Facilitating Play and Social Interaction between Children with Visual Impairments and Sighted Peers by Means of Augmented Toys

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Abstract

Children with visual impairments (VIs) in mainstream education often experience social participation difficulties during peer play with sighted children. It was investigated whether augmented toys were effective to facilitate peer play and social interaction in 18 dyads of children with VIs and their sighted classmates. Eighteen children aged 4-to-11 with a visual impairment (mean age = 7.46, SD = 2.19) and eighteen sighted classmates (mean age = 7.56, SD = 2.08) played with an augmented and with a non-augmented toy, using a counterbalanced crossover repeated measures design. A Playmobil® knight's castle was augmented with Radio Frequency Identification (RFID) technology, such that each play figure produced audio feedback during play. Video fragments were coded for social and cognitive aspects of play and peer directed interaction behaviors. Data were analyzed using multilevel logistic regression. Children showed more parallel play and object exploration, but less cooperative play when they repeatedly used the augmented castle compared to the non-augmented castle. Social interaction behaviors did not differ as a function of play condition. No differences were found between the play or interaction behaviors of children with VIs and sighted classmates. The addition of sounds to physical toys increased shared attention between children with VIs and sighted classmates, yet interfered with cooperative peer play.

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Introduction

In the Netherlands, at least 75% of children with visual impairments (VIs) attend mainstream education (Smeets and de Boer 2017). One of the main reasons for parents to send their child with a disability to mainstream settings is the opportunity for social participation (Scheepstra and Pijl 1998). Participation in peer activities provides children with impairments with possibilities for social interaction and the development of friendships (King et al. 2003). Peer relationships and friendships contribute to quality of life and wellbeing and provide possibilities for social development and social support (Geisthardt et al. 2002; Guralnick et al. 1995; Kef and Deković 2004).

However, children with impairments in mainstream settings are often perceived as less socially competent than their typically developing peers (McConnell and Odom 1999). Children with disabilities both initiated as well as received fewer peer interactions (Guralnick and Groom 1987; Guralnick et al. 1996) and were less accepted by typically developing children (de Monchy et al. 2004; Guralnick and Groom 1987; Hestenes and Carroll 2000; Manetti et al. 2001; Place and Hodge 2001; Solish et al. 2010). In order to support these children, the present study investigated whether augmented toys can facilitate peer play between children with VIs and sighted classmates without the need for adult support.

Former research shows that children with VIs are challenged to engage in peer play activities (Bishop et al. 2005; Celeste 2006; Ferguson and Buultjens 1995; Hughes et al. 1998; Lewis et al. 2000b; Roe 2008; Troster and Brambring 1994). Children with VIs in mainstream settings demonstrated solitary play more often than sighted peers, whereas they engaged less in cooperative peer play (Hestenes and Carroll 2000; Celeste 2006). In a recent study, teachers judged children with VIs as having poorer social skills than typically developing children (Ozkubat and Ozdemir 2014). In addition, children with VIs attending mainstream education were judged to have better social skills than children with VIs attending special education.

Because of their compromised visual functioning, children with VIs do not have the same opportunities as sighted peers to participate in social activities. During peer play, they often miss out on gestures and non-verbal interaction of others and are challenged to use non-verbal behaviors themselves (Perez-Pereira and Conti-Ramsden 2013; Roe and Webster 2002). It is also more difficult for them to engage in joint attention with peers, which is an important prerequisite for social interaction to occur (Mundy and Sigman 2015). In addition, they easily lose track of what playmates are doing, especially if others do not verbally describe what is happening (Roe 2008).

The impaired visual functioning also affects the way that children with VIs play and handle toys (i.e. their cognitive play). Children with VIs need a significant amount of time to examine new objects or toys before they understand its functions and use, and are subsequently able to integrate toys into play (Lewis et al. 2000b; Roe and Webster 2002). Since many toys for children in the school ages are primarily visually stimulating (such as miniature objects), they are often less interesting to play with for children with VIs (Troster and Brambring 1994). Prior studies reported children with VIs to experience difficulties with functional play, symbolic (i.e., pretend) play, and with physical activities or gross motor play (Bishop et al. 2005; Houwen et al. 2009; Lewis et al. 2000b; Schneekloth 1989). Collectively, these findings suggest that children with VIs in mainstream education are at risk for social participation

difficulties, especially if they do not receive adequate social and emotional support (Cosbey and Johnston 2006). This underlines the need for tools that can facilitate peer interaction and that children can use by themselves.

Several studies reported positive effects of augmented toys on peer play in both children with social difficulties as well as typically developing children (Farr et al. 2012; Farr et al. 2010; Yuill et al. 2014). Augmented toys combine physical materials with technology, creating additional toy features by means of sounds, vibrations or visual cues (Lampe and Hinske 2007). An important advantage of augmented toys is that they are easily accessible, since children can use them together without the need for adult assistance. Farr et al. (2012) found that children with autism demonstrated less solitary play when using a knight's castle with sound augmentation compared to a normal toy castle. In addition, a group of 48 6- to 11 year-old typically developing children showed more cooperative play and attention bids when using the augmented castle (Yuill et al. 2014). A recent study with 26 dyads of children with VIs in special education revealed that a similar augmented castle stimulated the children to explore the sounds during parallel play, but interfered with cooperative pretend play as a result (Verver et al. 2019). Notwithstanding, former research indicated that children with (visual) disabilities who played with typically developing peers in mainstream settings interacted more frequently than those playing together with other peers with disabilities (Guralnick et al. 1996). Together with the notion that children with VIs in Dutch special education often experience accompanying social-emotional, behavioral and learning problems (Inspectie van het Onderwijs 2010), the sound-augmented castle might be able to facilitate cooperative play between children with VIs and sighted peers in mainstream education.

The present study examined the effect of augmented toys with sounds on play and peer-directed social behaviors in dyads of children with VIs and sighted peers in mainstream elementary education. The first objective was to compare social and cognitive play behaviors of children with VIs and sighted classmates when they used a toy castle with and without additional sounds. The stability of effects was examined by offering the toys multiple times, since children with VIs need more time than sighted peers to explore new objects or object-features (Roe 2008). It was hypothesized that social play would increase and that higher levels of cognitive play would be demonstrated when participants used the augmented toy with sounds repeatedly. Sounds and music were expected to draw a child's attention (Robb 2003; Verver et al. 2019), thus facilitating joint attention between peers, by compensating for the non-verbal interaction behaviors that children with VIs miss out on during peer play. Sounds were also expected to provide children with VIs with more information on toy characteristics or functions, making it easier for them to integrate a multiplicity of toys in their play. Based on former research (Celeste 2006; Hestenes and Carroll 2000; Lewis et al. 2000b; Roe and Webster 2002), it was hypothesized that children with VIs would show less adequate social and cognitive play than sighted children. Participants with VIs were expected to engage in manipulative play more often and in functional play less often than sighted participants. Also, it was expected that they would show more solitary play and less cooperative play than the sighted children.

The second objective was to compare social interaction behaviors between both children in a dyad when they used the augmented versus the non-augmented toy. It was hypothesized that both children within a dyad would demonstrate more peer-directed

social behaviors and reactions to social bids of the peer when using the augmented versus the non-augmented toy. Furthermore, results of Guralnick et al. (1996) showed that peer-directed interaction occurred more frequently and more adequately in playgroups with typically developing children than in those with children with impairments. It was thus hypothesized that sighted children would demonstrate more peer-directed social behaviors than children with VIs.

Method

Participants

After receiving ethical approval from the local Ethics Comity, 110 children with VIs were approached for participation in this study. All children were registered at a national organization for people with VIs, namely Royal Dutch Visio or Bartiméus. Parents of 4- to 11-year-old children with VIs received an informed consent letter if the child: a) had a visual impairment as their primary disability, b) attended mainstream elementary education, c) had an IQ-score above 70, d) did not have hearing impairments, e) was able to play on the floor with small objects, f) had the Dutch language as their first language. Based on these criteria, a total of 21 children (19.1%) with a VI participated. The parents of 92 sighted classmates (at least four sighted children per child with a VI) were then approached with informed consent letters via the schools and 46% was willing to participate. Teachers were instructed to approach both boys and girls and to not only select friends of the child with a VI. If parents of more than one sighted classmate gave permission for participation, the researcher randomly assigned one of these children to participate their classmate with a VI. Two children with a VI had to be excluded from participation because none of their classmates were able to participate. Furthermore, one dyad refused further participation during the experiment.

The final sample involved 36 children (mean age = 7.51 years, SD = 2.11), with each dyad consisting of one child with a visual impairment (N = 18; mean age = 7.46, SD = 2.19; 68% boys) and a sighted child (N = 18; mean age = 7.56, SD = 2.08; 32% boys). The maximum age difference between children within the same dyad was 16.9 months. Dyads were divided in the following age groups: 4- to 6-year-olds (42.1%), 7- to 9-year-olds (39.5%) and 10- to 11-year-olds (18.4%). The children with VIs had a mean visual acuity of .22 (SD = .12). None of the participants were blind according to the criteria of the World Health Organization (2018). See Table 1 for a detailed description of participant characteristics.

Potential differences between sighted participants and those with VIs regarding verbal ability and social competence were evaluated (see Table 2), since both of these skills are related to play behavior (Lewis et al. 2000a, b; Lillard et al. 2011). Social competence was administered with the Social Cognitive Skills Test (short version A; van Manen et al. 2009) and verbal ability with the Vocabulary subtest of the Wechsler Intelligence Scale for Children–III (WISC-III) or the Wechsler Preschool and Primary Scale of Intelligence-III (WPPSI-III; Wechsler et al. 2009; Kort et al. 2005). Neither of these skills differed significantly between groups (social competence: t = .77, p = .449; verbal ability: t = −1.54, p = .135).

Table 1 Participant age, gender, visual acuity and etiology of children with VIs and sighted playmates

Dyad	Participants with VI				Sighted participants	
	Age	Gender	Visual acuity	Etiology	Age	Gender
1	4.58	M	.07	Oculocutaneous albinism	5.25	F
2	4.67	M	.40	Congenital cataract	4.50	F
3	4.92	F	.32	Congenital cataract	6.00	F
4	5.50	M	.32	Congenital nystagmus; rightsided aphakia	4.67	M
5	7.83	M	.12	Oculocutaneous albinism; nystagmus	7.00	F
6	6.25	M	.20	Retinitis pigmentosa	6.67	F
7	8.17	F	.06	Retinitis pigmentosa	8.92	M
8	9.17	F	.25	Retinitis pigmentosa	9.42	F
9	11.08	F	.08	Retinal dystrophy	9.67	F
10	7.08	M	.05	Steven Johnson syndrome; damaged cornea	8.00	M
11	5.75	F	.07	Congenital nystagmus; achromatopsia; light sensitivity	5.50	F
12	8.33	M	.25	Strabismus; nystagmus	9.08	M
13	5.42	M	.40	Congenital nystagmus	5.33	F
14	6.25	M	.30	Congenital nystagmus	6.00	F
15	10.58	M	.25	Retinal dystrophy	10.75	M
16	10.08	M	.30	Achromatopsia	10.17	F
17	8.67	M	.33	Congenital nystagmus	8.75	F
18	10.33	F	.20	Aniridia	10.00	F

M = Male; F = Female; Age is presented in years

Procedure

Play Sessions

The study took place in a quiet room at the participants' schools. A counterbalanced crossover repeated measures design with two conditions was used. During the same

Table 2 Social competence and verbal abilities of both participant groups

	Visually impaired			Sighted		
	N	Mean	SD	N	Mean	SD
Social competence	16	11.19	3.51	16	12.88	2.75
Verbal ability	18	12.00	2.35	18	11.22	3.17

A social competence score of 10 (SD = 3.00) represents average social competence in the Dutch norm population; a verbal ability score of 10 (SD = 3.00) represents an average subtest score in the Dutch norm population. Social competence could only be assessed in 16 participants per group: two children with VIs could not complete the assessment due to their compromised visual functioning and two sighted children had to leave the assessment early

week, all children played with both an augmented knight's castle (augmented condition; AC) and a non-augmented castle (non-augmented condition; NC). Ten out of nineteen dyads were randomly assigned to start in the AC (55.6%) in order to control for possible order-effects. After a week without measurements, 15 out of 19 dyads played in both conditions again (i.e., four play sessions in total). Four dyads were unable to participate in all play sessions due to absence of one of both children in the second measurement week. The sessions lasted 20 min each and were video-recorded. A brief demonstration of how to produce sounds was given before the AC-session began.

Coding

Observations of the social and cognitive aspects of play were performed in Observer XT version 11.5 of Noldus. Two coders received intensive observational training and were blind for the research objectives. Social play behavior was coded for 15-min fragments; 10-min fragments were used to code cognitive play. Start times of coding fragments were randomly selected between 120 and 300 s, since the first two minutes of each video-fragment were excluded from coding to allow children to adapt to the experimental setting (e.g., to the video cameras). Interval recording was used to code the predominant social and cognitive aspect of play in consecutive 10-s intervals of the video-fragments. If several of the social or cognitive play behaviors were observed during a 10-s interval, the one with the longest duration was coded. This resulted in 91 (social play) and 61(cognitive play) codes per video, respectively.

The children's peer-directed social behaviors were coded for 10-min fragments, using a coding sheet of the Individual Social Behavior Scale (ISBS; Guralnick et al. 1996). Event coding was used, resulting in frequencies of each behavioral category.

Instruments

Augmented Knight's Castle

The present study used an augmented toy comparable to the Augmented knight's castle of Lampe and Hinske (2007). It was also used to facilitate peer play in children with autism (Farr et al. 2012) and in dyads of children with VIs attending special elementary education (Verver et al. 2019). The augmented toy consisted of a Playmobil® knight's castle on a plywood base (see: Fig. 1), in which a microprocessor and Radio Frequency Identification (RFID) readers were integrated at five different locations. Thirteen play figures were equipped with RFID-tags, allowing them to produce a variety of sounds when placed on the RFID-readers. A total of 75 different sounds were available, involving identification sounds (e.g., 'I am the queen'), theme sounds (e.g., Medieval music) and play proposals (e.g., 'The red knight challenges the black knight to a duel'). Sounds differed as a function of location and play figure, but were the same during all augmented sessions.

Social and Cognitive Play Observations

In order to observe the social and cognitive aspects of play, a mutually exclusive observational system was used (see Table 3 for a detailed description of the play

Fig. 1 The Augmented Knights' Castle

categories). Inter-rater reliability was trained using eight 20-min videos from a pilot study. The overall Cohen's kappa between two different raters was .82 for social play and .85 for cognitive play, indicating good reliability. Inter-rater reliability was also

Table 3 Social and cognitive play observation scales

Social aspects of play	Cognitive aspects of play
Disengagement	*Manipulative play*
The child is not focused on playing but looks around or talks about subjects unrelated to play.	1) Object exploration, 2) sound exploration by putting play figures on readers, 3) Listening to or observing playmate during play.
Solitary play	*Functional play*
The child plays alone. He/she seems unaware of the playmate or may deliberately choose not to engage with the playmate.	Using play materials in ways they are supposed to be used (e.g., shooting a rock with the catapult).
Parallel play	*Functional play with pretense*
Children are playing in close proximity of each other, look or smile at each other, or imitate each other's play. There is no clear intention to play together.	Adding symbolic meaning to objects that is highly related to the function of play materials (e.g., the swords of two knights are ticking together).
Cooperative play	*Symbolic play*
Children are involved with each other and play together. They talk about play-related subjects, help each other, and actively try to reach shared goals during play.	1) An object is used as if it was another object, 2) Pretend play where characteristics or roles are added to play figures and meaningful actions are carried out.
	Games with rules
	A game is made up that has clear rules or a specific structure that is known to both children in a dyad.

A category was coded when the concurrent behavior was dominant within a 10-s interval. Social aspects of play are based on Parten (1932) and Farr et al. (2012). Cognitive aspects of play are based on Belsky and Most (1981), Wolfberg and Schuler (1993)

calculated for 20% of the present study's video-fragments, resulting in a kappa of .82 (social play) and .79 (cognitive play).

Individual Social Behavior Scale

Peer-related social behaviors between children within a dyad were observed using the Individual Social Behavior Scale (ISBS; Guralnick et al. 1996). This observational scale describes 14 different categories of social behaviors between a child and it's peer(s), thus consisting of both peer-directed social behaviors and responses to social behavior of the peer. In the present study, eight of these categories were coded for both children within a dyad. It was also coded whether the peer-directed social behaviors were successful or unsuccessful (see Table 4). After observational training with 10 video-fragments, sufficient inter-rater reliability of $k = .81$ was reached between two different raters for both frequency and sequence of the codes. Double coding of 20% of the present study's video fragments led to an inter-rater reliability of .80.

Background Information

In order to assess social competence, a shortened version of the Social Cognitive Skills Test was used (van Manen et al. 2009). This test administers social cognitive skills in 4- to 12-year-old children. Children are presented with short stories and are asked questions that refer to several social competence skills. A score of 10 ($SD = 3.00$) represents average social competence in the Dutch norm population. Reliability and validity of the total test range from sufficient to good.

Verbal ability was measured by administering the Vocabulary subtest of the Wechsler Intelligence Scale for Children–III (WISC-III) for children aged 6 to 17 (Kort et al. 2005). For children younger than 6, the Vocabulary subtest of the Wechsler Preschool and Primary Scale of Intelligence-III (WPPSI-III) was used (Wechsler et al. 2009). Scores range from 1 to 19 with a score of 10 ($SD = 3.00$) representing an average score in the Dutch norm population. Both intelligence tests have good to sufficient reliability and validity.

Table 4 Observed individual social behaviors

Peer-directed social behaviors	Reactions to social behaviors of peer	
Leads peer in activities (positive/neutral/negative)	Follows lead of peer	Refuses to follow or ignores lead of peer
Uses peer as a resource	Helps peer	Refuses to help or ignores peer
a) Seeking information		
b) Seeking judgment in a dispute		
c) Seeking help with equipment		
Takes unoffered objects	Defends objects	

Based on the Individual Social Behavior Scale (ISBS; Guralnick et al. 1996)

Statistical Analyses

Social and Cognitive Play

Data were analyzed using SPSS version 25 by means of generalized linear mixed models. In order to control for the nesting of participants within dyads (Kashy and Kenny 2011), multilevel logistic regression (MLR) was used to analyze the effects of sound augmentation of toys on social and cognitive play. Since all dyads participated in repeated measurements, both dyad and autocorrelation of the individual were entered as random intercepts in the three-level nesting MLR-model, with each aspect of social and cognitive play as dependent variables. Social play frequencies were corrected for the times that participants were unable to play together due to external factors. Condition (AC or NC), measurement week (1 or 2) and visual ability (sighted or visually impaired) were added as fixed dummy effects in the model. Because age is known to be an important predictor of play behavior, this variable was also entered in the model as fixed dummy effect (age groups: 4–6; 7–9; 10–11). The beta coefficients that resulted from the MLR were converted into odds ratios. An odds ratio > 1 indicates that the dependent variable is more likely to occur in a certain condition compared to another one (e.g., in the AC versus the NC).

Individual Social Behaviors

Data were analyzed in SPSS version 25. Non-parametric tests were most appropriate because of the small sample size and non-normal data distributions. Wilcoxon Signed Rank tests were used to analyze differences between conditions. Mann-Whitney U tests were used to examine differences between sighted and VI-groups.

Results

Social Aspects of Play

For each of the social aspects of play, results of the best-fitted model are presented in Table 5. Figure 2 shows proportions of each social aspect of play after controlling for the nesting of participants in dyads and autocorrelation of the repeated measurements. During the first week of measurement, participants spent significantly more time in both parallel and solitary play in the AC than in the NC. In the NC, more cooperative play was demonstrated. Although the analysis indicated that disengagement occurred significantly more often in the NC compared to the AC, predicted proportions equaled .02 in the NC and .01 in the AC. In the second week of measurement, both parallel and solitary play significantly decreased in the AC, whereas cooperative play increased. Because of this, demonstrated solitary play no longer differed between conditions. Parallel play was still demonstrated more frequently in the AC and cooperative play occurred more often in the NC.

No significant effect of visual ability on either of the social aspects of play was found. A significant effect of age was found on cooperative play and disengagement. For cooperative play this indicated that children aged 4-to-6 showed less cooperative play than the 10-to 11-

Table 5 Odds ratios of condition and measurement week and random variance for each social aspect of play

Social play categories	NC week 1 vs. AC week 1	NC week 2 vs. AC week 2	NC week 2 vs. NC week 1	AC week 2 vs. AC week 1	ICC dyad	ICC indiv.
Disengagement	1.67**	1.36*	1.72***	2.12***	.132	.131
Solitary	0.78**	0.90	0.69***	0.55***	.216	.000
Parallel	0.51***	0.80**	1.07	0.68***	.127	.013
Cooperative	1.96***	1.15*	0.98	1.66***	.140	.019

*** $p < .001$; ** $p < .01$, * $p > .05$. AC = augmented condition; NC = non-augmented condition; ICC dyad = intra-class correlation of the random dyad-effect; ICC indiv. = intra-class correlation of the random individual-effect

year olds (OR = 0.44, 95% CI = 0.22–0.90, $p = .025$). Disengagement occurred more often in the youngest group than in the 7-to-9 and 10-to-11 year olds (7–9: OR = 5.84, 95% CI = 2.17–15.74, $p = .001$; 10–11: OR = 10.51, 95% CI = 2.54–43.55, $p = .001$).

Cognitive Aspects of Play

Only one dyad engaged in games with rules, so this aspect of cognitive play was excluded from further analyses. As can be seen from Table 6 and Fig. 3, children demonstrated significantly more total manipulative play and less functional and symbolic play when they first used the augmented versus the non-augmented castle. This was due to exploration of the sounds, since no significant differences between conditions were found for basic manipulative play. In line with our expectation, the amount of time spent on manipulative play including sounds significantly decreased in the second measurement week. Yet manipulative play was still demonstrated more often in the AC, whereas functional play occurred more often in the NC.

The amount of time spent in symbolic play no longer differed between both conditions during the second measurement week because of an increase in symbolic play in the AC. Only functional play with pretense did not differ between both conditions, but it did decrease significantly from the first to the second week.

Contrary to our expectations, demonstrated cognitive aspects of play did not differ between children with VIs and sighted children, although a trend was found for children with VIs to demonstrate more manipulative play than sighted children (OR = 1.37, 95% CI: 0.98–1.91, $p = .067$). A significant effect of age on functional play
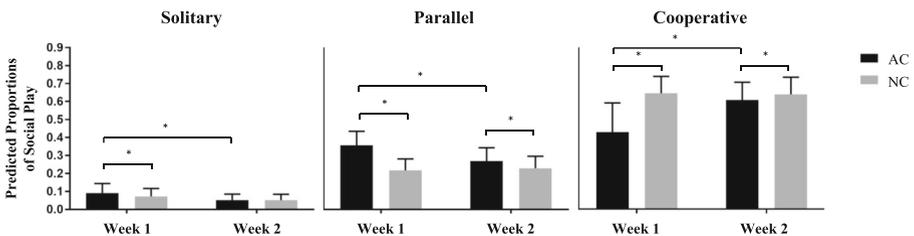

Fig. 2 Mean predicted proportions for each social aspect of play. *Note.* * p < .05. AC = augmented condition; NC = non-augmented condition. Error bars reflect 95% confidence intervals of the mean predicted proportions. Predicted proportions of disengaged behavior were not presented in this figure because it occurred too infrequently

Table 6 Odds ratios of condition and measurement week and random variance for each cognitive aspect of play

Cognitive play categories	NC week 1 vs. AC week 1	NC week 2 vs. AC week 2	NC week 2 vs. NC week 1	AC week 2 vs. AC week 1	ICC dyad	ICC indiv.
TMP	0.31***	0.46**	0.78	0.64***	.017	.058
BMP	0.87	1.01	0.91	0.78*	.001	.061
Functional	1.20*	1.26*	0.84*	0.79*	.027	.060
Functional pretense	0.93	0.90	0.77**	0.80**	.051	.046
Symbolic	1.58***	1.15	0.93	1.27**	.286	.076

*** $p < .001$; ** $p < .01$; * $p < .05$. AC = augmented condition; NC = non-augmented condition; TMP = total manipulative play including sound exploration; BMP = basic manipulative play; ICC dyad = intra-class correlation of the random dyad-effect; ICC indiv. = intra-class correlation of the random individual-effect

indicated that children aged 4-to-6 demonstrated more functional play than those aged 10-to-11 (OR = 1.95, 95% CI: 1.02–3.73, $p = .044$).

Peer-Directed Social Behaviors

The total amount of refuses or ignores was calculated by totaling the frequencies of 'refusing to follow' and 'refusing to help'. Descriptive information about the demonstrated social behaviors can be found in Table 7. Wilcoxon signed rank tests highlighted no significant differences between the AC or the NC with regard to both peer-directed behaviors as well as responses of the peer. When differences between the social behaviors of children with VIs and sighted children were examined, the only significant difference was for 'taking materials' during the AC ($Z = -2.47$; $p = .014$). This suggested that while playing with the augmented toy, children with VIs took materials from their sighted playmates more often than the other way around. However, a closer look at Table 7 shows that this effect was a result of changes in the sighted group rather than the VI-group: only one sighted child took play materials during the AC, whereas six sighted children did so during the NC. Indeed, a significant group * condition effect of 'taking materials' indicated that sighted children took more materials of their playmate with a VI during the NC than the AC ($Z = -1.98$; $p = .048$), whereas this effect was non-significant for the children with VIs.
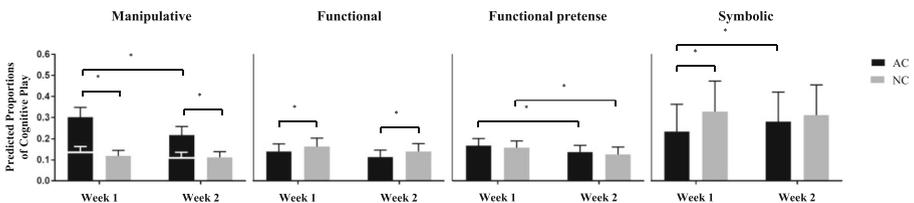

Fig. 3 Mean predicted proportions for each cognitive aspect of play. *Note.* * $p < .05$. AC = augmented condition; NC = non-augmented condition. Error bars reflect 95% confidence intervals of the mean predicted proportions. TMP = total manipulative play; BMP = basic manipulative play. Predicted proportions for BMP are projected in white over the black bars of TMP in the augmented condition

Table 7 Mean demonstrated social interaction behaviors by condition and group ($N = 30$)

Individual social behaviors	AC				NC			
	VI		Sighted		VI		Sighted	
	N	M (SD)	N	M (SD)	N	M (SD)	N	M (SD)
Leads	9	2.67 (3.20)	12	3.80 (4.11)	12	3.53 (3.62)	13	5.00 (4.87)
Uses as resource	12	3.00 (3.57)	15	1.80 (1.42)	12	3.33 (3.11)	13	1.73 (1.28)
Takes materials	7	.73 (1.03)	1	.07 (.26)	5	.67 (1.18)	6	1.06 (1.98)
Follows	12	3.00 (3.51)	9	1.87 (2.67)	13	3.87 (4.12)	12	2.87 (3.25)
Helps	12	1.20 (1.08)	11	2.27 (2.60)	12	1.47 (1.30)	11	2.67 (2.72)
Refuses/ignores	11	1.40 (1.88)	11	1.33 (1.76)	11	1.47 (1.55)	15	1.33 (1.12)
Defends materials	1	.07 (.26)	2	.13 (.35)	2	.20 (.56)	3	.20 (.41)

Discussion

The goal of the present study was to investigate whether sound-augmented toys were able to facilitate peer play in dyads of elementary school-aged children with VIs and their sighted classmates. To our knowledge, this is the first quasi-experimental study directly investigating the effect of sound augmentation on multiple aspects of peer play in children with VIs in mainstream elementary education. The present study also provides relevant insights in the play patterns and peer interaction behaviors demonstrated by children with VIs in mainstream education.

We found that the augmented toy facilitated joint attention during parallel play in children with VIs and sighted classmates, yet this occurred at the expense of cooperative play. The sounds drew the attention of both children to one another and to the toys as they explored the sound augmentation. Contrary to our expectations, children demonstrated more solitary play when they first used the augmented toy and the time spent in cooperative peer play decreased compared to the NC. Even though time spent in solitary play decreased during the second measurement week, participants still showed less cooperative play in the AC than the NC. It thus seems that merely increasing joint attention between children with VIs and sighted peers via augmented toys does not automatically lead to more active play together or more frequent interaction. In our study, the sounds actually seemed to interfere with peer interaction during play. Nonetheless, sound augmentation did not influence the type of social interactive behaviors that children with VIs or the sighted children displayed. Participants tried to lead their peer, ask for help or take toys just as often in the AC as in the NC and also the responses to these behaviors were similar between conditions.

One of the causes for reduced cooperative play with sound augmentation was that participants spent almost a quarter of their time exploring the variety of available sounds when they used the augmented toy for the first time. This led to a decline in functional and symbolic play compared to the NC. Since symbolic play in particular has many social elements while manipulative (i.e., explorative) play is often non-social (Lillard 2001), this

explains the decrease of cooperative play and increase in solitary play. It remains unclear why children still demonstrated less cooperative play when they used the augmented toy repeatedly. It could be that the sounds constantly drew the children's attention in such a way that they might have been hard to ignore, especially when children were talking to each other. Another possibility is that the children with VIs deliberately focused their attention on the sound output instead of on the other peer, which would be supported by the trend that children with VIs showed more sound exploration than sighted participants. In the absence of vision, the audio feedback presumably was more appealing to participants with VIs, yet this assumption is highly speculative.

Furthermore, the additional information that the children with VIs received from sound exploration was expected to facilitate functional play (with pretense) and symbolic play. Yet even when the participants used the augmented toy a second time, the additional object information did not lead to more functional or symbolic play than with the non-augmented toy. Notwithstanding, time spent on symbolic play was comparable between conditions during the second measurement week, suggesting that participants both explored toys and integrated them in play.

Even though it was anticipated that children with VIs would experience difficulties during play and interaction with sighted peers (Guralnick et al. 1995, Hestenes and Carroll 2000, Ozkubat and Ozdemir 2014), the present study suggests that this might not be the case. Interestingly, the participants with VIs showed comparable play and social interaction behaviors as the sighted children. This is in line with a study of D'Allura (2002) that found no differences in the frequency of social interaction between preschoolers with VIs and sighted peers in a reverse mainstream setting. The only difference that we found was a trend indicating that children with VIs made use of the sound augmentation more often than sighted children. In addition, the type of play that the participants in the present study demonstrated appeared to be relatively adequate compared to a study with 4- to 11-year-old typically developing children (Yuill et al. 2014). In our study, the most complex forms of social and cognitive play – cooperative and symbolic play – were demonstrated for the majority of time, independent of the type of toys that participants used. With the non-augmented toy, cooperative play was already demonstrated over 60% of time, whereas solitary play was demonstrated for less than 5%. Interestingly, demonstrated patterns of social play were similar between participants with VIs in mainstream education and those in special education (for more detailed information on play behavior in children with VIs in special education, see: Verver et al. 2019). In contrast, research of Yuill et al. (2014) showed that triads of typically developing children demonstrated solitary play most of the time when using a similar non-augmented castle, whereas cooperative play occurred the least frequent. When these triads used the augmented castle, the time spent in cooperative play doubled to approximately 40% of the total play session (Yuill et al. 2014). This seems to imply that a ceiling effect of the augmented toy on play behavior occurred in our sample, because the participating children with VIs already showed adequate peer play. Yet it should be noted that Yuill et al. (2014) used event sampling as observational method, which is a more precise observational method than the time sampling method used in the present study (i.e., coding the most dominant play behavior within a 10-s interval).

Limitations

Several limitations should be mentioned that might have influenced the results of the present study. First of all, this study involved only a small sample of children with VIs in mainstream education and it is possible that sampling bias occurred. Convenience sampling was used in order to include a sufficient number of children with VIs, which meant that children were approached if they received outpatient treatment. It appeared to be difficult to recruit a sufficient number of participants with VIs and many parents who refused participation mentioned that they believed it would be too demanding for their child with a VI, who already had to participate in mainstream education. This probably explains why most participants with VIs had a moderate VI (five children even had a mild VI with visual acuity >.30) and showed similar social competence and verbal ability as their sighted classmates and as the norm group of Dutch typically developing children of comparable ages. Although the latter made the comparison of play and interaction behaviors between both groups of children increasingly reliable, it also infers that the present study's sample is presumably not representative for the population of Dutch children with VIs in mainstream education. In addition, no children with blindness participated, while these children are often challenged the most during peer play (Roe and Webster 2002; Hughes et al. 1998). A study with a larger sample, including children with VIs that were found to experience peer play difficulties and are in need of support, is necessary to be able to draw firm conclusions about the usefulness of augmented toys for the population of children with VIs in mainstream education.

Furthermore, the observational method that was used (i.e., time sampling) resulted in a less precise measure of demonstrated play behavior than if event sampling would have been used. Unfortunately, sufficient inter-rater reliability could only be reached with time sampling because social interaction bids were often very brief (e.g., two seconds) and dyads could demonstrate as much as four different aspects of social play within ten seconds. Because time sampling was used for a set period of time, an increase in one aspect of play automatically led to the decrease of another. Event sampling would thus give a more detailed impression of the effect of augmented toys on play behaviors.

Finally, the small sample might have caused bias to the random variance estimates. Multilevel modeling (MLM) ideally contains over 20 higher order units (i.e., in this case the dyads) to avoid Type 1 errors (Heck et al. 2013), while our study involved 15 dyads that completed all measurements. Small samples have been found to cause positive bias in the intercept and slope variance estimates (Mok 1995; Clarke and Wheaton 2007). However, studies consistently showed little to no bias in the estimates of fixed effects in small sample studies (Bell et al. 2008; Clarke and Wheaton 2007; Maas and Hox 2004). This study used a relatively simple MLM-model without random slope variances, therefore limiting the potential bias to the random variance estimates (Heck et al., 201). In addition, recent research shows that incorrect conclusions are also reached if the nesting of observations in higher-level groups is ignored during data analysis, underlining the importance of MLM even for small samples or small ICC-values (Musca et al. 2011).

Future Directions

Several implications can be mentioned regarding the use of sound-augmented toys as a tool to facilitate peer play in children with VIs in mainstream education. An important advantage of sound-augmented toys is that the audio feedback encouraged exploration and object-interaction in children with VIs, also when they used the toys repeatedly. This suggests that sound-augmented toys provide these children with an interesting play context, as former research showed that children with VIs often use a limited number of different toys and soon lose interest if toys are primarily visually stimulating (Troster and Brambring 1994; Roe 2008). Furthermore, children can use the toys by themselves, without the need for adult presence. This is an advantage especially in mainstream education, where teachers often have little time to offer individual or small group assistance. However, it appears that the sounds interfered with children's own verbal utterances during cooperative play. Even though the participants in the present study already showed high amounts of cooperation when they used the non-augmented toy, it thus seems as if the sound-augmentation is less suitable for facilitating cooperative play between children with VIs and peers, at least in a pretend play context.

This study paves the way to more advanced studies examining the effect of sound augmentation on the complexity of play. For example, in our study it was observed that some children integrated the information they heard from the sound augmentation into the fantasy stories that they were playing during symbolic play. The present study only investigated the amount of time that children spent in certain play aspects, whereas the complexity of play can also be defined by the type of acts that children perform (e.g., role play as part of symbolic play) or whether they often invent novel acts or repeat similar acts (e.g., only repeating the scheme of knights attacking each other versus elaborating on this scheme with novel storylines; Belsky and Most 1981; Lillard 2001). In addition, Lewis et al. (2000a) used two standardized measures to assess the complexity of both symbolic play and functional play with pretense in detail, namely the Test of Pretend Play and the Symbolic Play Test (Lewis and Boucher 1997; Lowe and Costello 1988). Future studies using these measures can explore whether the sound augmentation involving play propositions or extra information about play figures is able to facilitate play complexity.

Finally, this study examined the usefulness of augmented toys in one context only (i.e., a pretend play context), suggesting that many other possibilities for the use of augmented toys are still to be discovered. For example, gross motor play and sports are also found to be challenging to participate in for children with VIs in mainstream education (Brambring 2006; Houwen et al. 2009). These social activities or free play contexts might better represent daily life settings than the structured play environment that was offered in the present study, and might be more demanding of the social skills of children with VIs. Additionally, since the sound augmentation particularly increased exploration in children with VIs, augmented toys producing informative sounds might also provide them with a playful learning context. Former work of Hinske et al. (2010) already showed that typically developing children implicitly gained knowledge when informative sounds were available while using the augmented castle. Future research that examines possibilities for augmentation of other settings or types of (play) materials is therefore warranted.

Conclusions

The aim of this study was to investigate the effect of sound-augmented toys on peer play and interaction in dyads of 4- to 11-year-old children with VIs and sighted peers. The results indicate that sound augmentation facilitated both, joint attention during parallel play and the exploration of play materials. However, this did not encourage social interaction or more complex play behaviors. The findings also suggest that children with VIs showed similar peer play and social interaction behaviors as the sighted children. In addition, both cooperative play and symbolic play were demonstrated for the majority of time by the dyads, independent of the type of toys they used. This implies that children with VIs in mainstream education show adequate peer play behavior while playing within a dyad in a structured setting. However, it is important to realize that this might exclusively be the case for children with a moderate visual impairment that have good social- and cognitive skills.

Compliance with Ethical Standards

Ethical Approval   All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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

Conflict of Interest   The authors declare that they have no conflict of interest.

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