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ORIGINAL PAPER

Improving Collaborative Play Between Children with Autism Spectrum Disorders and Their Siblings: The Effectiveness of a Robot-Mediated Intervention Based on Lego® Therapy

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Abstract The aim of the study was to investigate the effectiveness of a brief robot-mediated intervention based on Lego® therapy on improving collaborative behaviors (i.e., interaction initiations, responses, and play together) between children with ASD and their siblings during play sessions, in a therapeutic setting. A concurrent multiple baseline design across three child–sibling pairs was in effect. The robot-intervention resulted in no statistically significant changes in collaborative behaviors of the children with ASD. Despite limited effectiveness of the intervention, this study provides several practical implications and directions for future research.

Keywords ASD · Children · Robot-intervention · Lego® therapy · Collaborative play

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Introduction

Children with autism spectrum disorders (ASD) show impairments in social reciprocity, eye contact, shared interests and enjoyment, and interpreting social cues (Weiss and Harris 2001). These social impairments affect their interactions with other children. For example, during free play, they show more parallel play than collaborative play compared to typical developing children (Bauminger et al. 2008) and during games and social activities they show problems in initiating and maintaining interactions with peers (Bauminger et al. 2003). Given these characteristics, interventions are needed to improve the collaborative skills of children with ASD and to practice working and negotiating with peers (Ben-Sasson et al. 2013).

Lego® therapy is an intervention that aims at improving skills to initiate and maintain interactions and is based on collaborative Lego® play (LeGoff 2004; Owens et al. 2008). Specific target skills are verbal and non-verbal communication (e.g., self-initiated interactions), turn-taking, sharing, reciprocity, and collaborative problem solving. The results of several studies indicate that Lego® therapy is a promising intervention in improving the initiations and duration of social contact with peers in children with ASD (LeGoff 2004; LeGoff and Sherman 2006; Owens et al. 2008). Until now, research on the effectiveness of Lego® therapy mainly focused on therapy groups in which only children with ASD participated. No Lego® therapy studies are conducted in which social skills were trained in interactions between children with ASD and typical developing peers or siblings.

Robotic interventions are also used to improve the interaction skills of children with ASD. A robot can model social behavior, respond to a child, or mediate social behavior between children (Scassellati et al. 2012). Studies involving robots have focused on a range of social target behaviors such as imitation (e.g., Duquette et al. 2008), basic social interaction skills (e.g., Robins et al. 2004a) and joint attention (e.g., Robins et al. 2004b). In their review on the clinical use of robots for children with ASD, Diehl et al. (2012) concluded that, it is difficult to draw firm conclusions on effectiveness, because most studies are only exploratory and have methodological limitations. Furthermore, as most studies on robotic interventions in children with ASD involve qualitative reports, there is a need for studies providing quantitative measures (Scassellati et al. 2012). Recently, Huskens et al. (2013) investigated the differential effectiveness of an intervention that was conducted by a robot and a human trainer. A concurrent multiple baseline design and quantitative measures were used and it could be concluded that the robot-intervention was effective in increasing the self-initiated questions of children with ASD. For future research, Huskens et al. (2013) suggested to deploy robots as mediators to enhance the social interaction between a child with ASD and others (e.g., parents, peers, siblings) and to assess the social validity of robot-mediated interventions.

Parents of children with ASD often report difficulties in play between their children (Ferraioli et al. 2012). Interactions between a child with ASD and his/her sibling are often more negative than the interactions between two typically developing siblings. In improving the interactions between children with ASD and their siblings, several types of interventions have been used. In the study of Baker (2000), for example, improvements in interactions with siblings were the result of teaching children with ASD play interactions based on their thematic ritualistic behavior. Also, sibling mediated interventions have been used in improving interactions (e.g., Tsao and Odom 2006; Walton and Ingersoll 2012). In such interventions, siblings of children with ASD are taught strategies in promoting social interactions of their brother or sister with ASD. For example, Walton and Ingersoll (2012) used a sibling-implemented reciprocal imitation training in improving imitation and joint engagement in four boys with ASD, aged 45–57 months (3;9–4;9 years). Although all of the children with ASD showed some improvements during treatment, skill gains were found to be inconsistent across children.

Given the upcoming evidence for both robotic interventions and Lego® therapy in improving social skills of children with ASD, these two principles are combined in the current study. The aim of our study was to investigate the effectiveness of a brief robot-mediated intervention based on Lego® therapy between children with ASD and their siblings, during play sessions. We hypothesized that the combined intervention would improve the collaborative behaviors (i.e., initiations, responses and play together) of the children with ASD.

Methods

Participants

Three pairs of children participated in the study; a pair consisted of a child diagnosed with ASD and his/her sibling. Inclusion criteria for the children with ASD were: (a) age 5–13 years, (b) a full-scale IQ above 80, (c) an ASD diagnosis according to the DSM-IV criteria (American Psychiatric Association 2000) (clinical judgment) and (d) not participating in other interventions on social play skills or peer/sibling interaction during the intervention period.

Inclusion criteria for the siblings were: (a) a typical developing (TD) child who lives at home, (b) age 5–13 years, having a maximum age difference of 5 years with their brother or sister with ASD (to reduce possible influences of developmental age differences), and (c) visiting a regular elementary or regular secondary school.

Table 1 displays the characteristics of the included participants. Pair 1 consisted of two twin brothers. For all children the Social Communication Questionnaire (SCQ: Rutter et al. 2003; Dutch translation: Warreyn et al. 2004) was filled in by parents. The SCQ-score of Chris (pair 2; score 14) did not meet the ASD cut-off score of 15. However, his diagnosis was confirmed by a psychiatrist according to the DSM-IV criteria. Participation of the children was on a voluntary basis (i.e., no compensation) and informed consent was obtained from their parents. The study was approved by the Ethics Committee of the Faculty of Social Sciences of the Radboud University Nijmegen.

Setting and Materials

The sessions were conducted in a small meeting room at the Dr. Leo Kannerhuis, a treatment facility for individuals with Autism Spectrum Disorders. Lego® was used as play material for the children and consisted of 16 Lego® constructions. During baseline, assignment cards (with a written assignment and a photograph of the Lego® construction) and

Table 1 Child characteristics

Pair	Child	Age[a]	Gender	Diagnosis	SCQ-score[b]
1	Brett	10;1	Male	ASD, ADHD	24[c]
	Alex	10;1	Male	–	1
2	Chris	09;1	Male	Asperger Syndrome	14
	Debby	11;5	Female	–	8
3	Eric	05;7	Male	ASD	18[c]
	Felicia	07;4	Female	–	1

[a] Years; months

[b] Social Communication Questionnaire Total score

[c] Above cut-off score (≥15) for ASD

a general rule board were used. The assignment cards indicated what the children had to build and the general rule board consisted of six general play rules. During the intervention sessions, a NAO robot from Aldebaran robotics was placed in front of the children (just within reach) on the table. This robot was 57 cm tall, had a neutral color, a 'simple' face (only mouth and eyes), a syntactic Dutch female voice, and it could move its arms, legs, and fingers. In addition, the robot had a microphone, a speaker, digital cameras, and touch sensors. The speech of the robot was preprogrammed. To control the robot, a laptop was used by the trainer. TiViPE—a visual programming environment—was used for programming the robot (Barakova et al. 2013). Above that, an additional game rule board with four play rules, two role cards, four little instruction booklets with building steps, and three pictures of the Lego® construction for sessions four and five, were used in the intervention. The instruction booklets consisted of the building steps for the Lego® constructions and the building steps indicated which Lego® bricks the children needed and how they had to build the Lego® construction. Finally, to record all sessions, a digital video camera on a tripod was used. This camera was placed in the corner of the rooms.

Design

A concurrent multiple baseline design across child–sibling pairs was used to investigate the effectiveness of the intervention. By using a concurrent multiple baseline design across at least three pairs, the results are controlled for alternative explanations as maturation and history (Horner et al. 2005). The pairs were randomly assigned to the different baseline lengths of three, four and five sessions. Intervention and post-intervention were in effect for respectively five and three sessions.

Data Collection and Response Categories

All sessions were videotaped. The videos were observed and coded in a randomized order. In coding the behavioral categories a continuous 10 s partial interval recording system was used. Although each session lasted 30 min, only 10 min were used for data collection for practical reasons (i.e., one observation took 1.5–2 h to complete), establishing 60 intervals per session. The recording of baseline and post-intervention sessions started after the introduction of the session by the trainer and the registration of intervention sessions started after the introduction of the session by the robot.

Data was collected on collaborative behaviors, consisting of the following behavioral categories: (a) *Interaction initiations*, consisting of questions, statements and instructions directed to the TD sibling, (b) *responses*, consisting of adequate responses to a question and adequate responses to an instruction of the TD sibling, and (c) *play together*, consisting of manipulating materials together with the TD sibling in order to achieve a common goal. The definitions of the behavioral categories are presented in Supplementary material 1. Data was collected for each ASD child separately, except for 'play together' that was collected for each pair. When a behavior was present during an interval (e.g., ASD child directed a question to the TD sibling), a plus (+) was recorded on the datasheet. When a behavior category was absent during an interval, a minus (−) was recorded.

Reliability of Recording

In order to remain naïve of the intervention phase all 10-min videos were coded in a randomized order. The third author (i.e., primary observer) trained an independent, naive secondary observer (i.e., a research assistant) in recording the behavioral categories. The secondary observer was blind to the goal of the study. Interobserver agreement (IOA) was assessed on an interval-by-interval basis. Agreement was defined as both observers identifying the same behavior categories as absent or present during an interval. Disagreement was defined as both observers identifying different behavior categories as absent or present during an interval. To determine IOA, prevalence-adjusted and bias-adjusted kappa (PABAK; Byrt et al. 1993) was calculated. Before starting data collection, both observers practiced by observing independently the videos of a comparable unpublished pilot study. Instructions and recording were rehearsed until PABAK was above 0.80 on two consecutive recording sessions. The primary and secondary observer independently recorded 33 % of all sessions, equally divided across conditions and pairs. Observations started after participants finished all phases of the intervention.

Mean overall PABAK was 0.91 (SD = 0.06, range 0.81–0.99) indicating excellent agreement between the two observers (Cicchetti et al. 2006). Mean PABAK for the behavior categories were also excellent (i.e., interaction initiations $M = 0.92$, SD = 0.04; Responses $M = 0.94$, SD = 0.05; Play together $M = 0.85$, SD = 0.15).

Dependent Measures

For each child with ASD, the percentage of occurrence of each separate behavior category was calculated by dividing the number of pluses for that behavior category by the total number of registered intervals (i.e., 60), multiplied by 100 %. It was hypothesized that the percentages of occurrence of all behavior categories would increase during intervention.

Procedures

A detailed description of the procedures are presented in Supplementary material 2.

Baseline and Post-intervention

The baseline consisted of three to five 30-min sessions and the post-intervention consisted of three 30-min sessions; sessions were implemented once a week. During these conditions, the children received an assignment card and had to collaborate with each other during Lego® play for 25-min. The trainer did not provide any additional instructions and did not help the children in building the Lego® construction.

Intervention

The intervention consisted of five 30-min sessions, implemented once a week. Sessions were leaded by the robot instead of the trainer. The trainer was present during all sessions to control the robot with the laptop and to assist the robot when needed. In the session, the robot first introduced itself by telling that it would help the children to play together with Lego® during five sessions. After this, the robot explained the role of the trainer as an assistant in providing help and materials. Then, the robot explained the roles of the children during the Lego® play: one of the children would be the guide and one of the children would be the builder. The guide had to describe the instructions from an instruction booklet (task analysis) and the builder had to collect the Lego® bricks and had to put them together. The robot told the children that, in this way, they had to collaborate building the Lego® construction. While the children were working, the robot reinforced and prompted them. For example, when a child performed a role of the other child, when a child asked questions about the roles, when a child showed off-task behavior, or when a child did not do anything. The possible prompts for the guide were: (a) 'Guide, explain to the builder which bricks he needs', (b) 'Guide, explain to the builder what he has to do in this step', (c) 'Guide, wait until the builder is ready', and (d) 'Guide, can you help the builder?'. The possible prompts for the builder were: (a) 'Builder, wait for the instruction of the guide', (b) 'Builder, listen carefully to the guide', (c) 'Builder, look for the bricks you need', (d) 'Builder, put the bricks together, like the guide explained', and (e) 'Builder, can you help the guide?' A possible prompt for both children was: 'Boys, can you help each other?' The robot also reacted in cases of questions, rule violations, and other problems.

During the five intervention sessions, 19 rule violations occurred (4× Brett, 5× Chris, and 10× Eric) in which the robot had to ask the assistant for help. Most violations related to the rule to build things together (16×). All violations could be resolved by the assistant. Other problems occurred during the fourth intervention session, in which Brett as well as Chris were aggressive to their TD sibling (respectively hitting and yelling). The session of Brett and his TD sibling was interrupted for 5 min, but could be resumed. The aggression of Brett and Chris resulted in resistance in playing further by the TD siblings for 1 and 4 min respectively.

Social Validity

After the second post-intervention session, social validity questionnaires were filled in by all children and their parents to evaluate the acceptability of the procedures and the effectiveness of the intervention. All statements were rated on a 5-points Likert scale ranging from 1 (not at all) to 5 (very much). All children completed the questionnaire independently, with the exception of Eric, because he could not read. His mother helped him by reading out the statements. In the last question of the questionnaire parents and children gave the intervention a score ranging from 1 to 10.

Treatment Integrity

Data on treatment integrity was collected by an independent observer (a research assistant) for 33 % of all sessions equally divided across conditions and pairs. Treatment integrity was calculated per session and based on the ratio of number of executed components and the number of planned components (more specific, the number of events a procedural component was emitted as planned, divided by the number of opportunities to emit that component, multiplied by 100 %).

The mean percentage of treatment integrity during baseline was 94 % (SD = 3.44, range 90–98 %). During intervention, the mean percentage of treatment integrity was 98 % (SD = 1.52, range 97–100 %). Finally, during post-intervention, the mean percentage of treatment integrity was 93 % (SD = 6.19, range 82–96 %).

Data Analysis

First, data analysis involved the calculation of mean percentages of the behavior categories across conditions and visual inspection of the data. Second, to determine the effect size of the intervention, Tau-U was calculated. Tau-U can be used in single case research and examines the percentage of non-overlap of the data between conditions (Parker et al. 2011a). Additionally, Tau-U controls for a positive baseline trend (Parker et al. 2011b). Tau-U, the standard deviations of Tau-U and the p values were calculated across conditions for each pair. To calculate Tau-U, Single Case Research, a web based calculator for single case research analysis, was used (Vannest et al. 2011).

Results

Collaborative Behaviors

Interactions Initiations

Figure 1 presents the interaction initiations for all ASD participants across conditions. *Visual* inspection reveals an inconsistent pattern for all participants across conditions. Compared to baseline, all ASD participants showed more initiations during the 'guide' intervention sessions; however, during the 'builder' intervention sessions no changes were found compared to baseline. During the first intervention session all participants were builder as well as guide as two constructions were made. All participants increased the percentage interaction initiations during intervention (Brett: baseline $M = 7.78$, $SD = 6.73$, intervention $M = 17.00$, $SD = 17.73$; Chris: baseline $M = 15.00$, $SD = 9.13$, intervention $M = 37.33$, $SD = 36.87$; Eric: baseline $M = 9.00$, $SD = 3.84$, intervention $M = 11.67$, $SD = 7.64$). As expected from visual inspection, Tau-U analyses revealed no statistical significant changes for all children across conditions.

Responses

Figure 2 shows the responses of the ASD children across conditions. *Visual* inspection showed an increase in responses of Brett and Chris across sessions. Compared to baseline, Brett and Chris responded both at a higher level during intervention (Brett: baseline $M = 2.78$, $SD = 2.55$, intervention $M = 15.00$, $SD = 7.07$; Chris: baseline $M = 14.17$, $SD = 7.39$, intervention $M = 33.33$, $SD = 14.09$); however, no changes on level or trend were visible for Eric (baseline $M = 20.83$, $SD = 13.36$, intervention $M = 15.00$, $SD = 12.69$). An inconsistent pattern is shown for all participants across conditions. Tau-U analysis revealed no statistical significant changes across conditions for all children.

Play Together

Figure 3 presents the percentages of 'play together' for all participants across conditions. Visual inspection revealed a decrease for Eric and his TD sibling. Percentages varied across conditions for all pairs. Mean percentages of 'play together' decreased for all pairs during intervention, (Brett: baseline $M = 21.67$, $SD = 10.14$, intervention $M = 10.00$, $SD = 6.66$; Chris: baseline $M = 15.42$, $SD = 13.70$, intervention $M = 7.00$, $SD = 10.37$; Eric: baseline $M = 21.33$, $SD = 9.75$, intervention $M = 5.67$, $SD = 4.35$). Tau-U analysis indicated that the change for Eric and his TD sibling was statistically significant (Tau-U $= -0.96$, 90 % CI -1.00 to -0.33). During post-intervention, mean percentages of Brett and Chris were about the same as during intervention.

Social Validity

Parents reported that both the children with ASD and their siblings more enjoyed the robot sessions ($M = 4.3$, range 3–4) than the sessions without the robot ($M = 3.3$, range 3–5). Parents were mixed positive about the effectiveness of the training on improving the collaborative behaviors of their children ($M = 3.3$, range 2–5). Finally, the parents rated the robot-mediated training with a 7 ($M = 7$, range 5–9).

The children with ASD reported the sessions without the robot as a little bit more enjoyable ($M = 3.7$, range 3–4) than the sessions with the robot ($M = 3.3$, range 2–5), while the TD siblings enjoyed the sessions with the robot more ($M = 4.7$, range 4–5) than the sessions without the robot ($M = 3.3$, range 2–4). The children with ASD reported that they learned to play together following intervention ($M = 4.3$, range 3–5). The TD siblings were also positive, however they rated this item lower than the children with ASD ($M = 3.7$, range 3–4). The components of the intervention were rated as acceptable by both the children with ASD and the siblings, $M = 3.1$ (range 1–5) and 3.7 (range 1–5), respectively. In addition, all children liked to play with the Lego® ($M = 4.0$, range 3–5 for both children with ASD and their TD siblings) and liked to play with their siblings, respectively $M = 3.8$ (range 2.5–5) and $M = 3.7$ (range 3–4). The children had individual preferences to be builder or guide (ranges 1–5). The children with ASD reported the robot as exciting ($M = 4.0$, range 2–5), while the TD siblings reported it as less exciting ($M = 2.2$, range 1–4). However, both groups reported that they wished that they could have more training sessions with the robot, respectively $M = 3.3$ (range 2–5) and $M = 4.3$ (range 3–5). Finally, all TD siblings and two children with ASD rated the training as positive (respectively $M = 8.7$, range 8–10; $M = 7$, range 6–8). Eric did not rate the training, because he did not understand this question.

Discussion

The aim of the current study was to investigate the effectiveness of a brief robot-mediated intervention based on Lego® therapy on increasing collaborative behaviors of

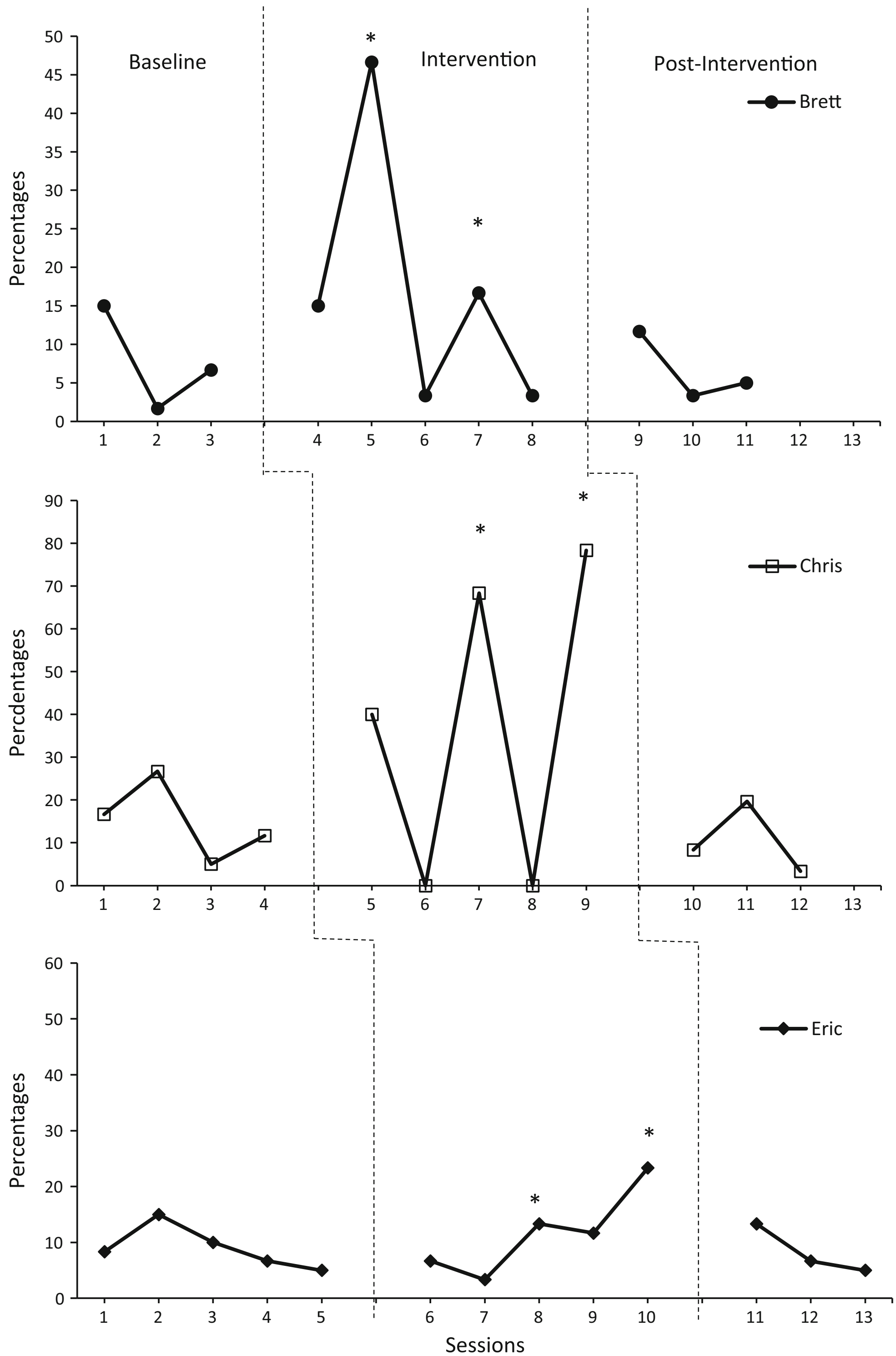

Fig. 1 Percentages of interaction initiations of ASD participants across conditions

children with ASD during play sessions with their TD siblings. Although no statistically significant changes in interaction initiations, responses and play together for the children with ASD were found, the robot-intervention revealed for two out of three pairs an increase in responses across sessions, as well as an increase in interaction initiations during the 'guide' sessions. It may be concluded that the robot-mediated Lego® therapy was not effective in improving collaborative behaviors of children with ASD, although visual analysis revealed some possible positive effects.

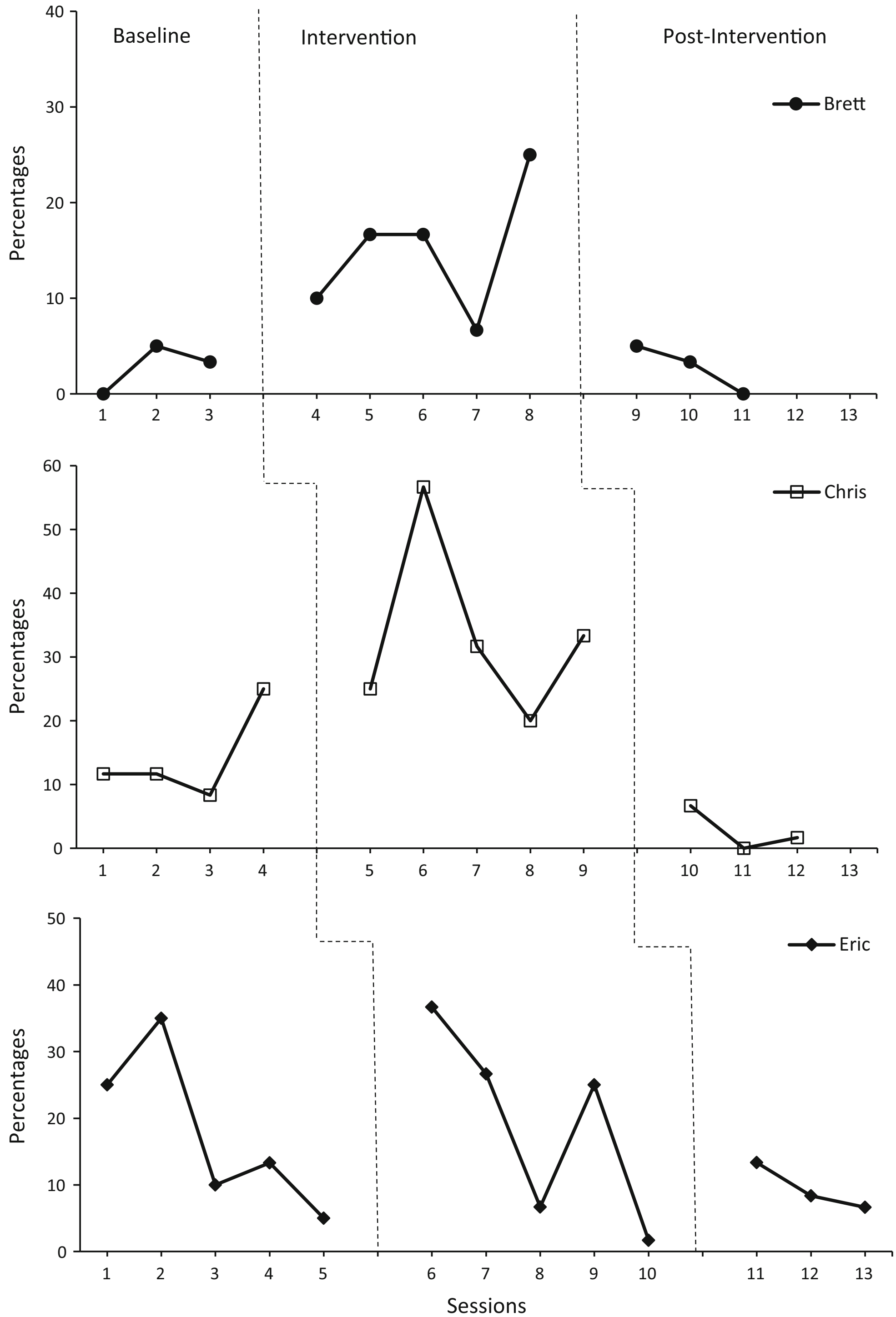

Fig. 2 Percentages of responses of ASD participants across conditions

The results of the current study are partially consistent with Owens et al. (2008) in that no significant changes in the percentage interaction initiations between baseline and the Lego® therapy intervention were found. In contrast, LeGoff (2004) and LeGoff and Sherman (2006) found increases in initiations with peers. There were several differences between the procedures of Lego® therapy in prior studies and in the current study, which may explain the inconsistent findings. These issues are discussed below.

In the current study, a robot was used. Despite the suggested benefits of the use of robots in interventions for children with ASD (Dautenhahn and Werry 2004; Diehl

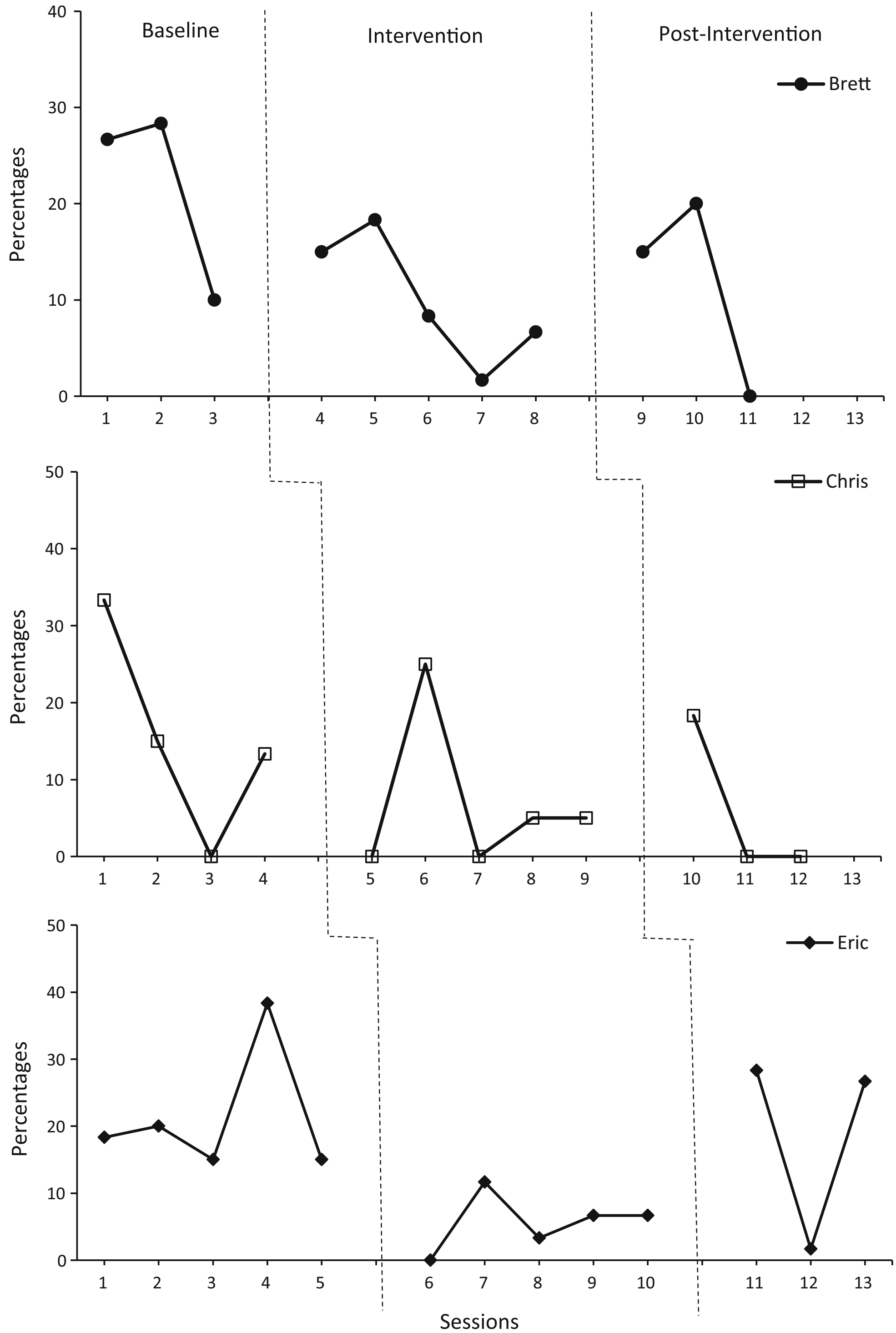

Fig. 3 Percentages of play together of ASD participants across conditions

et al. 2012), the use of a robot also induced some limitations. For example, the behavioral repertoire of the robot is limited, indicating limited prompt levels and reinforcement options. In the study of Huskens et al. (2013) a least-to-most prompt hierarchy was used with four prompt levels (i.e., open-question prompt, waiting prompt, tell-prompt, and fill-in prompt), all directed to only one target behavior (i.e., self-initiated questions). However, the current study focused on a broad range of target behaviors, related to the Lego® roles (e.g., builder has to give instructions on which

Lego® bricks are needed, and on how to put the Lego® bricks together). As a consequence, prompts needed to be directed to all of these specific target behaviors. As the robot only had a limited behavioral repertoire, no differentiation in prompt levels (e.g., least-to-most prompting) could be made for each target behavior. For example, in case of repeated incorrect responses, only the same prompt could be used directed to that specific behavior and no adaptations in prompt levels could be made by the robot. Therefore, the possibilities to adapt the robot's behaviors to the individual prompt needs and preferences of the children were limited. It is recommended to develop the robot by increasing the variability in prompt levels (e.g., least-to-most hierarchy) to respond to the children's individual needs and specific target behaviors. Some researchers start to address this problem. Greczek et al. (2014), for example, developed a computational model of graded cueing feedback, but the framework needs to be expanded to more complex interactions in the future. For now, it is recommended to use robots in interventions with only one or two specific target behaviors and not during interventions with a broader range of target behaviors, as for example Lego® therapy. Another important aspect concerns the fact that a technical assistant had to program the robot and had to be present during the sessions to set up the robot, next to the trainer. Simplifying programming the robot, could enable therapists to adapt the robot's behavioral repertoire without the help of a technical assistant. This could ameliorate the use of robots in interventions for children with ASD.

The procedures used in the current study differed from the procedures of Lego® therapy in prior studies regarding (a) the intensity of the intervention, that is compared to the studies of LeGoff (2004), LeGoff and Sherman (2006) and Owens et al. (2008), the intensity of the current intervention can be rated as low, which may have contributed to the limited results. (b) The opportunities to practice the different roles and skills, that is compared to the study of Owens et al. (2008), where children switched roles after a certain amount of time or instruction steps and when they demonstrated mastery of the skills of one of the roles, children in the current study had less opportunity to master the roles. (c) The moment of transition to more complex Lego® constructions differed, that is in the current study, no behavioral criteria were used and the moments of transitions were pre-determined, whereas in the study of Owens et al. (2008), transitions to more complex Lego® constructions were made when the children were able to build simple and quick models. (d) Baseline observations did not occur in unstructured play situations as in the study of Owens et al. (2008) and the general rules of Lego® therapy were already used during baseline. The use of the Lego® rules during baseline may have offered a certain amount of structure, which may have elicited children to show more collaborative behaviors than in unstructured play situations. In the current study different materials and types of verbal instructions were used as antecedent stimulus between baseline/post-intervention sessions and intervention sessions. It is recommended to keep these aspects constant between conditions.

The current study was the first study investigating the effectiveness of Lego® therapy for children with ASD and their TD siblings. As interactions between children with ASD and their TD siblings are often found to be more negative than between two TD siblings (Ferraioli et al. 2012) more and longer intervention sessions may also be necessary to break the negative interaction patterns and to improve results.

Results of social validity indicate that both the children with ASD and the TD siblings reported improvements in 'play together', while such improvements were not found according to the behavioral measures. This subjective perception of improvement may be caused by a placebo effect, by which participants report improvements after receiving an intervention, while real improvements are lacking (Linde et al. 2011). Another possiblity is that the children used a different definition of 'play together'.

Most studies on the effectiveness of robotic interventions in persons with ASD showed methodological limitations, decreasing their internal validity (Diehl et al. 2012). In addition, one of the major shortcomings of robot studies is the lack of quantitative measures (Scassellati et al. 2012). In the current study: (a) a single-subject design (i.e., concurrent multiple baseline design across child–sibling pairs) was used, providing control for alternative explanations as maturation and history, (b) adequate treatment integrity ($M = 95\ \%$) and interobserver agreement scores (overall $\text{PABAK} = 0.91$) were found, (c) dependent variables were quantified and operationalized in a transparent way, and (d) sufficient information was provided for replication. By taking in account these methodological characteristics, the current study substantially contributes to the research on the effectiveness of robotic interventions for children with ASD.

The current study was the first study that investigated the effectiveness of robot-mediated Lego® therapy on collaborative behaviors of children with ASD and their TD siblings. To improve the results, it is recommended in future studies to extend the intervention period with more sessions, to increase the duration of each session, to use the same materials and instructions across conditions, to switch roles more often, and to establish behavioral criteria to indicate when a child is ready for a transition to longer and more complex Lego® constructions. In order to get a more realistic impression of the target behaviors, it is also recommended to conduct baseline observations in unstructured play situations.

As long as robots cannot be programmed in a way that their behaviors could be easily adapted to children's individual abilities and needs, it may be concluded that robots may better be used in interventions that target one specific behavior than in interventions that target a broad range of target behaviors such as Lego® therapy.

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