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Babbling and consonant production in children with neurodevelopmental disabilities

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Abstract

The aim was to determine if early precursors to speech and language development; canonical babbling, occurrence of plosives, dental/alveolar plosives, and number of different consonants, could be detected in children with different neurodevelopmental disabilities. In a cross-sectional study, 18 children aged 12-22 months with disabilities such as Down syndrome, cerebral palsy and developmental delay were video recorded interacting with parents. Parent reported vocabulary was collected with the Swedish Early Communication Development Inventory, SECDI. Recordings were analysed by observation of babbling and consonant production, and calculation of canonical babbling ratio. A significant difference compared to typically developing children was found for all variables except for occurrence of plosives. There was a significant correlation between canonical babbling and age adequate expressive vocabulary. The subgroup with Down syndrome differed from controls only on number of different consonants. Further research is needed to determine the long-term relevance of the findings for the speech and language development of the children.

Babbling and speech are closely related in the typically developing child. Although individual children show different preferences regarding which sounds they use, these sounds tend to be the same in babbling and in early speech (Vihman, Macken, Miller, Simmons, & Miller, 1985; Stoel-Gammon, 1985). An important milestone in the development of babbling is the emergence of canonical babbling, i.e. well-formed syllables consisting of a consonant and a vowel, with a rapid transition between the two (Oller, Eilers, Neal, & Cobo-Lewis, 1998). Canonical babbling emerges at around 6 months in the typically developing infant and a late onset of canonical babbling (defined as not having reached the canonical babbling stage at 10 months) appears to be associated with later difficulties with speech and language (Oller et al., 1998). Late onset of canonical babbling has been found to be associated with delayed onset of meaningful speech (Stoel Gammon, 1989), a smaller expressive vocabulary at 18, 24 and 30 months (Oller , Eilers, Neal, & Schwartz, 1999; Fasolo, Majorano, & D'Odorico, 2008) and less accurate articulation at 36 months (Moeller, et.al., 2007a, b). The onset of canonical babbling seems to be robust, even in the presence of factors such as low socioeconomic status, prematurity and exposure to more than one language (Oller, Eilers, Steffens, Lynch, & Urbano, 1994; Oller et al., 1998). A common way of measuring canonical babbling is canonical babbling ratio (CBR), where number of canonical syllables is divided by total number of syllables (Oller et al., 1994). A child is commonly cathegorised as being in the canonical babbling stage when CBR is above 0.15 (Molemans, Van Den Berg, Severen, & Gillis, 2012; Levin, 1999; Oller et al., 1994).

Consonant production is another important feature in babbling and early speech. In typically developing children, anterior sounds tend to precede posterior ones, and early consonant inventories are dominated by plosives, nasals and glides (Stoel-Gammon, 1985). Early consonant production can be affected by disabilities such as cleft palate and hearing loss. In one study, children with hearing loss aged 10-24 months were found to have significantly less different alveolars compared to controls (Moeller et al., 2007a). Children with cleft lip and palate have been shown to have fewer dental/alveolar plosives at 12 (Lohmander, Olsson, & Flynn, 2011) and 18 months (Lohmander, Lillvik, & Friede, 2004) compared to controls. Early consonant production has also been shown to be related to phonological proficiency in the preschool years. Vihman & Greenlee (1987) found a significant negative correlation between use of true consonants (i.e. consonants that are not glottals or glides) in typically developing infants with around 15 active words and the phonological error score of the same children at age 3. In children with cleft lip and palate, Lohmander & Persson (2008) found a correlation between number of different consonants at 18 months and percent consonants correct (PCC) at 3 years as well as between number of dental/alveolar plosives at 18 months and PCC at 3 years. Klintö, Salameh, Olsson, Flynn, Svensson & Lohmander (2013) found the same association using age adjusted PCC (PCC-A) at 3 years.

Children with neurodevelopmental diabilities have an increased risk for developing difficulties in speech and language. Given that variables of babbling and early consonant production seem to be able to predict speech and language development in the preschool years, for children with typical development as well as for children with diabilities such as hearing loss and cleft palate, this would seem a promising field of research for children with neurodevelopmental disabilities as well. However, for many neurodevelopmental disabilities little is known regarding how onset of canonical babbling and early consonant production are affected.

Kent and Vorperian (2013) state in their review on speech impairment in Down syndrome (DS) that results regarding babbling are inconsistent: some studies have found no significant differences in babbling between typically developing children and Down syndrome children whereas others have. Smith & Oller (1981), for example found no significant difference between the onset of reduplicated babbling in Down syndrome infants and typically developing infants. There were also no significant differences between the two groups regarding consonant production: in typically developing as well as Down syndrome infants, alveolar consonants dominated from 9-12 months of age. Lynch, Oller, Steffens, Levine, et al.(1995) on the other hand found a two month delay in the onset of canonical babbling, and a less stable canonical babbling after onset. The onset of canonical babbling seems to overlap that of typically developing children and if a delay is present it is considerably smaller than would be expected based on delays in other areas of development, Kent & Vorperian (2013) conclude.

Levin (1999) studied babbling in eight infants (11-12 months old) with cerebral palsy (CP). Two of the children were found to be in the canonical babbling stage, three had some canonical babbling and two lacked canonical syllables. All participating children had less than 20% dental consonants and all produced canonical utterances were monosyllables.

Patten et al. (2014) examined home videos of infants later diagnosed with Autism Spectrum Disorder (ASD) and found that they were significantly less likely to have reached the canonical babbling stage, compared to typically developing children. Children later diagnosed with ASD also had significantly lower CBR. The authors argue that canonical babbling could prove a way of detecting ASD in infancy. Scheinkopf, Mundy, Oller, & Steffen (2000) found a significant correlation between joint attention and canonical syllables as well as expressive language (measured by Reynell language scales) and canonical syllables in a group preschool children with ASD.

Previous research has thus proved it relevant to study babbling and early consonant production as precursors to speech and language development. Although children with neurodevelopmental disabilities present with an increased risk of speech and language disorders, very little is known about canonical babbling and consonant production in this group of patients. The aim of this study was to explore early precursors to speech and language in a group of infants and toddlers with neurodevelopmental disabilities, as a possible way of identifying individuals in need of additional support.

Research questions

In a group of infants and toddlers with neurodevelopmental disabilities,

a. to what extent have the children reached the canonical babbling stage?
b. to what extent do the children use plosives and dental/alveolar plosives?
c. are there any differences compared to typically developing children in terms of canonical babbling or use of plosives or dental/alveolar plosives?
d. are there any differences compared to typically developing children in terms of number of different consonant used by the children?
e. are there any associations between canonical babbling and receptive or expressive vocabulary in the participating children?

Method

Participants

An explorative cross-sectional study of 18 children was performed. The children had different neurodevelopmental disabilities and were recruited from seven habilitation centers in the Stockholm area. In total, there are ten habilitation centers in the area. One center declined to participate and two had no children fulfilling the inclusion criteria. The children were recruited on the basis of the following inclusion criteria: a) receiving services from the habilitation center, b) age between 10 and 24 months, corrected if preterm, c) Swedish native language used at home by at least one parent, and d) child is able to participate in a 45 minute observation, as judged by a member of the staff that knows the child. Exclusionary criteria were no vocalizations. Children were recruited during March to May 2014 and the observations took place during March to August 2014. Twenty-four families were asked to participate. Six families declined. Thus, 18 children (10 girls and 8 boys) were finally recruited for participation. Not all families receiving habilitation services at habilitation centers were asked to participate. In the seven habilitation centers, around 60 children might have met the inclusion criteria. When the habilitation center staff chose not to ask a family to participate, the reason for this was for example that the families already participated in other scientific studies or had a history of non-attendance to habilitation services. The participating children were 12-22 months of age (*M* 16.6, *SD* 3.9). The children had different developmental disabilities, described in Table 1.

Table 1. Demographics of the children: age, sex, parent reported diagnosis, hearing history and results from the Ling Six-Sound Check (Smiley, 2004).

Child	Age (months)	Sex	Diagnosis	Hearing history	Ling Six-Sound Check: Sounds detected *
1	12	Boy	Down syndrome	No hearing loss at birth or at 5 months	uː aː ʃː
2	12	Boy	Developmental delay	No hearing loss	mː uː iː aː ʃː sː
3	12	Girl	Suspected cerebral palsy	No evaluation done	mː uː iː aː ʃː sː
4	13	Boy	Brain malformation	No hearing loss at birth	uː iː sː Testing interrupted, lack of participation.
5	13	Girl	Chromosomal deletion syndrome	Under evaluation, suspected hearing loss	mː uː iː aː ʃː sː
6	14	Girl	Chromosomal deletion syndrome, developmental delay	No hearing loss (but it took repeated testing)	mː uː iː ʃː sː
7	14	Girl	Developmental delay	No hearing loss at birth and later	mː aː ʃː sː Results uncertain
8	14	Boy	Cerebral palsy	No hearing loss	mː uː iː aː ʃː sː
9	16	Girl	Cerebral palsy	No hearing loss	mː uː iː aː ʃː sː
10	16	Girl	Developmental delay	No hearing loss at birth	mː uː iː aː ʃː sː
11	18	Girl	Suspected cerebral palsy, unilateral	No hearing loss	mː uː iː aː ʃː sː Results uncertain
12	19	Boy	Cerebral palsy, dyskinetic	No hearing loss	mː uː iː aː ʃː sː
13	20	Girl	Down syndrome	Evaluated and hearing loss suspected	sː Testing interrupted, lack of participation
14	21	Boy	Down syndrome	Hearing loss, uses hearing aid	mː uː iː aː ʃː sː (had HA on)
15	21	Girl	Down syndrome	No significant hearing loss	mː uː iː aː ʃː sː
16	22	Boy	Down syndrome	No evaluation done	mː uː iː aː ʃː sː Results uncertain
17	22	Boy	Down syndrome	Mild hearing loss, uses hearing aid.	mː uː iː aː ʃː sː (had HA on)
18	22	Girl	Cerebral palsy, bilateral spastic	No hearing loss	mː uː iː aː ʃː sː

* **at least one side and at least one distance**

Parents of the participating children reported if the child had undergone hearing assessment and if so, the results. Furthermore, a simple hearing screening was performed by the author using the Ling Six-Sound Check (Ling, 2002; Smiley, 2004). The sounds /mː/, /uː/, /iː/, /aː/, /ʃ/ and /sː/ were uttered at a distance of two, one and half a meter by the test leader, who was placed behind the child. Sounds were presented at the child's right and left side. A positive response was noted if the child turned the head towards the sound. For the children with severe motor disorders and insufficient head control, the parents were asked to identify whether the child reacted to the sound. Thirteen of the participating children responded to all Ling sounds. This included the two children who used hearing aids. 16 out of 18 children either passed the Ling Six-sound test at the time of the study or had passed a hearing evaluation after the newborn screening.

The study group was compared to a group of typically developed children (Lohmander et al., 2011), who acted as controls. These controls were recruited from child health care centers in the Gothenburg region and were matched to the participating children for age and sex. All of the controls had Swedish as their native language and no known developmental delay or syndrome. To control for parent educational level, a possible confounding factor, participants and controls were compared for mother's educational level (high school/middle school or university/college). A Fisher's exact test was used. There were no significant differences in educational level between participants and controls ($p=0.367$, Fisher's exact test).

Procedure

All children were video recorded while playing with one of their parents during 35 to 45 minutes. The same set of age appropriate toys was used for all children. The parents were encouraged to play with their child as they would at home. The recordings took place at the habilitation center that the child normally attended. A digital video camera (Canon FS100) with an external microphone (Sony ECM-MS907) was used for recording. The goal was to collect 100 utterances for each child; however, this was not always possible. Median of number of utterances was 202 (48-518). Five children had below 100 utterances (48, 50, 58, 64 and 83 utterances, respectively). Due to the exploratory purpose of the study, it was decided that no participants would be excluded due to low volubility.

The parent-child interactions were recorded by the author. Before the recording, the parents completed Swedish CDI – words and gestures (SECDI w&g) (Berglund & Eriksson, 2002), a parent-reported measure on language development. In the present study, the results of one particular section of the SECDI w&g was analysed, namely the vocabulary checklist for comprehension and expression.

Analysis

To control for bias, the participants were assessed from the video recordings by an independent examiner. Two different kinds of assessment were performed. First, an observation form for babbling and consonant production (Lohmander, in manuscript) was used. In this form, the degree of canonical babbling was assessed as well as the presence of plosives. Furthermore, all consonant or consonant-like sounds used by the child were marked on a list of all Swedish consonant phonemes if heard at least twice. If additional consonant sounds were heard, they could be added on the form. Secondly, all utterances and utterances containing canonical syllables were counted and CBR was calculated by dividing number of utterances containing canonical syllables with total number of utterances (modified from Oller et al., 1994). Thus, two different measures of canonical babbling were obtained: one based on observation and one based on calculation of utterances. In the observation form the degree of canonical babbling was rated on a 100 mm visual analogue scale. The participants were considered to have reached the canonical babbling stage according to observation if they were rated at a minimum of 8 mm on the visual analogue scale. This measure was chosen as it represented the 10^{th} percentile in a population of typically developed Swedish 10-month-old children (Eriksson & Holm, 2013). In the analysis of utterances a ≤0.15 CBR cut-off was used to determine if the child had entered the canonical babbling stage or not. In this study, the CBR measure was used for the analyses and the mm-rating was used to validate CBR.

Plosives were rated as present (yes) or absent (no) in the observation form. Participants were considered to have plosives if plosives were marked with "yes". Participants were considered to have dental/alveolar plosives if /t/ or /d/ was marked in the list of Swedish consonant phonemes.

Besides analysing the results for the group as a whole, separate analyses were made for the children with Down syndrome. This was done as previous studies have shown no or only a small delay in canonical babbling in this group. Furthermore, it is a group that is easily defined, even at this young age. Since the medical records for the children were not available for this study, other diagnostic subgroups could not be reliably formed.

For the analysis of the association between canonical babbling and vocabulary according to the SECDI, data was dichotomised. Canonical babbling was analysed as present or absent, based on CBR above or under 0.15. SECDI results were divided into age appropriate (results at or above the 10th percentile for typically developed children for the child's age, according to the manual) and not age appropriate. This analysis was done for the group as a whole only.

Statistical analyses

Non-parametrical tests were used, as the groups were small and the data was not normally distributed. Differences between the participant group and the control group were analysed with Fisher's exact test for canonical babbling (absent or present according to CBR ≤ 0.15), plosives and dental/alveolar plosives and Mann-Whitney U-test for number of consonant types. The association between canonical babbling and vocabulary was analysed with chi-square test for independence and Cramér's *V*.

Reliability and validity of measures

Inter-observer reliability was calculated from comparisons of the ratings of the independent examiner made from the video recordings with the ratings by the author, made during the session when the children were recorded. Reliability for observed canonical babbling was calculated using the Intra Class Correlation Coefficient (ICC), as was reliability for number of different consonants. Reliability for the occurrence of plosives and occurrence of dental/alveolar plosives was measured as percent agreement, point-by-point. When measuring number of different consonants, voiced and voiceless consonants with the same manner and place of articulation were counted as one consonant, as the voiced-voiceless distinction cannot be considered established at this young age.

Intra-observer agreement was assessed by repeated assessment on five children (28%) by the independent examiner and the author respectively. The children who were re-assessed by the author were randomly selected. For the independent examiner, three children had already been chosen for re-assessment, as they had rendered low inter-observer reliability The other two were randomly selected. Intra-observer agreement was calculated in the same way as inter-observer agreement for canonical babbling, number of different consonants, plosives and dental/alveolar plosives. Inter- and intra-observer reliability are presented in Table 2.

The consistency for CBR was calculated with ICC as well as by comparing CBR to observed canonical babbling. The intra-observer agreement for canonical babbling (ICC=.998, ($p<.0001$) suggested good validity for the CBR measure. The agreement between the two different measures of canonical babbling (point-by-point measure) was 83%.

Ethical considerations

All parents gave written consent to their and their children's participation in the study. The study was approved by the Regional Ethical Committee in Stockholm (2013/1989-32).

Table 2. The Inter- and Intra-observer reliability for the measures used in the study

	Inter-observer reliability	Intra-observer reliability Independent examiner	Intra-observer reliability Author
Observed canonical babbling (ICC)	.924 (p<.0001)	.992 (p<.0001)	.933 (p=.007)
Number of different consonants (ICC)	.582 (p<.0001)	.882 (p=.035)	.741 (n.s)
Occurrence of plosives (percent agreement)	89%	100%	100%
Occurrence of dental/alveolar plosives (percent agreement)	83%	80% (4/5)	80% (4/5)

Results

Thirteen of the participating 18 children (72%) had reached the canonical babbling stage. Fourteen of the participants (78%) used plosives, and 12 (67%) used dental/alveolar plosives. All children in the control group had canonical babbling, plosives and dental/alveolar plosives (Figure 1). The difference between controls and the study group was significant for canonical babbling (p=.045, Fisher's exact test) and dental/alveolar plosives (p=.019, Fisher's exact test), but not for plosives (p=.104, Fisher's exact test).

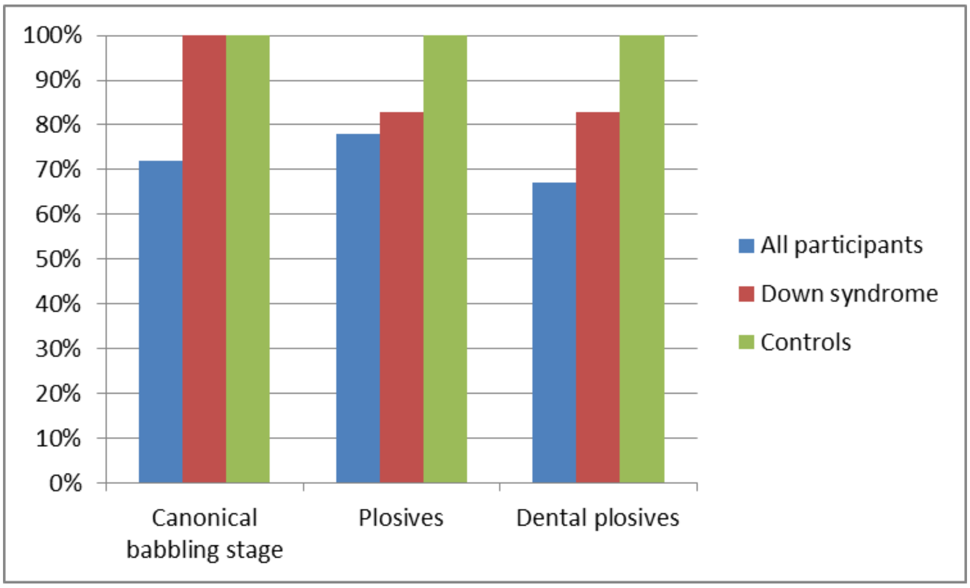

Figure 1. Canonical babbling, plosives and dental/alveolar plosives in all participants, Down syndrome subgroupand controls.

All children with Down syndrome had reached the canonical babbling stage and all but one used plosives and dental/alveolar plosives. The difference between the DS group and the control group was not significant. The participating children had significantly fewer different consonants (*M*= 5.61, *SD* 2.72) compared to controls (*M*=9.22, *SD* 2.10), (Mann Whitney *U*=47.0, p<.001). This difference was also significant when the DS group (Mann Whitney *U*=3.0, p= .013) was compared to matched controls.

Out of the 18 children, seven presented with age appropriate scores on expressive vocabulary according to the SECDI. For receptive vocabulary, two children presented with age appropriate scores. Another four children could not be classified as age appropriate or not, due to the fact that norm values for the SECDI receptive vocabulary are not available for children older than 16 months. A chi-square test of independence indicated that present or absent canonical babbling was associated with expressive vocabulary (χ^2_1=4.406, p=.036, Cramér's *V*= .495). There was, however, no significant association between present or absent canonical babbling and the receptive score (χ^2_1=1.296, p=.255, Cramér's *V*=.304).

Discussion

The participating children had difficulties compared to typically developing peers, both regarding canonical babbling, production of dental/alveolar plosives and number of different consonants produced. These are variables that have previously been shown to be important precursors to speech in typically developing children as well as in children with disabilities such as hearing loss and cleft palate. In the following discussion, the results will be compared to the few existing studies on babbling and early speech in children with neurodevelopmental disabilities, as well as results from studies on children with other disabilities. The results of the DS subgroup will be discussed separately.

As previously seen in children with CP (Levin, 1999) and autism (Patten et al., 2014), the children with neurodevelopmental disabilities lacked canonical babbling to a greater extent than controls. The fact that the children in this study were older than the children in previous studies further emphasizes the delay in speech and language development that is present in some of these children. When it comes to production of consonant sounds, no difference compared to controls was seen for plosives, but dental plosives were significantly less common. A similar pattern has been found for children with cerebral palsy (Levin, 1999). In Levin’s study, plosives were the most common manner of articulation for the children who were canonical, but they all produced more labials and velars than dentals.

The cause of speech and language difficulties in neurodevelopmental disabilities is often multifactorial; cognitive, language and motor capabilities combined affect the development of the child. The precursors of speech and language studied here have previously been studied in children with hearing loss and cleft palate. In both these conditions, the use of canonical babbling (Moeller et al., 2007a; Hardin-Jones, Chapman, Schulte, & Halter, 2001) and dental/alveolar consonants (Moeller et al., 2007a; Lohmander et al., 2004; Lohmander et al., 2011; Willadsen, 2013) have been found to be delayed. Although the causal mechanisms of speech and language difficulties are different in neurodevelopmental disabilities compared to in hearing loss or cleft palate, the early signs of these difficulties appear to share similar traits.

In the DS group, the results verified previous research (Smith & Oller, 1981), reporting no differences in presence of canonical babbling and dental/alveolar consonants. Thus, the group presented with two precursors to good development of the consonant system and vocabulary – two main domains in speech and language development. The lack of signs of delayed speech at this age could be explained in two ways: either the speech and language disorder in DS does not come into effect until later in the development, or the measures used failed to discover the signs of early difficulties that are present. Kent & Vorperian (2013) state that the speech pattern in Down syndrome becomes clearly different from typically developing children between the ages of 3 and 6 years. This is confirmed by Sokol & Fey (2013) who compared children with DS to children with similar disabilities at 24-33 months and 18 months later. Although the children with Down syndrome performed better than the children with other disabilities at 24-33 months regarding number of different consonants, canonical syllables and canonical vocal communication acts, the children with other disabilities had significantly higher results in all these variables 18 months later. According to this, it would seem as speech and language disorders in Down syndrome might become evident after the age of the participants in the present study. This confirms the experiences of many clinicians: children with Down syndrome often show a poor growth in active vocabulary and a slow development of articulation/phonology during their third and fourth year.

Although the DS group did not differ from controls on the variables canonical babbling, plosives or dental/alveolar plosives, there was a significant difference in number of different consonants used. If difficulties in babbling and early speech indeed are present in infants and toddlers with DS, number of different consonants might be a measure better suited to capture the difficulties in these patients. This could constitute a somewhat qualitative measure of the vocal development in which future difficulties in DS are evident.

Longitudinal studies are needed in order to study this hypothesis and the reliability of the measure need to be ensured. The results regarding DS from the present study should be interpreted cautiously, as all but one of the participants with this diagnosis were 20 months or older. It is thus possible, that the DS group might have presented with difficulties in canonical babbling and consonant production compared to typically developing children at a younger age.

It would of course have been interesting to analyse the six children with confirmed or suspected cerebral palsy as a subgroup and compare the results to previous research. However, as this group was not only small, but also very heterogeneous, this was not possible. The children were not only of different ages (ranging from 12 to 22 months), but they also represented a variety of CP types and gross motor functional levels. Further research is needed in order to describe the role of canonical babbling and consonant production in the speech and language development of children with CP.

The two methods used to classify the children as canonical or not (CBR based on calculation of utterances and canonical babbling based on observation) corresponded in 15 of 18 cases (83%). This is lower than previously reported (Lieberman & Lohmander, 2014). The reason for this could be that children with neurodevelopmental disabilities are more difficult to assess than children that have been studied previously, i.e. typically developing children and children with disabilities such as cleft palate and hearing loss. The participants had disabilities due to different (or unknown) medical conditions, but the most common conditions were DS and CP (confirmed or suspected). In both these conditions, speech is affected by deviant muscular tone. It is not unlikely that this might affect how easily speech production can be classified during observation. Lieberman & Lohmander (2014) stated that some of the children in their study were harder to observe, and that these, upon analysis, were found to have fewer different consonants. This was also true for the majority of the children with neurodevelopmental disabilities. Lieberman & Lohmander (2014) argue that it would be interesting to include a consonant inventory when assessing babbling (as in the form used for this study), but only if the measure is reliable. In the present study the number of different consonants had acceptable inter-rater reliability and good intra-rater reliability for the independent examiner. Therefore, number of different consonants was included as a measure. Number of different consonants became interesting, as it was the measure where the participating children differed the most from controls. Thus, number of different consonants may be a valuable measure when assessing babbling and early speech, especially for children who are difficult to assess.

This was an explorative study and it presented with some limitations that should be considered when interpreting the results. The participating children did not constitute a representative selection of children with neurodevelopmental disorders receiving habilitations services. Furthermore, information of participants' medical background was based on parental report only and is therefore less reliable than if it were based on medical records. Another limitation of the study is that the hearing of the children was not measured. As this was not possible due to timing and financial reasons, it was decided to perform a screening that combined with the hearing history was expected to give useful information on hearing status of the participants. Out of the two children that did not pass either the Ling Six-sound test within the study or a hearing evaluation after the newborn screening, one was judged to be in the canonical babbling stage and presented with both plosives and dental/alveolar plosives. That child also had a slightly higher number of different consonants than average. Based on this, it was concluded that the hearing status of this child probably did not affect the results of the study. The second child was not in the canonical babbling stage, lacked dental/alveolar plosives and had a slightly lower number of different consonants than average. It is unclear if this child's babbling and early speech was affected by a hearing loss.

The participating children presented with a wide variety of neurodevelopmental disabilities. It is worth noting that the observed difficulties in babbling and consonant production did not pertain to all studied individuals. The results of children with Down syndrome have already been mentioned, but there were also children with other diagnoses that performed within normal limits. In this cross-sectional study, no data was available for the subsequent development of the participating children. As previous studies have shown that canonical babbling and consonant production can predict aspects of speech and language development such as phonology/articulation and vocabulary in the preschool years, it would be interesting to follow these children longitudinally. When this was done for a group of at risk children without canonical babbling at 10 months, Oller et al. (1999) found significantly smaller expressive vocabulary at 18, 24 and 36 months compared to controls, whereas there were only small differences regarding receptive vocabulary. The present study indicated that this might hold true for the children with neurodevelopmental disabilities as a significant association between canonical babbling and age adequate expressive vocabulary was found, but no significant association between canonical babbling and age adequate receptive vocabulary. This enhances the relationship between canonical babbling and expressive language, as opposed to receptive language. It also shows that this relationship seems to hold even in a population where cognitive deficits are common.

Conclusion and clinical implications

Children with neurodevelopmental disabilities present with an increased risk for speech and language difficulties. The present study showed that precursors of normal speech and language development, as identified in typically developing children and in children with other disabilities, can be identified early also for children with neurodevelopmental disabilities. Compared to typically developing peers, these precursors were absent to a greater extent in the study group. The significance for the long-term development of the children remains to be seen. Future research might clarify the role of babbling and early consonant production in predicting speech and language difficulties in children with different neurodevelopmental disabilities, thus guiding families and professionals in deciding which children might benefit from early speech and language intervention.

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