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## RESEARCH ARTICLE

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# The impact of loose-parts-play on schoolyard social participation of children with and without disabilities: A case study

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## Abstract

**Background:** Outdoor social participation in the school playground is crucial for children's socio-emotional and cognitive development. Yet, many children with disabilities in mainstream educational settings are not socially included within their peer group. We examined whether loose-parts-play (LPP), a common and cost-effective intervention that changes the playground play environment to enhance child-led free play, can promote social participation for children with and without disabilities.

**Method:** Forty-two primary school children, out of whom three had hearing loss or autism, were assessed for two baseline and four intervention sessions. We applied a mixed-method design, combining advanced sensors methodology, observations, peer nominations, self-reports, qualitative field notes and an interview with the playground teachers.

**Results:** Findings indicated for all children a decrease during the intervention in social interactions and social play and no change in network centrality. Children without disabilities displayed also an increase in solitude play and in the diversity of interacting partners. Enjoyment of LPP was high for all children, yet children with disabilities did not benefit socially from the intervention and became even more isolated compared with baseline level.

**Conclusions:** Social participation in the schoolyard of children with and without disabilities did not improve during LPP in a mainstream setting. Findings emphasize the need to consider the social needs of children with disabilities when designing playground interventions and to re-think about LPP philosophy and practices to adapt them to inclusive settings and goals.

## KEYWORDS

children with disabilities, loose-parts-play, mainstream education, school playground, sensors, social inclusion

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## 1 | INTRODUCTION

Social participation at school, including social play, is considered crucial for children's health and social, emotional, cognitive and academic development (Gravin et al., 2015; McNamara et al., 2017; Yogman et al., 2018). The school's playground in particular plays a major role in facilitating (or inhibiting) social participation during recess (McNamara et al., 2017). The playground has the potential to provide rich opportunities for outdoor free social play, where children learn to negotiate, practice independent decision-making and develop self-regulation skills, prosocial attitudes and other socio-emotional competencies (e.g., Jarvis et al., 2014; Murray & Ramstetter, 2013; Veiga et al., 2017). However, during recess, children can also experience loneliness, exclusion and victimization (McNamara et al., 2017), which are risk factors for developing psychopathology (Bagwell et al., 1998; Deater-Deckard, 2001) and school dropouts (Frostad et al., 2014). A major group at risk is children with disabilities who are individually integrated into mainstream classes. Despite international ratifications of the UN Convention on the Rights of Persons with Disabilities (UN-CRPD) (UN General Assembly, 2006), acknowledging children's right for equal access to participation in play and other activities in the school system, research consistently shows that these children's social inclusion lags behind. Children with disabilities tend to be lonelier and more isolated at school (Evans & Plumridge, 2007; Rieffe et al., 2018; Woodgate et al., 2020; Xie et al., 2014), experience peer rejection or neglect and are often bullied (Koller et al., 2018; Lindsay & McPherson, 2011; Xie et al., 2014). Outside the classroom and in the playground, they face physical and social barriers and spend less time in play and conversation with other children (Coster et al., 2013; Fernelius & Christensen, 2017).

Various interventions have been developed to foster social inclusion of children with disabilities, yet they mostly focus on 'fixing' the child with disability through social skills training programs, thereby reinforcing the medical model of disability as an individual problem that needs to be cured (Koller & Stoddart, 2021). Although some of these programs are helpful in the short term, they do not attend environmental barriers and demand a high degree of commitment from staff and children, and their outcomes are limited (Koller & Stoddart, 2021; Woodgate et al., 2020). In this case study, we explored whether loose-parts-play (LPP), a cost-effective intervention commonly used to increase outdoor playfulness and creativity at the playground (Hyndman & Mahony, 2018), can facilitate social participation of children with and without disabilities, with the aim of enhancing social access without positing children with disabilities as a distinct group.

In LPP, children are provided with moveable materials that have no defined purposes in the playground context (e.g., tires and boxes). Minimizing adult direction as possible, the goal is to facilitate unstructured child-led play, which is crucial for the development of cognitive, emotional and social skills (Gibson et al., 2017). It has been shown that LPP increases children's physical activity (Hyndman et al., 2014), enjoyment, engagement, playfulness and creativity (Bundy et al., 2008; Engelen et al., 2018; Hyndman & Mahony, 2018). The

### Key Messages

- Children with disabilities often suffer from lack of social inclusion in mainstream schools, which may impede their socio-emotional development.
- More research is needed on interventions that focus on the school environment to facilitate outdoor social participation, in particular the playground.
- We examined the effects of a common intervention that changes the playground play environment on social participation of children with and without disabilities, integrating advanced sensors-technology with quantitative and qualitative methods.
- The experiences of children with disabilities, who did not benefit socially from the intervention, need to be included in the design and application of common playground interventions such as loose-parts-play.
- Loose-parts-play is enjoyable and engaging for children with and without disabilities and therefore would benefit from further research on its adaptation to inclusive goals.

social impact of LPP has been examined in different ways. Few studies, mostly qualitative, suggested increase in cooperative play (Bundy et al., 2008; Kuh et al., 2013; Mahony et al., 2017), and one case study found an increase in group connectedness expressed by decreased sex segregation and increased collaborative opportunities for marginalized children (Heravi et al., 2018). Yet, few quantitative studies found no improvement in indicators such as peer acceptance, social skills, peer group size (Gibson et al., 2017), or group connectedness (Gibson et al., 2018). It has been suggested that the social impact of LPP may be difficult to detect in children with high baseline level of social competence (Bundy et al., 2008) and that children at social risk may potentially benefit more from the intervention, possibly because LPP provides new social opportunities based on capacities such as creativity (Bundy et al., 2008; Gibson et al., 2017). In their meta-analysis, Gibson and colleagues (Gibson et al., 2017) concluded that more empirical quantitative evidence is needed to determine the social and emotional impact of LPP, calling for new methods for quantitative exploration of playground dynamics.

Despite the wide application of LPP since its development in 1971 (Nicholson, 1971), it has hardly been examined in relation to social participation of children with disabilities. Sterman and colleagues (Sterman et al., 2020) showed that LPP can stimulate creative and collaborative outdoor play between children with autism and/or intellectual disabilities, yet this was examined only in special educational settings. So far, only one qualitative study (Barbour, 1999) partially examined the impact of LPP on social participation in a mixed group of children with and without disabilities. More than 20 years ago, Barbour (Barbour, 1999) suggested that providing a variety of outdoor play opportunities, including loose-parts, increased interactions between children with and without delayed motor skills and

provided the first group alternatives for social play when being rejected or ignored by non-disabled peers. More updated research is therefore needed to determine the impact of LPP on social participation in inclusive settings.

## 2 | THE PRESENT STUDY

The first goal of this case study was to examine whether LPP had an impact on children's outdoor social participation. We focused on two primary school-aged classes, uniquely combining traditional with advanced observational and sensing methodologies in research on playground dynamics (e.g., Engelen et al., 2018; Gibson et al., 2018; Veiga et al., 2017). We applied a mixed-methods concurrent triangulation design (Hanson et al., 2005), where quantitative data were prioritized and qualitative data were analysed separately to cross-validate the quantitative findings and further understand them. We examined whether, compared with baseline sessions, there was a change during the intervention in social participation as measured by (a) playground social involvement, including the number of children participating in social interactions, social play and (inversely) in solitary play; (b) playground diversity of partners, including the variety of partners each child interacted with and (inversely) the level of sex segregation in children's interactions; and (c) children's centrality in the playground social network, based on peer nominations.

Next, uniquely focusing on the mainstream educational setting, we examined whether there was a difference between children with and without disabilities in baseline and changing scores of playground social involvement, diversity of partners and nomination-based network centrality. In addition, we compared between children with and without disabilities in their self-rated enjoyment of LPP. Because of lack of clear evidence on the social impact of LPP on children with or without disabilities (e.g., Hyndman & Mahony, 2018), all examinations in this study were exploratory and no specific directions were hypothesized.

## 3 | METHOD

### 3.1 | Participants

Participants were 42 Dutch primary school children at the ages of 8–11 years ( $M = 9.8$ ;  $SD = .98$ ; 45.2% females). The children belonged to two classes at the same school who attended the playground at the same recess time. During the assessment days, only these two classes attended the playground together. Two of the children had autism spectrum disorder (ASD), and one had hearing loss, all of them were boys. The school had a large playground out of which 1658 m<sup>2</sup> were available for the children during recess. The playground included grassy areas, a water canal, trees and bushes and fixed equipment including football gates, wooden bars at different heights, a climbing apparatus and a turn-around spin. Children were assessed by wearable sensors and observations at the playground six times, two of

which were baseline (T1, averaged across assessments 1 and 2) and four intervention sessions (T2, averaged across assessments 3 to 6). Peer nominations were administered twice, at T1 (at assessment 1) and at T2 (at assessment 5), and self-reports measuring enjoyment of LPP were administered at T2 (at assessment 5). Table 1 presents consent rates and data on missing cases. In addition, two teachers supervised the playground throughout all baseline and intervention sessions and they were interviewed at the end of the project.

### 3.2 | Materials

#### 3.2.1 | Playground social involvement

We measured at a group level the proportions of the number of children involved in social interactions, social play and solitary play on the playground using the System for Observing Outdoor Play (SOOP) (Engelen et al., 2018). The SOOP is an observation scheme developed to quantify different types of playground activities in a systematic and comprehensive way and was used with LPP (Engelen et al., 2018). We divided the playground into four parts. Two research students repeatedly observed each part for 1 min (one observation unit) in a clockwise manner. At each observation unit, the observers coded activity types and counted the number of children participating in each activity. We classified playground social behaviours based on the Howes Peer Play Scale (Howes & Matheson, 1992) as used by Mahony and colleagues (Mahony et al., 2017) in their study on LPP and adjusted to our research aims. Because our observations needed to cover the whole playground in very short time frames, we simplified the social play categorization by merging different types of play (simple social interactions, complementary, reciprocal and cooperative play). We also added categories for negative social interactions and coded each of the following categories as either with or without loose-parts:

**TABLE 1** Participation rates and missing cases.

	Class 1	Class 2
Total N in class	26	24
N attending regularly recess on this day of the week	25	18
N participating (positive consent)	24	18
Participation rate out of total N in class/ of N attending recess	92%/96%	75%/100%
Missing sensors <sup>a</sup> across all assessments	0	2
Missing self-reports	0	2
Missing peer nominations	0	1

Note: All participants contributed to playground observations ( $N = 42$ , 100%). Data available for examination of T2–T1 within-subject differences included sensor data ( $N = 40$ , 95%) and peer nomination scores ( $N = 41$ , 98%). Forty children (95%) filled out self-reports. Reasons for missing cases were temporary illnesses, except for one child who could not attend recesses during T2 due to reasons unrelated to the intervention. Children with disabilities provided full data at both T1 and T2.

<sup>a</sup>Cases in which there were no sensor data available either for baseline (T1) or for intervention (T2) scores.

solitary no play, solitary play, social no play (e.g., talking), social play, conflict and bullying. Unclarity was discussed between the observers and the researchers after each session and resolved with full agreement. Interrater reliability ranged from good to high. For a detailed information about reliabilities and stabilities of the study's variables, see Table 2. The number of children observed in each of the activities (social interactions, social play and solitary play) was divided by the total number of children counted during recess. These proportions were averaged across the two observers.

For children with disabilities ( $N = 3$ ), we measured playground social involvement with individual observations based on the time they were observed in various social activities. For each child with a disability, we computed the proportions of time he was involved in social interactions, social play and (inversely) in solitary play. Two researchers observed each child three times per recess (approximately every 10 min), for 2 min each time, coding the child's activities according to the aforementioned SOOP categories. We used the time-set as determined by Laevers (Laevers et al., 2005). A proportion score was calculated per activity, based on the number of times the child was involved in this activity divided by the total number of activities observed for this child during that recess. Scores were averaged across observers and across all baseline/intervention sessions. Interrater reliability was high. During individual observations, observers also counted the number of partners each child with a disability interacted with, which, unlike the sensor data (as will follow), did not focus on their variety (e.g., the number of partners was scored as one regardless of whether the child interacted with the same partner or with a different partner each time). An average score was computed per observer across all three observations per recess and then averaged across the two observers. Interrater reliability was high. This measure provided data on children with disabilities' quantity of meaningful social interactions, which could not be extracted from group observations, and which, unlike sensor data, was not based solely on physical proximity.

**TABLE 2** Reliability and stability data of playground measures.

	Statistic	Value T1	Value T2	Value across all assessments
% N children counted in playground activities	Interrater reliability ICC <sup>a</sup>	.883	.726	
% Time in social interactions (children with disabilities)	Interrater reliability ICC <sup>b</sup>			.851
N of partners (children with disabilities)	Interrater reliability ICC			.804
% N different partners	Stability of sensor data over time ICC <sup>c</sup>	.656	.823	
% Time with same-sex partners <sup>b</sup>	Stability of sensor data over time ICC <sup>c</sup>	.669	.676	
LPP enjoyment	Internal reliability $\alpha$			.782

Note: T1 = baseline; T2 = intervention; ICC = Intraclass Correlation Coefficient, applied for average measures in a two-way mixed effects model.

<sup>a</sup>Interrater reliability was computed at the first T1 session and at the last T2 session, using the most frequently observed categories (social play and social no play, with/without loose-parts) to avoid inflation in agreement.

<sup>b</sup>Interrater reliability was computed across all sessions, using the most frequently observed categories (solitary play, solitary no play, social play, with/without loose-parts).

<sup>c</sup>Stability was computed across all T1 sessions and all T2 sessions.

### 3.2.2 | Playground diversity of partners

#### *Number of different partners*

The variety of partners each child interacted with was measured at an individual level by wearable sensors, using OpenBeacon Radio Frequency Identification Devices (RFID) (Cattuto et al., 2010). RFID badges are worn by each individual child at the playground, measuring face-to-face interactions within an approximate distance of up to 1.5 m (Cattuto et al., 2010). When an interaction between two badges is detected, a signal is sent to an external receiver. To avoid loss of sensitivity due to fluctuations in signals, an interpolation with a cutoff of 20 s was applied (Cattuto et al., 2010; Elmer et al., 2019; Stehlé et al., 2013). This meant that an interaction was identified as one continuous interaction even if there was an interruption in signals  $\leq 20$  s. To assess a variety of partners, a degree centrality (Diestel, 2005) was used. It is measuring the number of different partners each child interacted with, normalized by the maximum possible partners, that is,  $(n - 1)$  for a group with  $n$  members. The stability of the sensor data across time ranged from good to high.

#### *Time spent with same-sex partners*

Diversity of interactions was also measured inversely by the proportion of time spent with same-sex partners, as measured by RFID badges (Cattuto et al., 2010), normalized by the total time this child spent in interactions during recess. The stability over time was good.

### 3.2.3 | Centrality in the social network

#### *Closeness centrality*

Peer nominations (Pijl et al., 2008) were used at two time points. At the beginning of the project, each child was asked to write down up to five children with whom they mostly liked to play with during recess. Towards the end of the intervention, children were asked the

same question, this time about LPP. For each child, a closeness centrality measure was computed to assess the child's network connectivity, based on all shortest paths, consisting of direct and indirect nominations, which connected this child with the rest of the group (Freeman, 1978). This closeness centrality was further weighted by the type of nomination between child  $u$  and child  $v$ , that is, edge  $(u,v)$ , as follows:

$$\text{weight}_{\text{PN}}(u,v) = \begin{cases} 1, & \text{One-way nomination} \\ 0.5, & \text{Mutual nomination} \end{cases}$$

Thus, the cost of traveling from one child to another for those with mutual nomination is lower ( $= 0.5$ ) than for those with one-way nomination ( $= 1$ ), that is, having more mutual nominations increasing one's closeness score.

#### *In-degree centrality*

In-degree centrality was used descriptively to examine the social position of children with disabilities relative to their peers, at baseline and at intervention. In-degree centrality counts the number of times the child was directly nominated by peers and captures the extent to which other children consider this child a social partner (Baek et al., 2022). At each time point, each child with a disability received a standardized score, after standardizing the total sample's distribution according to the sample's mean score and standard deviation.

### 3.2.4 | Enjoyment of loose-parts-play

An original self-report was designed to measure the children's overall enjoyment of LPP, based on the Lunchtime Enjoyment of Activity and Play (LEAP) (Hyndman et al., 2013). Children were asked to rate four items on a 5-point scale, ranging from 1 ('not at all', next to a sad-looking facial illustration) to 5 ('very much', next to a smiling face), regarding enjoyment of playing with loose-parts, enjoyment of playing with friends during LPP, willingness to play again with loose-parts and willingness to play with loose-parts more often. Internal reliability of the LPP items was acceptable.

### 3.2.5 | Qualitative measures

Qualitative data were collected through field notes and an interview with the playground teachers (Berg & Lune, 2017a). Field notes were registered during each group and individual observations, whereas each observer documented the children's behaviours at each time unit. The interview with the playground teachers was semi-structured (Berg & Lune, 2017b), focusing on their impression of the intervention with a special focus on its social aspects. We used a topic guide, including questions about the teachers' impression of the intervention, the extent to which they observed changes

in children's outdoor play or interactions, comparing recesses with or without loose-parts and before and during the intervention. We used prompts to encourage teachers to think about the types and contents of play they noticed, the quality of children's interactions, children's openness to play with new partners, the extent to which children played alone or together and the situation of relatively isolated children.

### 3.3 | Procedure

This study was approved by Leiden University Ethics Committee (CEP20-0118/031). The project was presented to children, parents and playground teachers as examining the impact of LPP on children's outdoor social participation. Written consent forms were signed by the parents of all participating children. The parents were also requested to mention at the consent form the disability of their child, in case there was one. Playground teachers were also asked for their consent to participate. All participants received detailed information about the project and were ensured that data were kept confidential and that they had the right to quit the project at any time. Playground assessments took place during one recess per week, always at the same day and time, and lasted about 30 min each. Children put on sensor badges shortly before they went to the playground. At the end of recess, they returned the badges to the researchers. During recess, student researchers stood at the borders of the playground and unobtrusively coded playground activities. Sensor data were recorded by a computerized receiver located at the border of the playground. Children were also administered questionnaires in the mornings of the first (baseline) and the fifth (intervention) assessment days.

The LPP sessions were coordinated by MvR, a trained facilitator on supervising LPP, who instructed student researchers on collecting parts and facilitating them. In total, 300 parts were collected in collaboration with recycle shops and stored at the school building. To enrich play possibilities, diverse parts without defined use and at different sizes were collected, such as crates, tires, old furniture, buggies, sunshades, tree trunks, pipes and cable reels. The choice of loose-parts was also determined by improved opportunities for challenging play (Bundy et al., 2009; Hyndman et al., 2014; van Rooijen & Jacobs, 2019). During the intervention sessions, approximately 200 parts were brought by the research team to the playground and were alternated between the sessions to maintain interest. Playground observers were trained by the SOOP manual and practiced group and individual observations prior to the project. The playground teachers were instructed on how to adapt their supervision to the intervention. After the last intervention session, they were interviewed together by a student researcher for 10 min in a quiet room at school. Because not all researchers spoke Dutch, the recording was transcribed and translated into English by the interviewer and checked by LvK to support the validity of the translation.

### 3.4 | Data analyses

#### 3.4.1 | Quantitative

The raw sensor data were first pre-processed using Python 3.9 (van Rossum, 1995). The NetworkX 2.6.3 Python package was used for social network analysis and visualization. Statistical analyses were performed using SPSS version 27.0 (SPSS Inc., Chicago, IL, USA). To examine changes in social participation scores for each of the study variables, scores were averaged across assessments to form single baseline (T1) and intervention (T2) scores. For data based on group counts (group observations), we used Chi-square tests to compare differences in proportions of activity counts between T1 and T2. For data based on individual scores, we used dependent samples parametric or non-parametric tests, which allow to compare the change from T1 to T2 per individual child. For the whole sample, the following analyses were conducted: (a) At a group level, T2–T1 changes in the number of children participating in social interactions, social play and solitary play were examined through three Pearson chi-square tests, followed by a Bonferroni correction. In addition, the number of children involved with loose-parts was computed for descriptive purpose. (b) At an individual level, T2–T1 changes in the diversity of social interactions, including variety of partners and time with same-sex partners, were examined through two paired samples *T*-tests and followed by a Bonferroni correction. (c) At an individual level, T2–T1 changes in nominations-based closeness centrality were examined through a Wilcoxon signed-rank test.

Next, T1 and T2 descriptive data were presented for children with disabilities in (a) their playground social involvement, including time spent in social interactions, social play and solitary play and the number of partners they played with. In addition, data were descriptively compared between children with and without disabilities in (b) playground diversity of partners, including variety of partners and time spent with same-sex partners; (c) nominations-based playground network centrality, including closeness centrality and standardized in-degree centrality; and (d) self-reported enjoyment of LPP. Visualizations were presented for each child with a disability for all variables based on repeated measures, including playground social involvement and diversity of partners. We used visual analyses for explorative purpose, examining the percentage of non-overlap between baseline and intervention sessions. For each child with a disability, we computed the percentage of non-overlapping data (PND), in which intervention data points were counted if they exceeded the most extreme baseline measure at the expected trend direction (Lobo et al., 2017). To exploratively examine the significance of the intervention effect on children with disabilities as a group, we calculated per each variable a combined Tau, a single-case design statistic that relies on the analysis of several phase contrasts (Vannest et al., 2016). We used an online Tau calculator (<http://www.singlecaseresearch.org/calculators/tau-u>).

#### 3.4.2 | Qualitative

Qualitative data were analysed separately from the quantitative data, leaving the integration between the two data sets for the interpretation stage (Hanson et al., 2005). Applying content analysis (Berg & Lune, 2017a), AE and LvK read and re-read all individual and group field notes and the interview transcript, identifying and coding emerging themes, attending also the issue of data convergence across different sources of information. We used directed content analysis (Berg & Lune, 2017a), in which we explored themes emerging from the data while the coding categories reflected our conceptual framework, focusing on aspects of playground social dynamics. Findings were then discussed between both researchers, reaching at a full agreement.

## 4 | RESULTS

### 4.1 | Quantitative data

#### 4.1.1 | Differences in outdoor social participation between baseline and intervention for the total sample

Findings from group observations indicated high involvement with LPP during the intervention sessions, with most of the play activities (84%) observed with loose-parts. Table 3 presents the mean scores, averaged across baseline (T1) and intervention (T2) sessions, in playground social involvement, diversity of partners and nominations-based network centrality. Visualizations of the social networks at both time points, based on sensor data and peer nominations, are presented in Figures 1 and 2. Findings indicated decreases from T1 to T2 in the proportions of social interactions and social play and an increase in solitary play activities, based on group-level observations. Findings based on individual-level sensor data showed at T2 a broader variety of interaction partners and a shrinkage in the proportions of same-sex interaction time, compared with T1. No difference was found between T2 and T1 in nominations-based closeness centrality.

#### 4.1.2 | Differences in outdoor social participation of children with and without disabilities across baseline and intervention

Table 4 presents the means, variances and range scores and difference scores between T1 and T2, compared between children with and without disabilities, in playground social involvement, diversity of partners and nominations-based network centrality. Comparison between the groups in self-reported enjoyment of LPP is presented in Table 5. The results per each individual child with a disability are presented in Table A1. Graphs and visual analyses for variables based on sensors and observations are presented in Figure A1. Findings showed

**TABLE 3** Pre-post changes in social participation in all children.

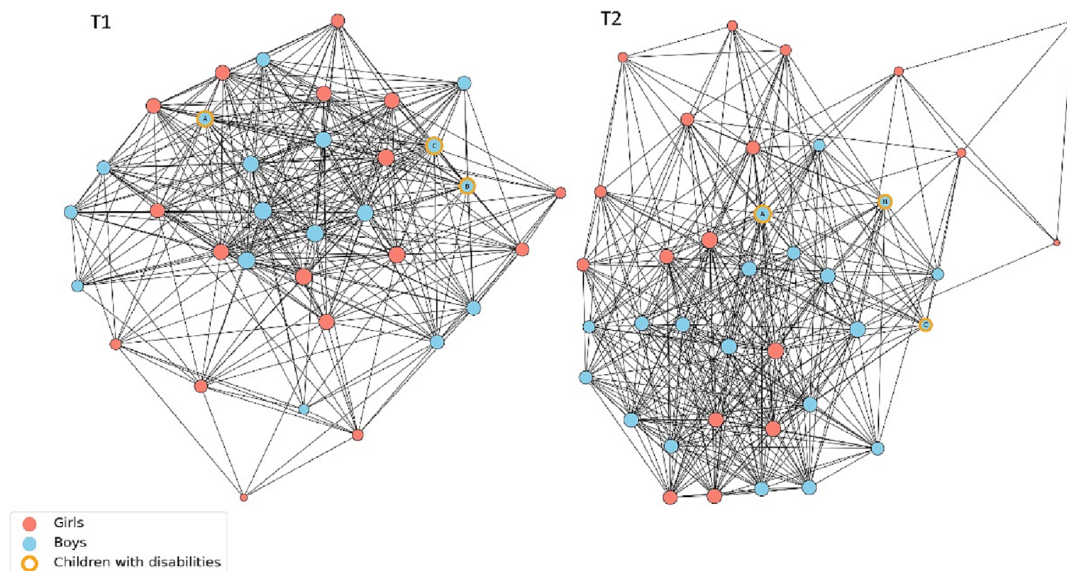
	Mean T1 (SD)	Mean T2 (SD)	Test	Value	df	p (two-tailed)
<b>Playground social involvement</b>						
% N children in social interactions <sup>a</sup>	90.46	73.45	$\chi^2$	31.31	1	.000
% N children in social play <sup>a</sup>	68.50	51.27	$\chi^2$	19.08	1	.000
% N children in solitary play <sup>a</sup>	3.18	13.82	$\chi^2$	23.86	1	.000
<b>Playground diversity of partners</b>						
% N different partners <sup>b</sup>	55.74 (14.67)	63.25 (14.47)	T	3.42	39	.001
% Time with same-sex partners <sup>b</sup>	69.51 (14.67)	61.59 (13.08)	T	-3.28	39	.002
<b>Nominations-based playground network centrality</b>						
Closeness centrality <sup>c</sup>	.32	.28	Z	-1.63	40	.104

Note: T1 = baseline; T2 = intervention; T = paired sample T-test;  $\chi^2$  = chi-square test; Z = Wilcoxon signed-rank test.

<sup>a</sup>Based on group observations, total N cases = 622.

<sup>b</sup>Based on individual sensor data.

<sup>c</sup>Based on individual peer nomination data.



**FIGURE 1** Number of different partners at the playground at baseline and at intervention, based on sensor data. Note: T1 = baseline; T2 = intervention; the size of the node and its location are based on the number of different partners the child interacted with, with larger size and more central location indicating a broader variety of interaction partners.

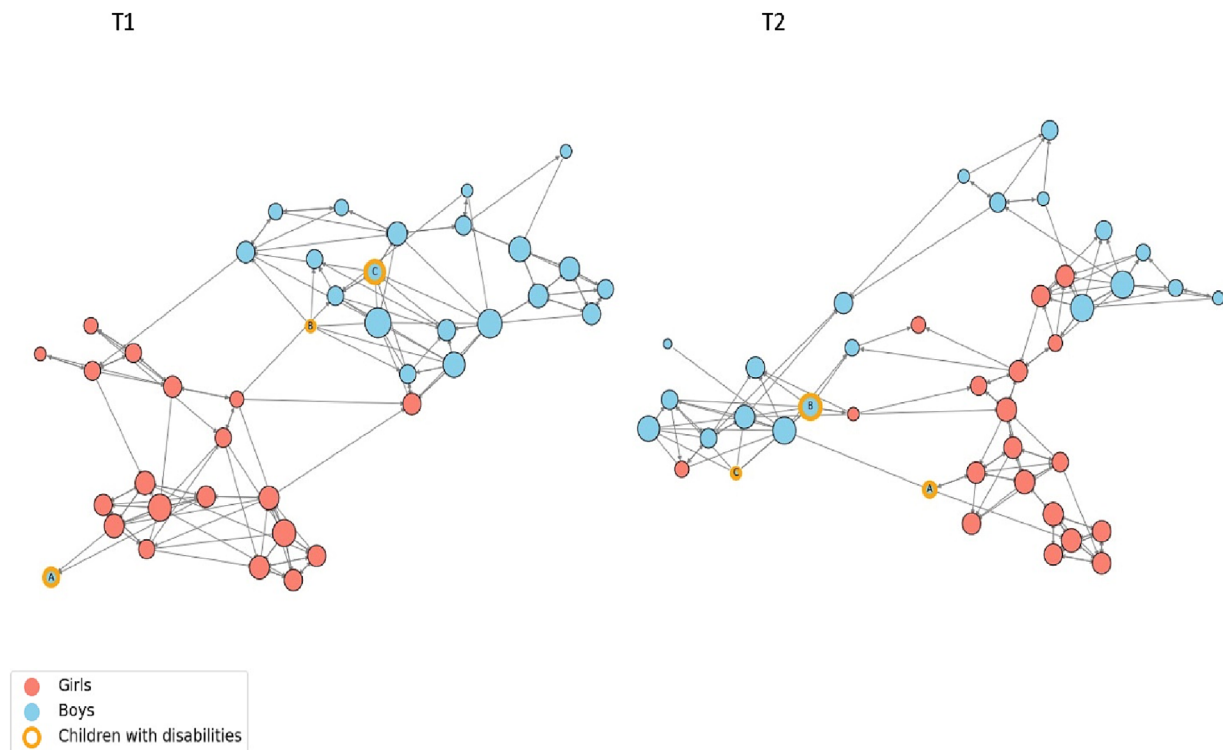
that, on average, at baseline, children with disabilities were observed in social interactions and social play less than half of the time and played on average with only 1.5 partners during recess. Their time spent in social involvement further decreased during the intervention by 23%–25%, with a significant decrease in social interactions and a close-to-significant decrease in social play. The average number of partners with whom children with disabilities interacted significantly decreased at the intervention to less than one. Next, children with and without disabilities showed on average similar baseline levels of diversity of partners, but although children without disabilities showed a clear increase in diversity of partners from baseline to intervention, this was not the case for children with disabilities as a group. Regarding network centrality, at T1, children with disabilities showed on average less connectivity and were less nominated by their peers.

In both groups, there were no essential changes in network centrality measures. Nevertheless, T2 self-reported enjoyment of LPP was high for children with and without disabilities alike.

## 4.2 | Qualitative data

Themes extracted from the interview and field notes included the types and contents of play and no-play activities; play context (e.g., independent decision-making, or how parts were played in relation to existing playground equipment); the valence of children's behaviours (e.g., bored vs. enthusiastic); conflicts; and social dynamics (e.g., keeping the same playgroup or being socially excluded).





**FIGURE 2** Peer nominations for playground playmates at baseline and at intervention. Note: T1 = baseline; T2 = intervention. Distance between every pair of nodes (children) is based on received in-degree nominations for playground mates, weighted by mutual nominations. The direction of the nomination is indicated by an arrow. The size of the node is based on the number of nominations each child received, with larger size indicating a larger number of nominations received.

#### 4.2.1 | Impact of LPP on social participation and activities at the playground

Both the interview and the field notes indicated the intense enthusiasm and enjoyment with which the loose-parts were accepted by the children, with almost all the children engaging with the parts during all the intervention sessions. The playground teachers described how (some) children liked playing with the loose-parts to the extent that they were asking for the parts on other days of the week:

Teacher A: You also notice that the children are very happy, so like 'yes it is there again!'. They like it a lot.

Teacher B: Yes, it's fun.

A: Yes, 'I'm not so bored anymore now'.

[...]

B: They ask on Monday, will the parts come today? Really that.

A: Yes.

B: They do get excited.

A: Yes.

Although field notes hardly indicated any signs of aggressive behaviours during T1/T2 sessions, according to the teachers,

compared with baseline/no-LPP breaks, during LPP, there were less signs of boredom and conduct behaviours, although very few children showed up again conduct behaviours towards the end of the intervention, this time with the parts (e.g., breaking parts). Both the interview and the field notes indicated during LPP more imaginary (e.g., family role play) and collaborative play (e.g., building a TV room together), creativity and independent problem solving (e.g., finding out by themselves how to build certain constructions), as well as spending time relaxing on the parts (alone or with other children), collecting parts and at times arguing about parts. For example:

Teacher A: [during the intervention] they are much more ... they are playing really nice, and also the kids who are a bit bored actually you really see them come to play a lot. [...] You really see that they do other things, you see real role play, fantasy play also comes out very much.

Teacher B: Yes and they actually collaborate with each other, 'oh you take this and we'll add that and then we'll make ...' They really do it together.

Yet, according to the teachers, no essential changes were observed in social cliques, as children were playing LPP with the same peers they used to play with in other breaks or before the intervention: 'You see the same groups all the time. Yes' (Teacher B).

**TABLE 4** Pre-post changes in social participation in children with and without disabilities.

	With disabilities N = 3			Without disabilities N = 37–38		
	Mean (SD) T1 [range]	Mean (SD) T2 [range]	T2–T1 [range]	Mean T1 (SD)	Mean T2 (SD)	T2–T1
<b>Playground social involvement</b>						
% Time in social interactions <sup>a</sup>	47.92 (12) [35–58]	24.84 (14) [16–41]	–23.08 [–32––18]			
% Time in social play <sup>a</sup>	45.14 (8) [35–50]	19.75 (15) [7–37]	–25.39 [–43––13]			
% Time in solitary play <sup>a</sup>	18.75 (26) [0–48]	36.34 (17) [16–49]	17.59 [–4–40]			
N of partners <sup>a</sup>	1.48 (.60) [1.13–2.17]	.34 (.12) [.25–.47]	–1.14 [–1.70–.84]			
<b>Playground diversity of partners</b>						
% N different partners <sup>b</sup>	60.59 (8.30) [56–70]	62.37 (21.46) [47–87]	1.78 [–3–17]	55.00 (15.02)	62.57 (14.74)	7.57**
% Time with same-sex partners <sup>b</sup>	68.64 (27.21) [37–86]	63.94 (3.81) [60–66]	–4.7 [–17–23]	69.13 (13.94)	62.05 (13.99)	–7.08**
<b>Nominations-based playground network centrality</b>						
Closeness centrality <sup>c</sup>	.22 (.21) [0–.41]	.20 (.18) [0–.33]	–.02 [–.41–.04]	.32 (.07)	.28 (.08)	–.04
Standardized in-degree centrality <sup>c</sup>	–.92 (1.03) [–1.96–.11]	–.77 (1.47) [–1.88–.89]	.15 [–1.99–2.85]	.07 (.97)	.06 (.95)	

<sup>a</sup>Based on individual observations.<sup>b</sup>Based on individual sensor data.<sup>c</sup>Based on individual peer nomination data.\*\**p* (two-tailed): <.01, and \*\*\**p* (two-tailed): <.001.**TABLE 5** Self-reported enjoyment of LPP in children with and without disabilities.

	With disabilities N = 3	Without disabilities N = 37
	Mean T2 (SD) [range]	Mean T2 (SD)
LPP enjoyment (1–5)	4.92 (.14) [4.75–5]	4.85 (.38)

#### 4.2.2 | Impact of LPP on outdoor social participation of children with disabilities

According to the interview, the issue of isolated children went unnoticed by the playground teachers. Observations focusing on the three children with hearing loss/ASD indicated that they were engaged with the parts and showed interest in them. Yet, no essential changes were observed in their patterns of social participation. At both baseline and intervention, these children were often observed alone, watching others from the outskirts, sometimes trying to make contact but being rejected or ignored, or alternatively having sporadic short-term interactions with peers. The intervention did not change their essential social dynamics (e.g., being alone while collecting or playing with the parts and being denied of access to popular parts by other children

taking over). Finally, observations suggested that although one of these children (child 2 in Figure A1) kept similar low levels of social participation at both baseline and intervention, the other two children became even less socially involved during the intervention, albeit in different ways: One child (child 1 in Figure A1) was wandering around onlooking, and it was only in the last LPP session that he could engage in play (albeit in solitude). The other child (child 3 in Figure A1) showed more solitude activities or relaxation from the first intervention session onwards (e.g., lying down on the parts and playing alone with them), but compared with the other two kids, he seemed to the observers as comfortable with this solitude. According to the quantitative observations, this child showed a significant increase of 40% in the time spent in solitary play, compared with the other two kids, who showed much smaller increases (Table A1 and Figure A1).

## 5 | DISCUSSION

The goal of this study was to examine the extent to which LPP in a mainstream educational setting impacts outdoor social participation, in particular of children with disabilities. Quantitative findings indicated a decrease for children with and without disabilities from baseline to intervention in social interactions and social play and an increase for children without disabilities in solitude play and in the

diversity of partners, yet no change for both groups in network centrality. Children with disabilities presented on average low levels of playground social involvement and were less central in the peer network, at baseline and intervention. The diversity of their interactions was similar to children without disabilities, yet they seemed to benefit less from the intervention in this aspect compared with their peers. Nevertheless, both groups reported on high enjoyment of LPP. Group and individual qualitative findings support the outcomes based on quantitative data and provide additional perspectives that contribute to their interpretation. Results are discussed first in relation to social participation in general, followed by focus on children with disabilities.

According to the qualitative findings, social dynamics at the playground did not change during the intervention, but the nature of the interactions sometimes changed, for example, to being more collaborative. Thus, the change in the type of activities did not necessarily result in children having more interactions. Quantitative data based on observations showed a decrease in the quantity of social activities during LPP, which might be partially explained by an artificial decrease in social play due to time spent in search and collection of parts. Yet, the observed increase in the quantity of solitude play, which might have attracted less attention and therefore went unnoticed by the teachers, suggests that the affordances of the loose-parts provide children with more opportunities for solitude play, which they were happy to take. Recently, Gibson and colleagues (Gibson et al., 2018) suggested a greater variability in social connectedness across LPP sessions and an increase in connectedness over time. In our data, we noticed a peak in social participation at the first LPP session, followed by a decrease during the remaining sessions. Future research may focus on longer periods to explore the impact of LPP on social participation over time.

Sensor-data findings indicated—only for children without disabilities—more diverse interaction partners during the intervention and a decrease in sex segregation, which has also been found elsewhere (Heravi et al., 2018). Increase in social diversity could result from the novelty of the parts, the enthusiasm and the increased opportunities for collaborative and imaginative play. Yet, it might also stem from the time children spent in searching and collecting parts at the same area of the playground and their negotiations or arguments about different parts. According to the teachers' impressions, social play became more collaborative during LPP, but no essential changes occurred in social cliques. In addition, no changes were found in children's nominations-based network centralities. Further comparison between sensor data and individual observations (see Table 4; children with disabilities) suggests that the number of meaningful partners as detected by observations was smaller than the number of proximity-based face-to-face interactions registered by sensors. The increase found for children without disabilities in sensor-based diversity of playground interactions, therefore, does not necessarily indicate more positive or meaningful interactions. These findings highlight the necessity of combining various measures (e.g., observations) with sensing technologies in behavioural research to obtain the valence of interactions registered by a sensing system.

All quantitative and qualitative findings in our study suggested that the LPP intervention was successful in terms of enjoyment and engagement, similar to findings reported in previous studies (e.g., Bundy et al., 2008; Engelen et al., 2018). Yet, the intervention seems not successful in creating new social opportunities, especially for relatively isolated participants with ASD/hearing loss. Rather, they stayed at the outskirts of the group, having short-term interactions, many times observed alone, ignored or rejected. Interestingly, their situation seemed to go unnoticed by the playground teachers, whose attention was directed to overt arguments or conduct behaviours, in addition to the general atmosphere of enthusiasm and playfulness. Socially neglected children are indeed often overlooked by teachers, as they do not display prominent behavioural differences compared with their peers (Gifford-Smith & Brownell, 2003).

It has been shown that the social participation of children with disabilities in special educational settings increased during LPP (Serman et al., 2020). Although non-verbal aspects of LPP might enhance interactions for children with communication difficulties, it seemed that communication barriers in the mainstream context even worsened during the intervention. Possibly, the novelty and unstructured nature of the LPP, without explicit rules to rely on, made it harder to follow quick and implicit social exchanges between non-disabled peers (e.g., making decisions on what construction to build and how). Additionally, verbal communication was still widely used (e.g., negotiation about parts, fantasy games, relaxing on parts and chatting).

Moreover, as also suggested elsewhere (Gibson et al., 2018), some time for exploration might be needed before children can immerse themselves in a new and adventurous play environment that possibly involves different social dynamics. A child who feels lonely in mainstream education can be tense because s/he cannot understand others well, or because of being bullied, may find it difficult to feel comfortable enough to fully engage in creative play, even in solitude, or at least may necessitate a longer period to do so. That being said, it is important to note that the level of enjoyment reported by our participants with disabilities was as high as the level reported by their peers. Perhaps because of low social expectations, their enjoyment was not related to their social experience as it was related to the novelty and potential of the parts to provide them with alternative play options.

## 5.1 | Limitations and suggestions for future research

This research is based on a small-scale case study, including only three children with disabilities, which enabled a deep exploration of playground dynamics, but limited its generalizability. More research is therefore needed with children of various ages and disabilities, for longer periods. As with other interventions, more research is needed on the intervention's efficacy over time and across settings (Koller & Stoddart, 2021). The interview with the playground teachers provided

rich information on what teachers noticed and did not notice when observing children, which informed us not only on the intervention but also on the extent to which the social situation of children with disabilities can be overlooked. Yet, the short duration of the interview may have limited the depth of the teachers' responses. An optional way to deal with it in the future might be to provide teachers with focus topics before the intervention starts, to facilitate their awareness to the details of interest.

The enthusiasm and enjoyment of LPP presented by all children in our study suggest that this intervention has the potential to facilitate meaningful social participation. However, it might be asked whether the LPP philosophy of minimal adult interference can be kept if a social goal is set up in mainstream education. There is evidence suggesting that active support of adults, such as teachers, can promote social inclusion, for example, by facilitating collaborative learning (Koller & Stoddart, 2021; Woodgate et al., 2020), modelling or suggesting ideas for play (Sroka, 2006), suggesting structured activities with defined rules, providing a variety of play options and implementing proactive practices to prevent aggression and increase empathy (McNamara et al., 2017). Future research would therefore benefit from exploring the adaptability of LPP to inclusive settings and goals, attending both the need for child-led free play and the need for social accessibility.

This study used advanced sensing methodologies to gain new insights into playground social dynamics. New directions in research that have not yet been applied to the playground context, such as  $\mu$ EMA (Ponnada et al., 2022) or machine-learning emotion detection (Guerra et al., 2022), are promising for detecting fine-tuning differences in valence of social interactions and may contribute to future research on social participation and field interventions.

## 5.2 | Conclusion

The findings of this case study suggested that during LPP children may have interacted with a wider variety of partners, but their overall involvement in social interactions and social play decreased, whereas no change was observed in their social network positions. Furthermore, the three children with communication difficulties (ASD, hearing loss) participating in this study remained at the social outskirts and did not benefit from the intervention in terms of social participation. Nevertheless, both groups with and without disabilities were motivated to engage with LPP and enjoyed it. Findings emphasize the importance of researching how LPP can be further adapted to enhance playground social participation and benefit the socio-emotional development of all children.

### AUTHOR CONTRIBUTIONS

Research funding was obtained by Adva Eichengreen, Carolien Rieffe and Alexander Koutamanis for the broader research project. All authors contributed to the study conception and design. The manuscript was drafted by Adva Eichengreen with contributions from

Martin van Rooijen, Lisa-Maria van Klaveren, Maedeh Nasri, Yung-Ting Tsou and Carolien Rieffe. All authors critically revised the manuscript, and all read and approved the final manuscript.

### CONFLICT OF INTEREST STATEMENT

The authors report no conflicts of interest.

### DATA AVAILABILITY STATEMENT

The dataset and associated information used in the current study will be archived on the Leiden University archiving platform DataverseNL (<https://dataverse.nl/>) once the manuscript is accepted.

### ETHICS APPROVAL

All procedures performed in this study were in accordance with the ethical standards of the Leiden University Ethics Committee (approval number CEP20-0118/031) and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

### PARTICIPANT CONSENT

Informed consent was obtained from all individual participants included in the study.

### PERMISSION TO REPRODUCE MATERIAL FROM OTHER SOURCES

N/A.

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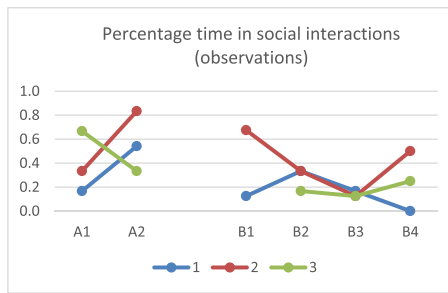
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## APPENDIX A

**TABLE A1** Individual data of children with disabilities.

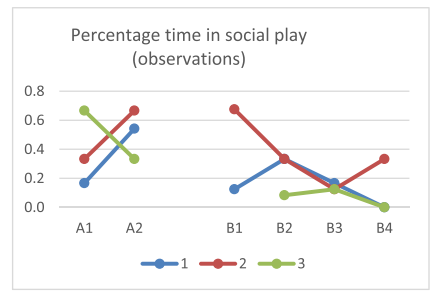
Child number		T1	T2	T2-T1
1/2/3	Playground social involvement (observations)			
	% Time in social interactions	35/58/50	16/41/18	-20/-18/-32
	% Time in social play	35/50/50	16/37/07	-20/-13/-43
	% Time in solitary play	48/0/8	44/16/49	-04/16/40
	N of partners	1.15/2.17/1.13	.25/.47/.29	-.90/-1.70/-.84
	Playground diversity of partners (sensors)			
	% N different partners	70/56/56	87/47/53	17/-09/-03
	% Time with same-sex partners	37/83/86	60/66/66	23/-17/-20
	Nominations-based playground network centrality			
	Closeness centrality	.24/0/.41	.28/.33/0	.04/.33/-.41
	Standardized in-degree centrality	-.92/-1.96/.11	-1.33/.89/-1.88	-.41/2.85/-1.99
	Enjoyment of LPP (self-report)		4.75/5/5	

**FIGURE A1** Visual analyses of children with disabilities' playground social involvement based on repeated measures.



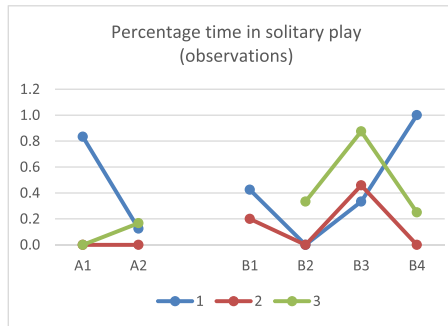
Note: A denotes baseline, B denotes intervention.

Between-phase combined $Tau$	
$-0.659, p = .039$	
Child number	$PND$ (expected decrease)
1	0.25
2	0.25
3	1



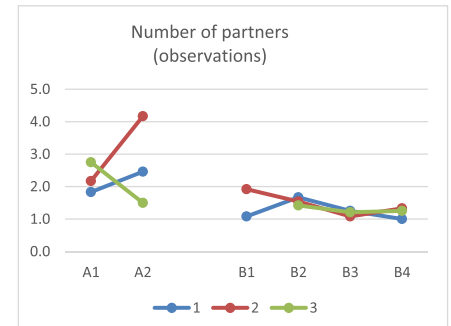
Between-phase combined $Tau$	
$-0.617, p = .053$	
Child number	$PND$ (expected decrease)
1	0.5
2	0.25
3	1

Note:  $50 < PND < 70$  = questionable effect;  $PND > 70$  = effective effect

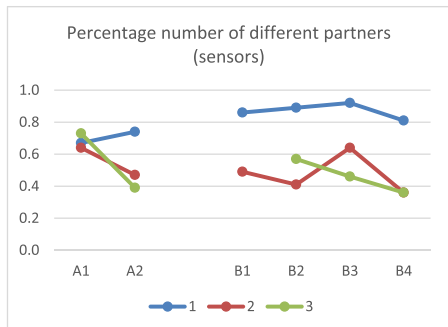


Note: A denotes baseline, B denotes intervention.

Between-phase combined $Tau$	
$0.489, p = .126$	
Child number	$PND$ (expected increase)
1	0.25
2	0.5
3	1

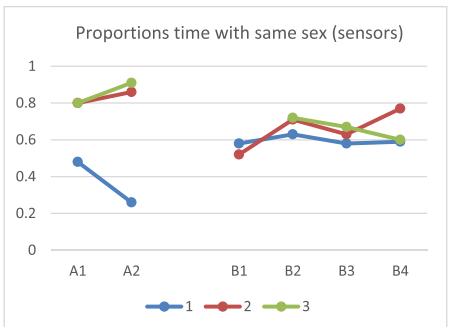


Between-phase combined $Tau$	
$-1.000, p = .002$	
Child number	$PND$ (expected decrease)
1	1
2	1
3	1



Note: A denotes baseline, B denotes intervention.

Between-phase combined $Tau$	
$0.107, p = .738$	
Child number	$PND$ (expected increase)
1	1
2	0
3	0



Between-phase combined $Tau$	
$-0.318, p = .318$	
Child number	$PND$ (expected decrease)
1	0
2	1
3	1

Note:  $50 < PND < 70$  = questionable effect;  $PND > 70$  = effective effect