history of effectiveness with school age children with ASD (e.g., Hu et al., 2021; Strain et al., 1979), and there are several features of PMI that make it particularly attractive to use in classroom settings. These features include increased opportunities for students with ASD to interact with a variety of communication partners, potentially increased likelihood of generalization of social skills across peers and settings, fewer constraints on teachers to be the sole provider of intervention access, and ease of incorporating PMI into the natural context of typical classroom activities (Carr & Darcy, 1990; Chan et al., 2009; Hemmeter, 2000; Strain & Kohler, 1998; Trembath et al., 2009). For peers without disabilities involved in intervention, socializing with classmates with ASD may confer such benefits as improved self-concept, increased understanding and acceptance of differences, and more welcoming friendships (DiSalvo & Oswald, 2002). Stay-Play-Talk (Goldstein et al., 2007) is one such widely used PMI for children with disabilities that was designed to lessen implementation demands on peers by employing simple support behaviors (i.e., staying next to the friend, playing with the friend, and talking to the friend) rather than a complex or overly burdensome package of strategies (Ledford & Pustejovsky, 2021). Stay-Play-Talk has been used successfully with young children (e.g., Barber et al., 2016) and has also been adapted for implementation delivery with older children using additional strategies to support skill use (e.g., Tsao & Odom, 2006).

The need for special education professionals to utilize evidence-based practices such as PMI to improve the outcomes of school-aged children with autism continues to grow (Odom et al., 2021) and training approaches that are effective in improving implementation of practices and are feasible in the typical school environment are needed (Brock et al., 2017; Smith & Iadarola, 2015). Indeed, the adoption, facilitation, and sustainability of intervention practices are an important goal of implementation science (Powell et al., 2015). However, teachers often lack access to training and may not possess sufficient knowledge or have adequate skills to implement these practices with fidelity in classroom settings. Regarding PMI specifically, of 535 special educators surveyed by Knight and colleagues, 65.2% reported that they had never received any training on how to implement PMI (Knight et al., 2019), indicating a need for increased focus on how to train and support teachers to use this practice. In a review of special education practitioner training studies, Brock and colleagues found that behavioral skills training (BST) was associated with improvement in implementation fidelity, and the use of modeling, written instructions for implementation, and verbal performance feedback were statistically significant predictors of effects (Brock et al., 2017). BST is an empirically supported procedure used to teach pro-social skills involving instruction, modeling, rehearsal, and feedback (Leaf et al., 2015; Miltenberger, 2012), and it has been used effectively to train natural intervention agents such as teachers and peers to implement interventions for children with ASD (Ledbetter-Cho et al., 2020; Watkins et al., 2019a). The authors, however, noted that it was unclear if the trainings described in the included studies were feasible under typical circumstances, with most practitioners involved in multiple follow-up training sessions, which may not be feasible (or cost-effective) in practice (Brock et al., 2017). To better improve dissemination of evidence-based practices such as PMI into school settings, it is necessary to develop both effective and efficient training procedures that can be used under typical conditions.

Additionally, much of the PMI research has involved a fairly limited subset of the population, with white, male participants and those with less severe characteristics of ASD often represented (Watkins et al., 2019a). Therefore, there is a growing need to examine the efficacy of interventions with students with autism with more significant support needs, as well as to include participants with more diverse backgrounds (Pierce et al., 2014). The inclusion of participants with a wider range of characteristics and backgrounds is more representative of the heterogeneous nature of autism, as well as reflects the racial and ethnic diversity of the autistic population. Further, most interventions have been implemented by researchers rather than teachers (Watkins et al., 2019a). That is, researchers rather than teachers have been involved in the training of peers and in implementing and monitoring the intervention procedures. Thus, there is a need to develop procedures to train teachers in how to train peers to use PMI strategies and to equip teachers with the skills needed to accurately implement and monitor the effects of the intervention in the natural classroom setting. Further, the feasibility and acceptability of PMI procedures across stakeholders (i.e., teachers, participants with ASD, and typically developing peers) must be assessed to ensure a socially valid intervention that is likely to be incorporated into an educator's typical practice.

Therefore, the purpose of this study was to assess the effects of a time and resource sensitive training model to support a classroom teacher in facilitating a PMI in the typical classroom setting and to examine the effects of the PMI on social outcomes for both the participants with ASD and their typically developing peers. Specifically, we sought to answer the following: (1) Is the PMI training package effective in teaching the teacher to train peers and monitor the use of PMI strategies in the typical classroom setting? (2) Can peers implement PMI strategies with fidelity? (3) Is there a functional relation between the PMI and play and interaction between the students with and without ASD? and (4) What is

the socially validity of the interventions' goals, procedures, and outcomes across stakeholders (i.e., teachers, children with ASD, and typically developing peers)?

Method

Participants

The participants attended a Title 1 elementary school in a small city within a rural area of the Southeastern United States. The student population was 74% African American, 13% White, 7% Hispanic, and 5% Asian. Seventy percent of students came from low-income families. The intervention was implemented in a self-contained "autism unit" classroom with ten 3rd–5th grade students with a diagnosis of ASD. The self-contained classroom served students with ASD with more significant support needs because the local education agency was unable to sufficiently meet the needs of the students in their locally zoned community schools. The students were included with their grade level typically developing peers at various points during the school day, including lunch, recess, and physical education, but most students received the majority of instruction in the self-contained classroom with one special education teacher, two paraprofessionals, and related service providers who provided both push-in and pull-out services. General education peers pushed into the self-contained classroom at various times during the week to socialize with the students with ASD (e.g., during morning meeting or afternoon choice time), but no specific intervention, social skills instruction, or support strategies were in place during these times.

Three students with ASD from the self-contained classroom (hereafter referred to as participants), three typically developing students in general education (hereafter referred to as peers), and a special education teacher participated in this study. The special education teacher was in her 3rd year of teaching and had recently completed a master's degree in collaborative special education. She had taught in the self-contained classroom for all 3 years of her teaching experience. Prior to developing the intervention, researchers met with the teacher to discuss instructional priorities and support needs for her students. She identified a need to improve social interaction skills and indicated a priority to create opportunities and provide support for the inclusion of students with ASD in activities with their typically developing peers. All participants included in this study used vocal communication, had social skill related Individualized Education Program (IEP) goals, and had expressed a desire to make new friends and play with other students.

Zion was an 11-year-old African American male 5th grader with an educational diagnosis of ASD. He scored a 32 on the Childhood Autism Rating Scale-2 (CARS-2; Schopler et al., 2010) which, according to the CARS-2, indicated "mild-to-moderate" symptoms of ASD. He participated in the state's alternate assessment for students with cognitive disabilities. Zion had well-developed vocal speech, spoke in short complete sentences, demonstrated functional play skills, and initiated and responded independently. His interactions with peers most often consisted of responses to peer initiations. During play with others, he tended to engage in parallel play (e.g., playing with Lego® side by side with his play partner but not regularly interacting or coordinating play actions) or onlooker behavior (e.g., watching his partner play and not engaging in the play activity himself). Zion occasionally engaged in scripted talk or self-talk while playing with others. Zion was included in the general education setting for science, PE, lunch, and recess, and he received the rest of his education in the self-contained classroom.

Madison was a 10-year-old African American female 4th grader with an educational diagnosis of ASD who participated in alternate assessment. She scored a 39.5 on the CARS-2 (Schopler et al., 2010), indicating "severe" symptoms of ASD. Madison communicated vocally in phrases of four to six words and typically spoke in a quiet and low voice. She demonstrated functional play skills and often engaged in restricted and repetitive activities during play time (e.g., running her hands repeatedly through the block or bead bins) or engaged in solitary play activities. Madison primarily initiated to the adults in the classroom rather than to peers and was frequently prompted by her teacher to respond to initiations from others. She often relayed the actions and behaviors of her classmates to the teacher. Madison was included in the general education setting for PE, lunch, and recess, and she received the rest of her education in the self-contained classroom.

Luke was a 10-year-old African American male 4th grader with an educational diagnosis of ASD who participated in alternate assessment. He scored a 41 on the CARS-2 (Schopler et al., 2010), indicating "severe" symptoms of ASD. Luke spoke in short phrases of three to four words. He had limited functional play skills and preferred to engage in play or leisure activities that were structured (e.g., picture and word matching activities) or solitary (e.g., listening to music independently). Luke rarely initiated to peers and frequently initiated and responded to the adults in the classroom. He demonstrated some instances of vocal stereotypy during class activities and exhibited difficulty with changes in the usual classroom routines. The teacher used "First, Then" visuals frequently with Luke (e.g., first math, then music). Luke was included in the general education setting for PE, lunch, and recess, and he received the rest of his education in the self-contained classroom.

All peers were 5th grade general education students who participated in student council. They were recommended by the student council sponsor, a 5th grade general education

teacher, based on age appropriate social and language skills, a history of positive interactions with students with disabilities, and willingness to participate as a peer buddy. The general education and special education teachers provided recommendations for the student pairings in the participant peer dyads. Vincent was an African American male who was paired with Zion (dyad 1), Nicole was a Mexican American female who was paired with Madison (dyad 2), and Trevor was an African American male who was paired with Luke (dyad 3). Institutional review board approval and informed consent and assent was obtained for the study.

Procedure

Setting

The study took place in the self-contained special education classroom. This setting contained four group worktables, with a large rug at the front of the classroom that served as the morning meeting area and play space. Play materials included blocks and Lego®, musical instruments, arts and craft materials, play sets (e.g., kitchen, zoo, trains), and various games. During free play "choice time," students could select among these items. In a corner of the classroom, there was a reading area with a bean bag and bookshelves, and a desktop computer station was at the back of the classroom. Baseline and intervention sessions with the participants and peers took place either on the play area rug or the table adjacent to the rug. The paraprofessionals and other students were in the classroom during sessions but were engaged in their typical classroom activities (e.g., small group activities, one-to-one teaching, or computer time). Other than during the teacher-supported intervention sessions described below, the classroom teacher was also engaged in her regular classroom activities during all other sessions.

Research Design

A concurrent single-case multiple-probe design (Horner & Baer, 1978) across participant-peer dyads was used to examine the effects of the intervention on cooperative play, social initiations, and social responses of the peers and participants. We conducted intermittent probes during baseline and continuous probes during intervention. Sessions occurred in the afternoon at times agreed upon by the general and special education teachers and arranged so that neither the participant nor peer would be missing academic instruction time. Data were collected two to three times a week, depending upon the school schedule. Prior to each session, the participant and peer were asked if they wanted to play together that day; all children answered in the affirmative for all sessions.

Baseline

Baseline observation sessions were 10-min in duration and consisted of free play between the participant and peer in the play area of the classroom. The teacher told the participant and peer that it was time for them to play together, and the students were allowed to select any of the play materials typically available, other than computers or iPads. They were allowed to switch among available play activities if they wanted during this time (e.g., play a game and then play with blocks). The teacher provided no social skills instruction to either the participant or peer, but she provided directions or reminders as would be typical within the structure of the classroom routine (e.g., instructions on classroom expectations such as "stay on the carpet while you're playing" or reminders on what activity was next on the schedule "five more minutes of play time, and then music"). The teacher monitored the sessions but was engaged in working with other students nearby while the participant and peer played.

Teacher Training

We used a cascading coaching model (Meadan et al., 2020), or a train-the-trainer approach, in which researchers train a practitioner (i.e., the teacher), who then trains and supports multiple intervention agents (i.e., the peers). Before beginning intervention, the research team trained the teacher in the strategies used in the PMI as well as how to train peers to deliver the intervention. The training took place after school hours during a single 1-h session. Researchers provided an overview of the intervention and explained the peer-mediated strategies, which were adapted from the Stay-Play-Talk intervention (Goldstein et al., 2007; Tsao & Odom, 2006). The peer support strategies used in this study included (1) suggesting an interactive play activity, (2) staying near the friend (i.e., participant) while playing, (3) talking to the friend, (4) asking the friend questions, (5) reinforcing what the friend says and does, and (6) redirecting the friend back to the play activity if needed. A detailed description of the peer support strategies can be found in Table 1.

In addition to introducing the teacher to the peer support strategies, we also taught her to use BST to teach peers how to use the strategies and to collect data on their accuracy. We provided the teacher with a PowerPoint with visuals detailing the peer support strategies for the peer to view. We also provided a written peer training implementation checklist that detailed using BST for each of the six support strategies. We used verbal instruction, modeling, role-play, and feedback to train the teacher to implement the peer training procedures. Using role-play with the researchers, the teacher demonstrated accuracy of the peer training procedures within one training session.

Table 1 Peer-mediated intervention strategies

Strategy	Description of strategy
Suggest an interactive activity	Suggest ideas and choices of play activities to the friend that require two people to do together
Stay next to your friend	Stay in physical proximity of the friend while playing
Talk to your friend	Get the friend's attention by saying their name and looking at them, comment on the play activity, talk about things friends typically talk about such as likes, interests, school, etc
Ask your friend questions	Offer the friend choices, ask questions related to the play activity, ask the friend to help with the activity, ask questions to get to know each other better such as about likes and interests
Respond to your friend	Respond or reply to what the friend says or does, provide positive reinforcement/feedback to the friend
Reengage your friend	Reengage the friend in the activity or interaction if play ceases by providing a gentle verbal redirection

Peer-mediated intervention strategies were adapted from Goldstein et al., 2007, and Tsao & Odom, 2006

Peer Training

Following baseline, the teacher used BST to individually teach each peer to use the PMI support strategies. The first author was present during the peer training session to measure the teacher's fidelity of the training procedures or answer any potential questions from the teacher, but the research team was not otherwise directly involved in training the peers, and no additional training of the teacher occurred. Participants with ASD were not present during peer training sessions. Each training session lasted approximately 20–25 min and took place in the empty special education classroom during recess or gym periods. The teacher began the training session by telling the peers she was going to teach them some ways to help them play and interact with their friend. She shared with the peer some of the interests and preferences of their specific play partner with ASD (e.g., "Madison likes art, fashion, and Lego®" or "Zion enjoys games and Teen Titans Go!"), and she also shared some of the communicative behaviors unique to their play partner (e.g., "Luke sometimes squeals in a high-pitched voice when he gets excited. That means he's happy" or "Madison speaks in a quiet voice and may take a little while to answer when you say something to her.") Then, the teacher used BST to directly teach each of the peers the support strategies. First, the teacher used verbal instruction with the PowerPoint with visuals to introduce the strategy to the peer. Next, she modeled the strategy for the peer. Then she provided opportunities for the peer to role-play and rehearse the strategy with her and provided positive and corrective feedback following the peer's role-play of the skill. Lastly, the teacher provided opportunities for the peer to additionally role-play the skill until accurate implementation of each strategy was demonstrated. This BST process was used to teach each of the six support strategies.

Teacher-Supported PMI

Following the individual teacher training session with the peer, the teacher helped facilitate the play and provided support as the peer implemented the PMI strategies with the participant in the next scheduled play session. Prior to the play session, the teacher reviewed the PMI strategies with the peer and reminded the peer to use the strategies while playing with the participant. A visual used in the peer training session listing the strategies was available during the teacher-supported session, and the peer could refer to it freely. During the play session, the teacher visually or verbally prompted the peer to use a strategy if play or interaction was not occurring after about 1-min had elapsed (e.g., visually prompted a peer to talk to the participant or then verbally prompted the peer to talk to the participant about the play activity if the visual prompt was not effective). At the end of the play session, she identified what the peer had done well (e.g., "I love how you gave Zion a high five and told him he did a good job putting together the train track") and provided suggestions for next time (e.g., "when you're playing Candy Land, you can ask Madison what color she wants to be before starting the game"). During the teacher-supported sessions, the teacher used a dichotomous checklist to collect fidelity data on which of the six strategies the peer had implemented during the session. After the peer had independently demonstrated use of each strategy across two consecutive sessions (i.e., reached the predetermined mastery criterion), the teacher withdrew her support.

PMI

In the PMI condition, the peer independently implemented the PMI strategies in a 10-min play session. Conditions were identical to baseline, with the exception that the visual was available for the peer to refer to as they chose. The teacher

did not review the PMI strategies with the peer prior to the session, provide prompts during the session, or provide feedback at the conclusion of the session. The teacher continued to monitor fidelity of peer strategies for approximately every third session. If a peer dropped below 83% strategy use (i.e., using less than five of the six strategies), the teacher would have provided additional supported sessions; however, no peer dropped below 83% use of the PMI strategies.

Generalization

Generalization with novel peers was conducted during baseline and intervention sessions. Generalization peers were the peer partners involved in the intervention but not the participant's typical play partner. Thus, during baseline, generalization occurred with a novel untrained peer and during intervention, generalization occurred with a novel trained peer. Generalization peers were rotated across sessions.

Measures

Dependent Variables

Dependent variables included percentage of 5-s intervals engaged in cooperative play and frequency of social initiations and responses. Cooperative play was defined as the participant remaining in proximity (i.e., approximately 3 feet) to the peer and engaging in an interdependent, shared activity (MacDonald et al., 2009). Examples of cooperative play included playing a game together (e.g., Connect Four), creating something together (e.g., a shared craft activity), or engaging in pretend play in which the children took on clearly defined roles (e.g., a waiter and customer at a restaurant). Nonexamples included play activities in which the children were not playing with a shared, common purpose (e.g., playing side-by-side but separately with blocks). Cooperative play was measured using 5-s whole interval recording and was scored if both the participant and peer engaged in cooperative play during the whole 5-s interval.

We recorded frequency of social initiations and responses from both the participants and peers. Social initiations were defined as any verbal, nonverbal, or motor behaviors directed toward the play partner such as greetings, asking questions, commenting, or sharing materials. (Watkins et al., 2019b). Examples included verbal phrases such as "let's play," "watch this," or "your turn." Nonverbal or motor behavior initiations included such behaviors as a student leading the play partner to play materials, handing a play partner a toy to play with or an item to use in a game, sharing materials, or gesturing for a play partner to take a turn. If a student repeated the same initiation (such as re-asking a question if the play partner did not respond to the initial initiation), it was recorded as two initiations. If a verbal initiation was also paired with a nonverbal motor behavior (such as saying "let's color it yellow" while handing the play partner a yellow marker), it was recorded as one initiation (Hu et al., 2021). Non-examples included a smile or a look at the play partner without additional verbal or physical contact. Social responses were defined as a reply to an initiation made by the play partner (Watkins et al., 2019b). Examples included looking when the student was called, following the play partner's direction or request, answering the play partner's question, accepting materials given by the play partner, or head nodding after a play partner's comment. If a verbal response was also paired with a nonverbal motor behavior (such as saying "thank you" while accepting a toy from the play partner), it was recorded as one response (Hu et al., 2021). Non-examples included smiling or looking at the peer after he or she made an initiation but without additional verbal or physical or contact.

Interobserver Agreement

A graduate student trained to criterion in the measurement of the dependent variables conducted interobserver agreement (IOA) using a total-agreement approach (Kennedy, 2005). The primary and secondary observers established 90% agreement on independently coded videos prior to collecting IOA data for this study. The trained observer collected IOA data from recorded sessions and was masked to the study's condition in each video.

For dyad 1 (Zion and Vincent), IOA was collected for 50% of baseline sessions and averaged 100% agreement for all dependent variables. IOA was collected for 30% of Dyad 1's intervention sessions and averaged 99% for cooperative play (range 98–99%), 96% for participant initiations (range 93–100%), 98% for peer responses (range 95–100%), 91% for peer initiations (range 85–98%), and 92% for participant responses (range 85–97%). For dyad 2 (Madison and Nicole), IOA was collected for 40% of baseline sessions and averaged 100% agreement for all dependent variables. IOA was collected for 33% of dyad 2's intervention sessions and averaged 90% for cooperative play (range 85–97%), 94% for participant initiations (range 75–100%), 100% for peer responses, 86% for peer initiations (range 77–98%), and 85% for participant responses (range 80–87%). For dyad 3 (Luke and Trevor), IOA was collected for 40% of baseline sessions and averaged 99% agreement for cooperative play (range 98–100%); 100% for participant initiations, peer responses, and participant responses; and 96% for peer initiations (range 92–100%). IOA was collected for 33% of dyad 3's intervention sessions and averaged 90% for cooperative play (range 82–95%), 93% for participant initiations (range 84–100%), 92% for peer responses (range 84–100%), 88% for peer initiations (range 85–91%), and 89% for participant responses (range 79–100%). Some of the lower IOA results

occurred due to background noise in the classroom and some vocalizations being difficult to hear on recordings.

Procedural Fidelity

Researchers collected peer procedural fidelity data for 100% of baseline and treatment sessions across all dyads, and the teacher monitored peer use of strategies for 35% of PMI sessions. Researchers collected fidelity data from video recordings of sessions, and the teacher collected in vivo fidelity data. Other than reviewing and receiving feedback on their use of strategies in teacher-supported sessions, peers were not directly aware of fidelity of implementation measurement. Procedural fidelity was measured using a dichotomous checklist that included the six essential components of the peer support strategies (i.e., suggesting an interactive play activity, staying near the buddy, talking to the buddy, asking the buddy questions, providing positive reinforcement to the buddy, and redirecting the buddy back to the play activity if needed). Procedural fidelity was determined by dividing the number of checklist items scored as correct by the total number of checklist items and multiplying by 100%.

During baseline sessions prior to training, peers used an average of 26.2% of the strategies (range 0–50%). During teacher-supported PMI sessions, peers used an average of 93.8% of the strategies (range 67–100%). During independent PMI sessions, peers used an average of 96.5% of the strategies (range 83–100%). Teacher fidelity data compared to researcher fidelity data indicated 100% agreement.

Social Validity

Social validity was assessed both pre and post intervention. Prior to the intervention, researchers collaborated with the teacher to ensure the suitably of intervention goals and procedures, including the time and resources required to implement the intervention. Prior to the intervention, the participants were asked if they would like to play with new friends and what kinds of activities they like to do with friends, and the teacher was asked about social goal priorities for each participant. Post intervention, the participants were asked if they liked playing with their peer buddies and what kinds of activities they had liked the most. Post intervention, peers were asked if they enjoyed playing with the participant, if they thought the support strategies were easy to use or helpful, if there was anything challenging about using the support strategies, and if they would like to do more things at school with their peer buddy. Social validity feedback from participants and peers was communicated vocally through open response questions. Post intervention, the teacher completed a researcher created questionnaire on the acceptability of the intervention goals, procedures, and outcomes using a Likert scale and open response questions.

Data Analyses

We collected data on the dependent variables from video recordings of sessions, and then subsequently graphed the results. We performed visual analysis of graphed data by examining changes in trend, level, and variability in responding across phases to determine whether a functional relation between the independent variable and dependent variables was demonstrated (Kratochwill et al., 2010). In addition to visual analysis interpretation of the data, we calculated Tau-U, a nonparametric effect size estimate suitable for single case designs to examine within-phase and across-phase difference (Parker et al., 2011). Though not interpreted as a strict benchmark nor as a magnitude of effect, a Tau-U effect size estimate of 0.20 typically indicates a small change or effect, 0.20 to 0.60 indicates a moderate effect, 0.60 to 0.80 indicates a large effect, and above 0.80 indicates a very large effect (Vannest & Ninci, 2015). We used a web-based tool to calculate effect sizes (Vannest et al., 2011).

Results

Cooperative Play

Figure 1 shows the percentage of intervals the participant and peer dyad engaged in cooperative play during baseline, teacher-supported PMI, and independent PMI sessions. Visual analysis indicated a functional relation between the intervention and cooperative play, and Tau-U results indicated very large effects. Cooperative play in generalization sessions showed similar increases in the intervention phase compared to baseline.

During baseline, cooperative play for Zion and Vincent showed a low level and decreasing trend ($M = 7.3\%$, range 0–15%). During the teacher-supported PMI sessions, cooperative play immediately increased in the two supported sessions ($M = 74.5\%$, range 57–92%). Following the teacher's removal of support in the PMI condition, cooperative play remained at a high and relatively stable level ($M = 90.3\%$, range 75–100%). Tau-U equaled 1.

During baseline, cooperative play was not observed for Madison and Nicole during any of the play sessions ($M = 0\%$). During the teacher-supported PMI sessions, cooperative play immediately increased during the first session, followed by a decrease that was still above baseline levels, before increasing again and remaining stable across the final two teacher-supported PMI sessions ($M = 56.5\%$, range 21–71%). Following the teacher's removal of support in the PMI condition, cooperative play remained at levels above baseline, with some variability before demonstrating stability in the final three sessions ($M = 58.6\%$, range 33–73%). Tau-U equaled 1.

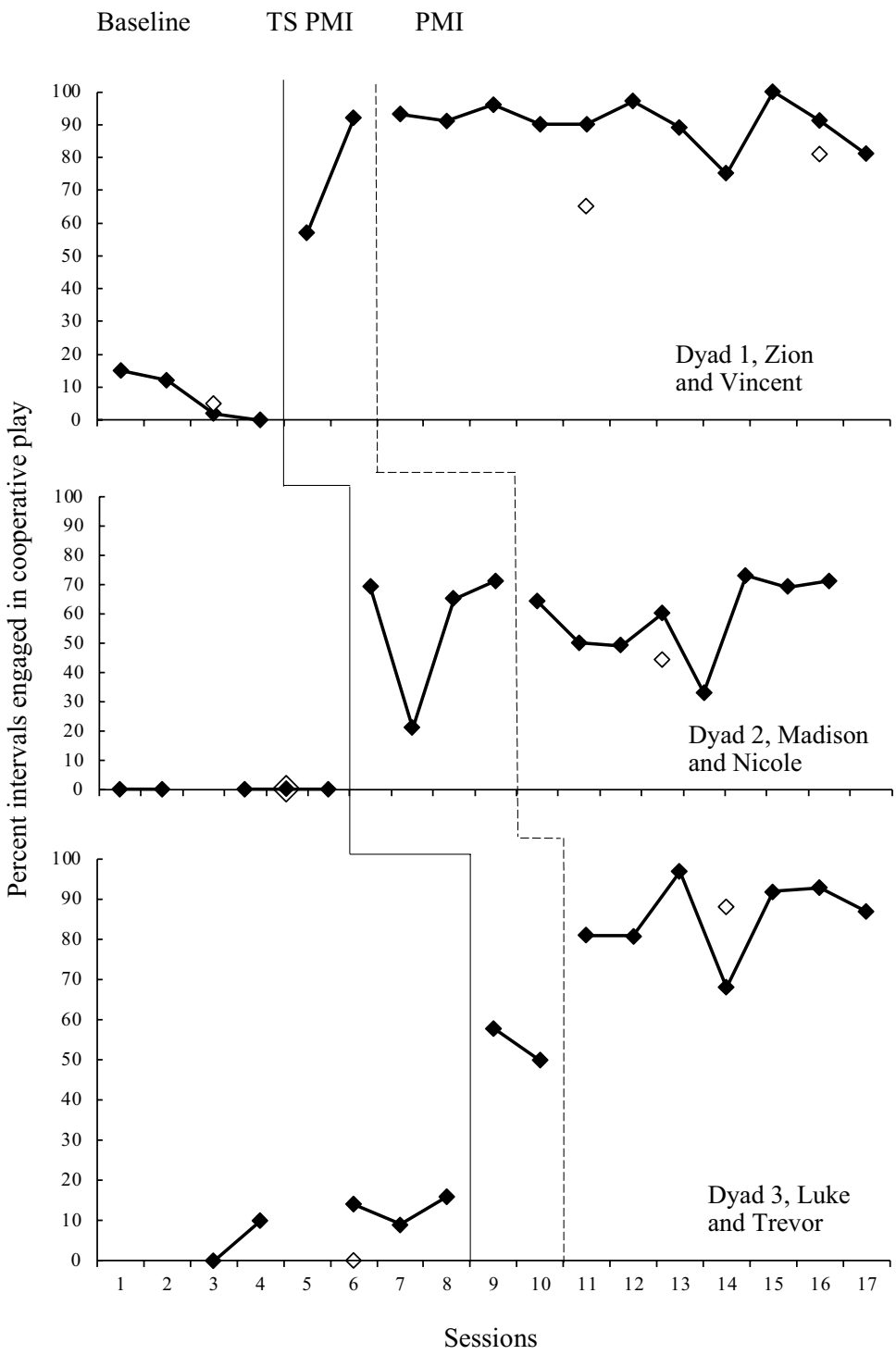

Fig. 1 Cooperative play. Percentage of 5-s intervals participant and peer dyads engaged in cooperative play in baseline, teacher-supported peer-mediated intervention (TS PMI), and PMI. Open characters indicate generalization probes

During baseline, low levels of cooperative play, with a slightly increasing trend, were observed for Luke and Trevor ($M = 9.8\%$, range 0–16%). During the teacher-supported PMI sessions, cooperative play immediately increased in level during the two supported sessions ($M = 54\%$, range 50–58%). Following the teacher's removal of support in the PMI condition, cooperative play remained at a high level with some initial variability before demonstrating stability ($M = 85.6\%$, range 68–97%). Tau-U equaled 0.87.

Peer Initiations and Participant Responses

Figure 2 shows the frequency of peer initiations and participant responses. Visual analysis indicated a functional

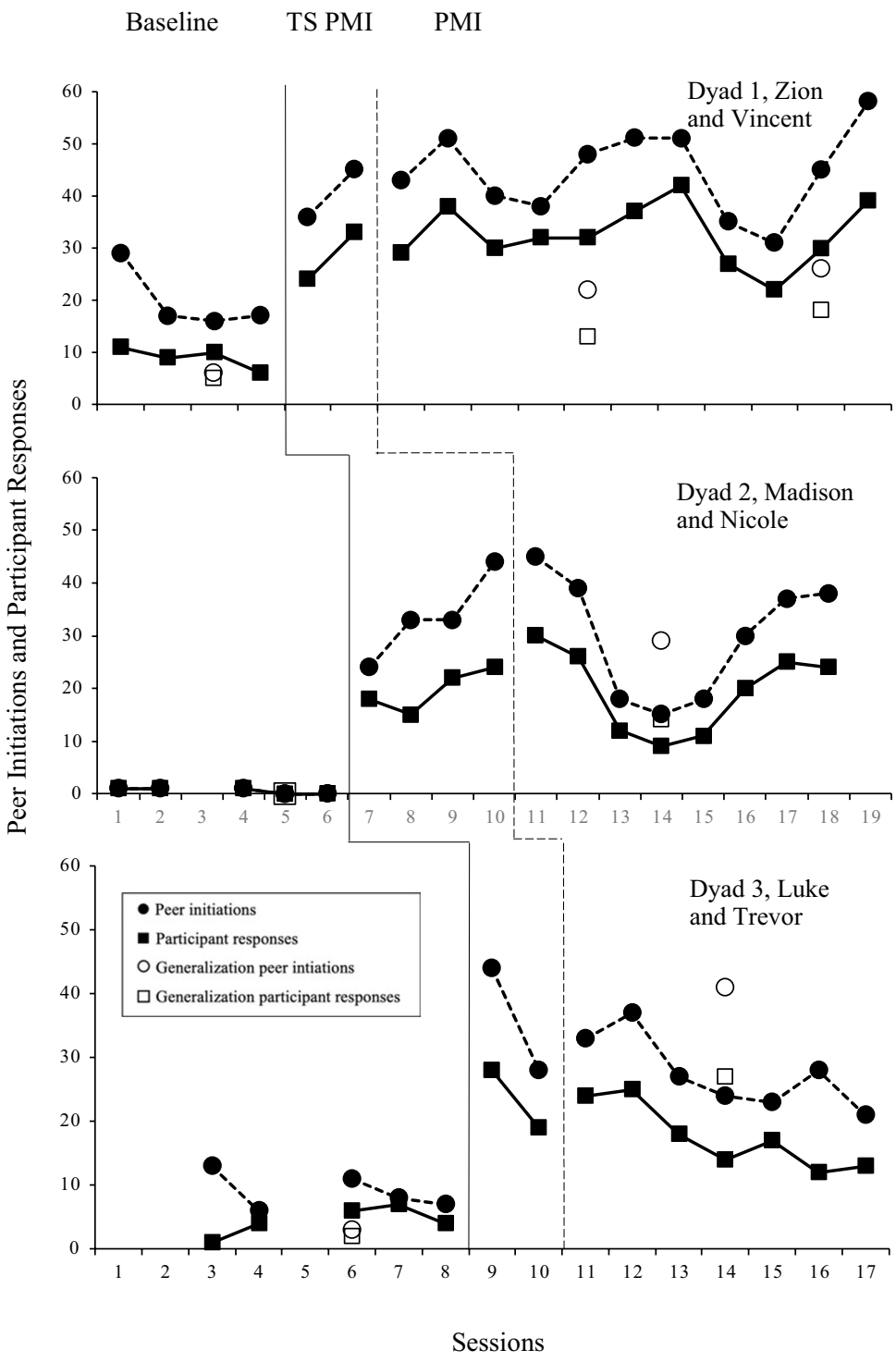

Fig. 2 Peer initiations and participant responses. Number of peer initiations (circles) and number of participant responses (squares) in baseline, teacher-supported peer-mediated intervention (TS PMI), and PMI. Open characters indicate generalization probes

relation between the intervention and peer initiations and participant responses, and Tau-U results indicated very large effects. Initiations and responses in generalization sessions for dyads 2 and 3 showed similar increases in the intervention phase compared to baseline, with initiations and responses for dyad 1 showing less robust evidence of generalization, though still improved from baseline.

During baseline, Vincent initiated to Zion an average of 19.8 times per session (range 16–29), and Zion responded to 45.6% of peer initiations. In the teacher-supported PMI sessions, peer initiations immediately increased ($M = 40.5$, range 36–45) and remained at elevated levels throughout the remainder of the PMI condition ($M = 44.6$, range 31–58). Zion responded to 72.7% of peer initiations during PMI

sessions. Tau-U equaled 1.0 for peer initiations and 1.0 for participant responses.

During baseline, Nicole initiated to Madison an average of 0.6 times per session (range 1–0), and Madison responded to 100% of peer initiations. In the teacher-supported PMI sessions, peer initiations immediately increased ($M = 33.5$, range 24–44) and remained at elevated levels throughout the remainder of the PMI condition ($M = 30$, range 15–45). Madison responded to 63.1% of peer initiations during PMI sessions. Tau-U equaled 1.0 for peer initiations and 1.0 for participant responses.

During baseline, Trevor initiated to Luke an average of 9 times per session (range 6–13), and Luke responded to 48.9% of peer initiations. In the teacher-supported PMI sessions, peer initiations immediately increased ($M = 36$, range 28–44) and remained at higher levels compared to baseline throughout the remainder of the PMI condition, though a decreasing trend in peer initiations, with a subsequent decrease in participant responses, was observed ($M = 27.6$, range 21–37). Luke responded to 64.2% of Trevor's initiations during PMI sessions. Tau-U equaled 1.0 for peer initiations and 0.89 for participant responses.

Participant Initiations and Peer Responses

Figure 3 shows the frequency of participant initiations and peer responses. Visual analysis indicated a functional relation between the intervention and participant initiations and peer responses, and Tau-U results indicated large to very large effects. Initiations and responses in generalization sessions for dyads 2 and 3 showed similar increases in the intervention phase compared to baseline, with initiations and responses for dyad 1 showing less robust evidence of generalization, though still improved from baseline.

During baseline, Zion initiated to Vincent at low levels ($M = 4$, range 2–6), and Vincent responded to 87.5% of Zion's initiations. In the teacher-supported PMI sessions, participant initiations increased ($M = 9$, range 6–12) and remained at increased levels throughout the remainder of the PMI condition, though responding was variable ($M = 18.2$, range 6–29). Vincent responded to 93.1% of Zion's initiations during PMI sessions. Tau-U equaled 0.96 for participant initiations and 1.0 for peer responses.

During baseline, Madison did not initiate to her peer Nicole ($M = 0$), which allowed zero opportunities for Nicole to respond. In the teacher-supported PMI sessions, participant initiations increased modestly ($M = 1$, range 0–2) and remained at similarly increased levels throughout the remainder of the PMI condition ($M = 2.5$, range 0–4). Nicole responded to 83.3% of Madison's initiations during PMI sessions. Tau-U equaled 0.75 for participant initiations and 0.75 for peer responses.

During baseline, Luke initiated to his peer Trevor infrequently ($M = 0.8$, range 0–1), and Trevor responded to 75% of Luke's initiations. In the teacher-supported PMI sessions, participant initiations increased ($M = 8.5$, range 6–11) and remained at variable but increased levels throughout the remainder of the PMI condition, with an increasing trend toward the end of treatment ($M = 11.3$, range 4–21). Trevor responded to 89.6% of Luke's initiations during PMI sessions. Tau-U equaled 1.0 for participant initiations and 1.0 for peer responses.

Social Validity Findings

The teacher provided feedback on the feasibility of the intervention using a 5-point Likert Scale. She strongly agreed (rating = 5) that the intervention was time and cost effective, the training process was efficient, the intervention was effective in improving interactions and was beneficial to both the participants and peers, the students seemed to enjoy the intervention, she would likely continue to use this strategy, and it would be beneficial for other typically developing students in the school to be receive training in the strategies. She also noted that she "gained confidence in implementing the intervention in [her] classroom" as a result of the training. The teacher reported that the most difficult aspect of the intervention involved coordinating with the general education teachers to schedule consistent push-in times with the general education peers. Due to typical changes in schedule in the both the special education and general education classrooms (e.g., field trips, assemblies, testing periods), consistent scheduling at times was challenging.

The participants and peers provided informal feedback following the conclusion of the intervention. When asked who his friends at school were, Zion named both Vincent and Trevor, as well as a peer not involved in the intervention who had reportedly started playing with them during recess. Zion noted that he liked playing with the peer, particularly playing games with Vincent in the classroom and playing tag on the playground with Vincent, Trevor, and the peer not involved in the intervention. He reported that playing with his friends made him "feel happy" and that he liked his friends because "they are also happy." Madison identified Nicole as her friend, noted that she liked playing with her, and said that she liked to "play Lego®, do art, and talk about hair[styles]" with her. When asked how she felt when she played with Nicole, Madison also reported that she felt happy. Luke identified Trevor as his friend, noted that he liked playing with him, and when asked how he felt while playing with Trevor, he reported "happy and better". Luke also said that he liked "to tell him Happy Birthday, Trevor" when they were playing together on Trevor's birthday.

All peers also named their play partners as their friends. Vincent indicated that he enjoyed playing with Zion and

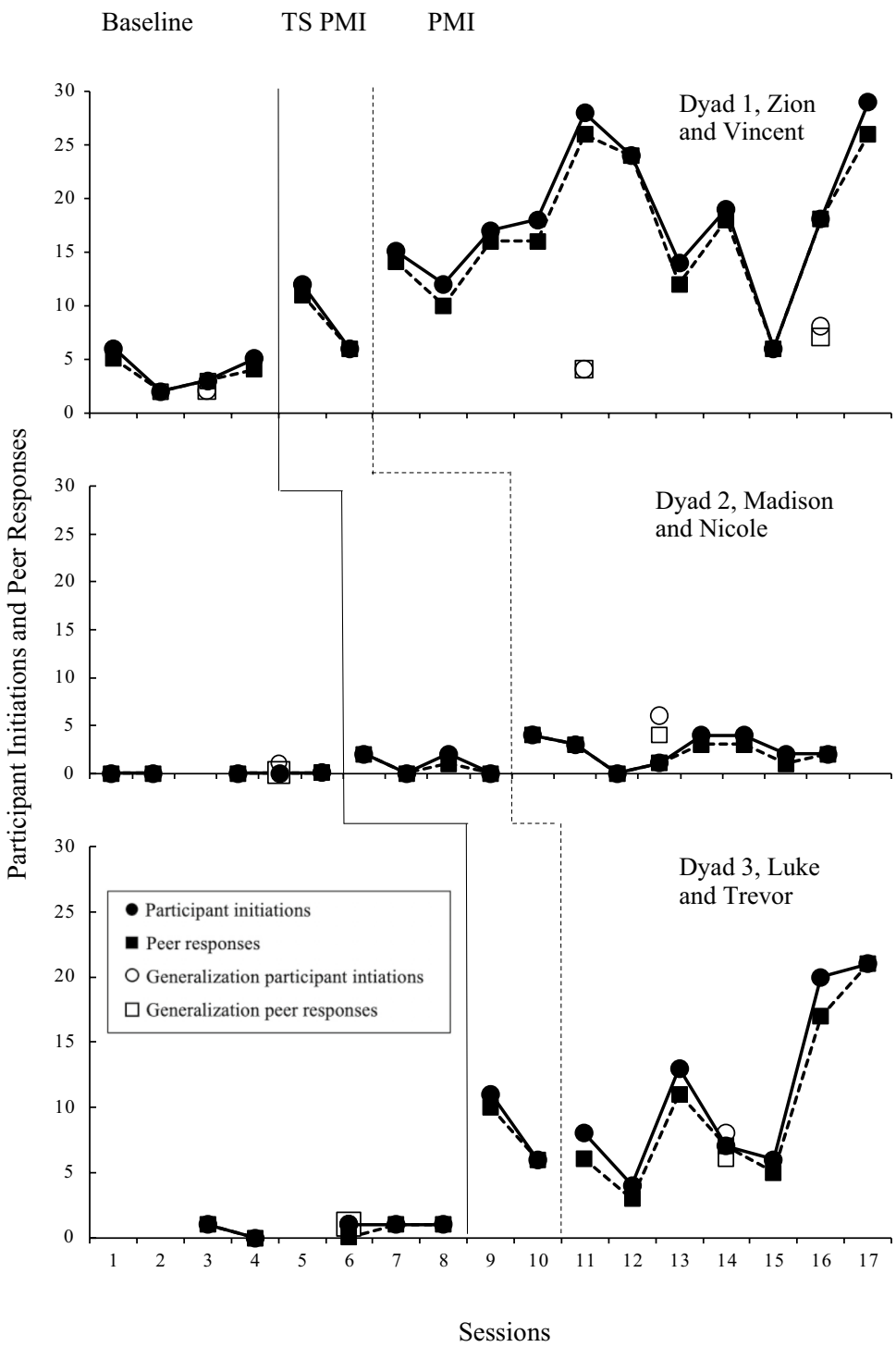

Fig. 3 Participant initiations and peer responses. Number of participant initiations (circles) and number of peer responses (squares) in baseline, teacher-supported peer-mediated intervention (TS PMI), and PMI. Open characters indicate generalization probes

noted that Zion seemed more interested in trying different types of play activities with him as the sessions continued. He reported that he found it "a little hard" in the beginning to remember to use the strategies but that he found the strategies helpful, and it became easier as the intervention progressed, and he felt more confident. He said playing with Zion "was great all around" and that he would like to do more with him in other classes. Nicole indicated that she enjoyed playing with Madison, that the strategies were helpful, and that using them helped her "play with [Madison] better" and that Madison then started to "talk to [Nicole] more." Nicole noted that she especially liked doing art projects with her and that Madison was "really good at it." Nicole reported that a challenging aspect of the intervention

was when Madison would get distracted or upset by other students in the classroom, and she found it difficult to redirect and reengage her back to the play activity. She indicated that she would like to play more with her. Finally, Trevor also indicated that he enjoyed playing with Luke and that the strategies were easy to use and helpful. He noted that he liked how Luke and he were both "good sportsmen" when they played games together. Like Nicole, Trevor also reported that the most challenging part of the play sessions were when Luke got distracted by other students or activity happening in the classroom. He also indicated that he would like to continue playing with Luke.

Discussion

This study contributes to the growing body of research supporting the efficacy of PMI strategies to support social interactions for students with ASD and their peers (Hume et al., 2021) in several ways. First, it extends the evidence of Stay-Play-Talk PMI strategies used widely with younger children with ASD in early childhood settings to an older population of school-age children (e.g., Tsao & Odom, 2006) and, more specifically, to a diverse population not well-represented in the autism literature (Pierce et al., 2014; Watkins et al., 2019a). In addition, this study provides further evidence of the efficacy of using BST to teach natural intervention agents to implement evidence-based strategies with children with ASD (Leaf et al., 2015; Ledbetter-Cho et al., 2020), as well as extends the evidence of a cascading coaching model, or a train-the-trainer approach (Meadan et al., 2020), to the implementation of a school-based PMI. Studies examining cascading coaching models have shown positive effects in teaching typical intervention agents to train additional natural intervention agents (e.g., researchers teaching early interventionists to train parents, Meadan et al., 2020; researchers teaching parents to train peers, Raulston et al., 2020; researchers teaching parents to train siblings, Sheikh et al., 2019), with resulting increases in interaction and play for children with ASD. The results of the present study extend this area of research and demonstrates promise in using a cascading coaching model to teach educators to train peers to implement evidence-based strategies for students with ASD in the context of a typical classroom setting.

As social interaction between children with autism and their peers may decrease particularly in the upper elementary grades (Rotheram-Fuller et al., 2010), feasible and effective interventions for this age group are especially relevant. Although participant initiations were not directly taught, the number of initiations directed toward peer partners increased substantially over the course of the intervention for some participants. These results align with previous interventions demonstrating social initiations for children with ASD can increase when paired with peer partners who have well developed social and language skills (e.g., Harper et al., 2008; Katz & Girolametto, 2015; Watkins et al., 2019b). An increase in participant initiations can help maintain more balanced peer interactions, whereby the interaction does not consist solely of initiations from the peer and responses from the child with ASD. This was demonstrated by the 3rd dyad. Although peer initiations demonstrated a decreasing trend during PMI, with a subsequent decrease in participant responses, participant initiations simultaneously showed an increasing trend. In other words, as Luke's initiations (and his peer's responses) increased throughout intervention, his peer partner's initiations (and Luke's responses) decreased, which suggests a more balanced interaction with greater reciprocity compared to baseline and as the intervention progressed. Future work should continue to examine whether PMI may improve the reciprocity of social interactions and relationships between children with ASD and their peers (Travers & Carter, 2022).

We also observed variability in initiations and responses during intervention. This variability in responding may be due to the activities and materials chosen by the children which often differed from session to session. Given the child led design of the intervention, the children were free to suggest and select play activities and materials of their choosing. Certain activities may have been more conducive to social interaction between the children (e.g., playing a board game together versus building blocks); however, we elected not to dictate the play activity as offering choice to children with disabilities can increase motivation and is important to the development of self-determination skills (Kurth et al., 2015). Nor did the teacher direct peers to use each intervention strategy a certain number of times within each intervention session. Even though peers used most strategies consistently across intervention sessions, this may have led to variability in the peers' use of the strategies, which contributed to variability in responding. However, we aimed to facilitate naturalistic interactions by allowing the peers to use the strategies to support and maintain play as they felt appropriate, with the intent that the peer's role was that of a friend and playmate, rather than the role of an instructor or teacher. The variability in initiations and responses may also be due to implementing the intervention in the natural environment of the classroom. During intervention sessions, multiple activities were occurring with other students within the classroom, as is typical, and disruptive behaviors from other students not participating in the intervention sometimes occurred. This may have led participants to become distracted during play sessions. For example, Madison often seemed preoccupied with the behavior of other students and the activities they were participating in with the teacher or paraprofessionals while her play sessions were occurring. Although the intervention produced increases in cooperative

play, initiations, and responses within the typical classroom setting for all participants, some students with autism may benefit from peer play sessions with fewer potential environmental distractions. However, depending on the set up of a classroom and resources (e.g., space, availability of support staff) this may not always be feasible. These findings are similar to those of Ousley et al. (2022), who also reported variability in responding during child-selected activities taking place in a home setting with similar yet typical disruptions that occur in the natural environment.

Using a cascading coaching model to teach the teacher to train the peers was neither time nor resource intensive, which makes such a model a potentially attractive option in typical school settings. Following the initial training from the research team, the teacher was able to implement peer trainings and facilitate and monitor intervention sessions independently, with no follow-up coaching from the research team required. The BST training package was efficient and effective in teaching the teacher how to train peers to use PMI strategies with fidelity, and after individual training with the teacher, peers quickly demonstrated use of the strategies within 2–4 teacher-supported play sessions. While some peers may require additional teacher support or training, no further peer training was provided in this study. The teacher was also able to accurately monitor the peers' use of strategies during intervention using a simple checklist, which she indicated was feasible to use in her social validity feedback. These findings align with prior research that has found that BST is associated with high implementation fidelity and that modeling, written implementation instructions, and performance feedback (all strategies employed in the present study) are predictors of intervention success (Brock et al., 2017). Such efficient, low intensity strategies to support peer interaction may be more acceptable and readily adopted into classroom practice than those that involve multiple trainings and extensive adult involvement. Although peers were trained individually by the teacher for purposes of demonstrating experimental control within a single case design, in actual practice, teachers may find it even more efficient to train peers simultaneously in small groups.

Social validity results also indicated a high level of satisfaction across the teacher, participants, and peers and would seem an acceptable way to implement PMI in elementary school settings. However, the teacher noted that the most difficult aspect of intervention involved coordinating consistent peer push-in times with general education teachers. A lack of time for planning and collaboration between general and special education teachers is often noted in the literature, and such time is vital in providing effective, inclusive services for students with disabilities (Billingsley & Bettini, 2019). Peer feedback was also positive, though each peer noted that reengagement/redirection was the hardest strategy to use if the participant became distracted or unengaged in the play session, and they felt unsure in redirecting the participant back to the play activity if the initial attempt to redirect was not successful. Redirection is not typically included in Stay-Play-Talk procedures, and though peers were not instructed to continuously redirect a participant back to the play activity if their initial attempts were unsuccessful to avoid creating a coercive dynamic, asking a peer to redirect the behavior of another student may be viewed as burdensome or uncomfortable, and the use of this strategy may need to be reconsidered or refined in future interventions. Within the peer-mediated literature, research that examines how to extend benefits and reduce costs (or burdens) to peers continues to be an important focus (Goldstein et al., 2007). If possible, limiting distractions during play sessions may also help prevent the need for redirection. Interestingly, the teacher anecdotally noted that participants more often played with their peers during recess following intervention, and the peers noted that other general education students joined in with them during this time. Examination of generalization across settings to further support the social validity of this approach is warranted.

Finally, a goal of this study was to extend the research supporting the efficacy of PMI for students with diverse characteristics. The results of this study demonstrate that PMI can also be effective for students with co-occurring intellectual disabilities and those with limited language skills and more severe characteristics of ASD. Indeed, all students with ASD may benefit when paired with responsive peer partners who are trained to support interactions and are knowledgeable of how the child with ASD communicates. This is illustrated particularly with the increases in play and interaction demonstrated by Madison and Luke, who had more severe symptoms of ASD and more limited language and play skills. This study also extends the existing PMI literature by including participants who reflect the cultural and ethnic diversity of autism. Given the limited data from participants from minority racial and ethnic groups in intervention research, it is increasingly important for researchers to extend the support of evidence-based practices by including diverse populations (Steinbrenner et al., 2022).

Limitations and Future Research

This study is not without limitations. We did not collect maintenance data due to the study concluding at the end of the school year, and four of the children involved in the study were at new schools the following year. Researchers should endeavor to collect maintenance data to examine the durability of intervention effects. Promisingly though, the teacher indicated that she continued to use this PMI effectively with her new class of students the subsequent year, indicating that the intervention was successfully incorporated into her regular practice. Although we found promising evidence that

improvements in play and interaction may generalize to other novel, trained peers, generalization data was limited and did not extend across settings. Future research examining the use of this PMI across other social activities (e.g., recess or lunch) or adapting the strategies for use across more academic focused times during the school day (e.g., reading centers, science experiments) is warranted. In addition, the use of whole interval recording to measure cooperative play presents some limitations and is not as accurate, for example, as duration recording procedures. Relatedly, background noise from other activities occurring in the classroom may have impacted the accuracy of the recording of the dependent variables, as additional initiations and responses could have been made that were not captured clearly on the videos. Future research may also want to consider outcomes with greater specificity, such as examining different types of interactions beyond initiations and responses and different types of play (e.g., functional vs. symbolic), to provide a more nuanced analysis of intervention effects. Finally, though commonly used to provide an estimate of intervention effect in single case design research, Tau-U (and other non-parametric measures) do not convey the magnitude of a treatment effect (Barnard-Brak et al., 2021). Thus, it is necessary to interpret these statistical findings in light of visual analysis interpretation of the results and within the specific intervention context. Finally, given the robust evidence-base of PMI, and its potential to promote inclusion and benefit both students with autism and typically developing peers, future research aimed at the further dissemination and scaling-up of this strategy through the development of resources such as free online trainings for educators that explain the characteristics of PMI, how to train peers to use the strategies, and how to implement PMI with fidelity within the typical school context, seems warranted.

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Author Contribution LW: designed and implemented the study, coded and analyzed data, and wrote the manuscript. MF: supported the implementation of the study, supported teaching training procedures, assisted in data coding and analysis, and collaborated in writing and editing the manuscript. XH: assisted in the conceptualization of the study, participated in data analysis, and collaborated in writing and editing the manuscript. KLC: assisted in the conceptualization of the study, participated in data analysis, and collaborated in editing the manuscript.

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Declarations

Ethics Approval This study was approved by The University of Alabama Institutional Review Board.

Informed Consent The teacher provided informed consent to participate in this study. Parents of all minor participants provided informed consent on behalf of their child to participate in this study. All child participants provided assent.

Conflict of Interest The authors declares no conflict of interest.

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