

MA Thesis

Vocal development in young children with hearing loss

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0. Abstract

Vocal development is found to be delayed in children with hearing loss compared with children with normal hearing (Cantle Moore, 2014; Moeller, 2007). Therefore, it may be important to stimulate the vocal development in children with hearing loss, and an intervention can make the delay as small as possible.

This study investigated the vocal development in young children with hearing loss compared to the vocal development of children with normal hearing in the Netherlands. In addition, the interventions used national and international are investigated.

In this study I used the Infant Monitor of vocal Production (IMP) this questionnaire is designed in Australia by Robin Cantle Moore (2008). For a larger currently running project this questionnaire is translated in Dutch. To analyze the vocal development of babies I used the data available from the IMP collected at 6 and 9 months of age in children with hearing loss and children with normal hearing. I found no significant differences at both ages. I analyzed the raw scores and also the ceiling question.

For the interventions I found some literature about interventions for children with hearing loss although no specific interventions for the vocal development. In addition to the literature search I interviewed four national professionals and sent an online survey to international research groups. I found that the need for a new instrument to measure the vocal development before the age of 1 year differs within the national organizations, although most organizations do have a need to measure the vocal development. The interventions given found in the literature, the online survey and the interviews have in common that they are home based. The main difference is the age at the start of the intervention, the intervention starts earlier in the Netherlands then found in the literature and in the online survey.

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1. Introduction

Vocal development is found to be delayed in children with hearing loss compared to children with normal hearing (Cantle Moore, 2014; Moeller, 2007). Therefore, it may be important to stimulate the vocal development in children with hearing loss, and an intervention can possibly make the delay as small as possible. This study has two aims: the first aim of this study is to give insight in the vocal development in young Dutch children of 6 and 9 months of age who are early diagnosed with hearing loss. The second aim of this study is to investigate currently used interventions (national and international) and identify possible new ways to stimulate vocal development in children with hearing loss in the Netherlands.

In order to introduce the objects of this study in greater detail, some context should be provided on two important factors, namely: hearing loss and vocal development. Approximately 18.8 per 10,000 children are born with hearing loss in the Netherlands (Zoutenbier et al. 2016). Since 2002 the neonatal hearing screening was introduced in the Netherlands, the hearing of babies is tested in the first week after they are born (Audiologieboek.nl). When the screening results show that the child has hearing loss, the child receives their first hearing aid at approximately 3;7 months old (Uilenburg & Van der Zee, 2014). When the child has a hearing loss of minimal 85 dB in the better ear, it can receive a Cochlear Implant (CI), the implant is often implanted around the first birthday (kno.nl; onici.be).

Now that the process of identifying and treating hearing loss in babies is contextualized, the normal vocal development is explained. Vocal development can be seen as a precursor of later language development. The vocal development begins with the first birth cry of the child. During the first weeks children make simple voice sounds without

articulatory movement. After the first weeks the child can start and stop vocalizing in one breathing cycle. For this stop and start of voice, children need more control of the vocal cords. This results in a first form of multisyllabic structure although only voice is used. After that, children begin to combine voice and one articulatory movement; this is called cooing (Cantle Moore, 2014; Van Beinum and Doppen, 2010). After cooing, children begin to vary more in the articulatory movement and voice. Also, the sounds can begin to sound more like two syllables when children make an articulatory movement within the voice given. For example, [a:ba:]. When children have more control of the vocal cords they are ready to combine voice with multiple articulatory movements, for example [a:ba:da:]. This is called canonical babbling (Goorhuis and Schaerlaekens, 2000; Van Beinum and Doppen, 2010). The three stages in vocal development are crying, cooing and canonical babbling, can be used to evaluate the vocal development. This knowledge is needed to now explain the delayed vocal development of children with hearing loss, and makes it possible to compare the two groups in their vocal development.

The vocal development in children with hearing loss is found to be delayed compared to children with normal hearing. One factor named in the literature which might influence the vocal development of children with hearing loss is the auditory loop. The auditory loop is the auditive feedback that children need in the further vocal development and development of spoken language. The auditory loop is argued to influence the vocal development from the stage of canonical babbling. From this stage in the development it seems more important to have auditive input to further develop the canonical babbling and the first words (Cantle Moore, 2014; Davis et al., 2005; Iyer and Oller, 2008; Van Beinum and Doppen, 2010). An argument in favor of the influence of the auditory loop is that the vocal development of children with hearing loss is found to be delayed from the stage of canonical

babbling (Van Beinum and Doppen, 2010; Moeller, 2007). Also, it is found that the vocal development until canonical babbling is the same for children with and without hearing loss, this would mean that the auditory loop is indeed involved from the stage of canonical babbling (Cantle Moore, 2008). In this line with the normal early beginning of the vocal development, it seems that before canonical babbling the vocal development is mainly anatomical driven. That there is no auditive feedback needed for the first steps of vocal development. Because the auditory loop and thereby auditive input is important for the vocal development it is necessary to make a distinction between children who are diagnosed early and children who are diagnosed later. This distinction is needed because children who are diagnosed earlier also receive earlier their first hearing aid. This makes it possible for these children to earlier receive auditive input. The results in the study from Van Beinum and Doppen (2010) were before the neonatal screening, the children in this study were diagnosed later. In this study twelve children were included, six with normal hearing and six children with hearing loss. The children received their first hearing aid on average at 4;8 months of age. Van Beinum and Doppen found that children with hearing loss differed from children with normal hearing in number of utterances, duration of utterance, place of articulatory movement and combinations of voice and articulation. Also, it seems that children with hearing loss do not combine voice and articulation like children with normal hearing. Moeller (2007) included 33 children, 21 infants with normal hearing and 12 with hearing loss. The children with hearing loss were diagnosed early at the mean age of 2;5 months, and received their first hearing aid at 4;7 months of age. Moeller followed the vocal development of these children from 10 months until 24 months of age. She found also found that the canonical babbling onset was delayed in the children with hearing loss. Iyer and Oller (2008) included sixteen children, eight children with hearing loss and eight children

with normal hearing. The children with hearing loss were at average diagnosed at 12;8 months of age, and the average age when the child receives their first hearing aid was 14;3 months of age. They focused more on the characteristics of the babbling. They found no differences in volubility and glottal and glide productions between the groups. They did find differences in the growth in canonical babbling (Iyer and Oller, 2008). Based on the found studies it can be concluded that the vocal development of children with hearing loss is found delayed especially from the stage of canonical babbling. The age of diagnosis and first hearing aid (4;7, 4;8, and 14;3 months of age) differs between the found studies, this might influence the outcomes of the studies because of the auditive input the children receive. Because of the delay in vocal and language development, interventions are designed to make the delay as small as possible. This makes it possible to move on to the interventions found to improve the language development in children with hearing loss. Because vocal development can be seen as a precursor of language development it is also interesting to look at the total spoken language development.

To improve the spoken language development of children with hearing loss multiple interventions have been developed. Moeller (2000) found that age of enrollment in early intervention was significantly negatively correlated to language outcome at 5 years of age. This study included 112 children with variate levels of hearing loss. The intervention in this study was started at 11 months of age (Moeller, 2000). Holzinger et al. (2011), also investigated the influence of early diagnosis and age at onset of intervention on language outcomes in children with hearing loss at 5 years of age in Austria. In this study 63 children were included. The children included in this study were diagnosed on average on 9;3 months of age with an SD of 11;9, and the first hearing aid was received at 11;5 months of age (SD: 11.9). To measure the language development of the children, clinical language assessments

were performed by clinical linguists. The conclusion of the study by Holzinger et al. (2011) is that early intervention is important for the language development of children with hearing loss at 5 years of age. Vocal development was not specifically mentioned in this study.

Harrison et al. (2016) investigated factors affecting early services for children with hearing loss. They sent questionnaires to 122 professionals and 131 parents in the United States. The professionals involved in this intervention are speech-language pathologists or teachers of children who are deaf or hard of hearing. The study concluded that when the intervention is home-based the family involvement is the highest. Family involvement is positive related to the language outcomes in children with hearing loss (Harrison et al., 2016). Meizen-Derr et al. (2011) also investigate the influence of early intervention on expressive and receptive language development. They found that there is a significant difference between children who started before 6 months of age and children who were older than 6 months. In this study 328 children were included (Meizen-Derr et al., 2011). So, the studies found about interventions in children with hearing loss are only about language development and not about the vocal development specific. The start of the interventions differs between the studies, some studies start before 6 months of age (Meizen-Derr et al., 2011). In the study of Holzinger the intervention starts on average when the children were 11;5 months of age. Other studies more focused on the characteristics of the intervention for example the effectiveness of family-based intervention (Harrison et al., 2016).

To sum up, there are studies available about the vocal development in children with normal hearing and children with hearing loss. The start of the diagnosis and of the start of the hearing aids differ between the studies. All studies did find a delay in the canonical babbling in children with hearing loss. The focus of the studies differs, some studies (Van Beinum and Doppen, 2010) have more focus on the characteristics of the canonical babbling

and others (Moeller, 2007; Iyer and Oller, 2008) investigated the onset of the canonical babbling. Also, some studies focusing on interventions to improve the spoken language development in children with hearing loss exist. It is however unknown how the vocal development proceeds in Dutch children whose hearing is screened in their first week and who receive their first hearing aid when they are on average 3;7 months of age. In addition, it is unknown which factors influence the vocal development, such as intervention. There were no studies found specifically on how interventions can improve the vocal development. Because intervention in children with hearing loss differs between countries it is important to investigate this in the Netherlands. In this way the vocal development of Dutch children with hearing loss can be evaluated and an appropriate intervention to stimulate the vocal development can be designed.

This study addresses this gap to provide an evaluation of the vocal development in children with hearing loss which are screened in the first week after they are born. Also, to investigate the already existing interventions and compare them with interventions found internationally and to make a first step in designing a possible new intervention to improve the vocal development in children with hearing loss.

Therefore, the following research questions are designed:

1. What are the differences in the vocal development of Dutch babies with hearing loss who are diagnosed early, compared to normal hearing babies at 6 and 9 months of age?
2. Which interventions are being used (in the Netherlands and abroad) to stimulate the vocal development in young children with hearing loss, and are they effective?

3. What are the needs and limitations for an intervention to stimulate the vocal development in young children in the Netherlands?

This thesis is divided into two studies due to different methods. Study 1 addresses research question 1, about the vocal development of babies with hearing loss at 6 and 9 months of age. In order to answer this question, an analysis of the vocal development at 6 and 9 months of age using the Infant Monitor of speech Production (IMP; Cantle Moore, 2008) is used. Study 2 addresses questions 2 and 3, in this study the interviews and surveys are explained and the outcome of the interviews and surveys are integrated in the needs and limitations of a possible new intervention to improve vocal development in children with hearing loss in the Netherlands.

The hypothesis about the questions are: first, that at 6 months of age there is no difference between the babies with hearing loss and the babies with normal hearing. At the age of 9 months I do expect to find a difference. I only expect a difference at 9 months of age because of the auditory loop as discussed in the introduction, which influences the vocal development after 6 months (Study 1); second, I believe that interventions are given to children with hearing loss, although I expect that these interventions are not specified for the vocal development, based on the literature I found and described in the introduction (Study 2).

In this thesis first study 1 is elaborate, first the method of study 1 (§2.1), followed by the results (§2.2), and the discussion (§2.3). Next, study 2 is discussed, §3.1 the method, §3.2 the results and finally in §3.3 the discussion. At the end of the thesis is a general conclusion (§4).

2. Study 1

2.1. Method

The data from the larger project 'Klankontwikkeling' from the NSDSK (Dutch Foundation for the Deaf and Hard of Hearing Child) is used for my study. This larger study is conducted by Lizet Ketelaar and Bernadette Vermey. The current study focuses on two aims of the larger project namely: (1) to investigate the vocal development of babies with hearing loss and to compare this with babies with normal hearing, and (2) to develop an intervention to stimulate the vocal development of children with hearing loss. In the larger project data is still collected, and the vocal development is measured at 6, 9, 12, 15 and 18 months of age. Due to the restricted set of data available at the time of writing this thesis, only the measurements of 6 and 9 months are used. All parents signed informed consent for the participation of the larger project.

2.1.1. Participants

The participants of study 1 are the babies who are included in the larger study of the NSDSK. In my study 15 babies with hearing loss and 32 babies with normal hearing are included. The inclusion criteria of the larger project are used: participants are monolingual Dutch children between 6 and 18 months of age, with hearing parents. Additionally, for the children with hearing loss the loss must be minimally 40 dB for the better ear. Exclusion criteria are: suspicion of additional impairments like cognitive delay. For the children with hearing loss, additional exclusion criteria were auditory neuropathy and a cochlear implant (CI). The reason for excluding the children from the moment the CI is regulated is the deviant development from that point onwards: Children with a CI develop faster than children without a CI.

2.1.2. Materials

To measure the vocal development, the Infant Monitor of Vocal Production (IMP; Cantle Moore, 2008) is used, this instrument is designed in Australia. The IMP is an instrument which presents as a series of parent-professional conversations that combines parent observation to evaluate the vocal development (Cantle Moore, 2008). The IMP is developed in response to the challenges of earlier identification and to support the evolving practice of professionals working with parents of babies diagnosed with hearing loss. The IMP consists of 16 questions which are asked to parents in an interview with a trained speech language therapist (SLT). The questions are hierarchically ordered. All answers are divided in a five-point Likert scale (never (0), rarely (1), sometimes (2), often (3), always (4)). The first interview with parents is at the age of six months of the baby, thereafter the interview is planned every three months until the age of 18 months or until CI regulation. The first questions are about the voice use of the baby and the quality of the voice, the reflexive vocal ability. In addition, the perception of speech sound is also asked. Further questions are about the articulation of the sounds the baby is making. The questionnaire is ended when two successive questions scored zero. At six months the questionnaire starts with question one, for the following interview the SLT starts at the last two scored questions. So, for example if in the first interview the last question with a score above 0 was question six, the SLT will start the second interview at question four.

For the larger project of the NSDSK the IMP was translated into Dutch. Before the start of this project there was a small pilot study with 18 children to investigate the feasibility of the IMP in the Netherlands.

2.1.3. Analyses

For the analysis I made an SPSS datafile. In this file first characteristics of the child were included such as a code for the child, birthday and gender. Followed by all the IMP questions, each question is a variable which is the score (zero to four) on the question. Further, I added a separate variable for the ceiling question, this variable consists of the number of the last question scored before the two successive questions with a score of zero. I also created a variable for the raw score of each interview: this is the sum of all the scores on the questions of that interview. For the analysis, independent samples t-tests were used. With this independent samples t-test I first analyzed the difference in ceiling question between the babies with and without hearing loss at IMP1 and IMP2. Also, I analyzed the difference of the raw scores between the two groups in IMP1 and IMP2 with the independent samples t-test.

2.2. Results

In table 1 the characteristics of the babies are shown. As can be seen in the table most babies (34) participated at IMP1 and IMP2. Some babies (10) had not participated IMP2 yet at the time of analysis, and three babies were included that were older than 6 months and their first IMP interview was at 9 months of age. There are more babies included without hearing loss (31) than babies with hearing loss (13).

Code	gender	group	age IMP1 (months)	ceiling question IMP1	raw score IMP1	age IMP2	ceiling question IMP2	raw score IMP2
1005	female	control				9.82	13	17
1006	male	control	6.67	9	22	8.94	15	38
1008	male	control	5.82	11	27	8.94	14	37
1009	male	control	5.98	10	25	8.94	16	38
1010	female	control	6.37	9	13	9.63	16	30
1011	female	control	5.72	10	27	8.94	13	38
1012	female	control	6.21	13	31	9.40	15	39
1013	female	control	5.91	11	15	8.94	16	33
1014	female	control	6.01	8	21	9.07	13	38
1015	female	control	6.44	10	26	9.26	13	34

1016	female	control	6.28	13	35	8.80	13	39
1017	male	control	6.24	11	29	9.23	14	42
1020	female	control	5.62	10	25	8.77	16	44
1021	female	control	5.85	10	25	8.74	15	38
1022	male	control	6.51	13	28	9.3	16	38
1023	female	control	5.78	11	20	9.46	16	35
1024	female	control	6.21	11	29	9.40	13	33
1025	male	control	5.72	13	29	8.94	15	34
1026	male	control	5.95	13	33	8.74	14	39
1027	male	control	5.98	13	35	8.71	14	45
1029	female	control	5.82	10	25	9.63	13	37
1030	female	control	5.98	8	15	8.94	12	25
1031	male	control	5.88	13	30	8.87	14	35
1032	male	control	6.11	9	22	8.74	13	34
1035	female	control	5.95	4	7	9.4	14	30
1036	female	control	5.88	9	21	8.87	13	41
1037	female	control	6.18	8	16	8.84	14	23
1038	female	control	5.65	9	22			
1039	male	control	5.95	11	25			
1040	male	control	6.51	10	21	missing	13	31
1041	missing	control	6.18	9	17			
1042	male	control	5.88	9	17			
2001	female	hearing loss	6.31	9	19	9.30	14	30
2002	male	hearing loss	6.18	9	24	9.30	13	35
2005	male	hearing loss	6.24	4	11	9.43	14	42
2006	male	hearing loss				8.67	13	34
2007	male	hearing loss	6.31	9	15	9.10	10	22
2008	male	hearing loss	6.01	10	21			
2009	male	hearing loss	6.01	9	19	9.03	13	25
2010	female	hearing loss	5.85	10	23			
2011	female	hearing loss	6.18	11	28	9.00	14	39
2012	female	hearing loss	5.95	11	24	8.90	16	38
2015	female	hearing loss				9.07	13	33
2016	male	hearing loss	6.77	11	12			
2019	male	hearing loss	6.01	13	3			
2022	female	hearing loss	5.85	10	9			
1028/2013	female	hearing loss	5.85	6	11			

Table 1: characteristics of the children

The data were normally distributed; therefore, a t-test could be used. First the ceiling question at IMP1 and IMP2 was compared between the babies with hearing loss and the babies with normal hearing.

In table 2 the outcome of the statistics is shown. In the data can be seen that there is a difference in the mean of the ceiling question between the two groups (0.88 IMP1 and 0.81 IMP2). Also, can be seen that the range of the questions differs between the groups at IMP2. Some babies with hearing loss start at question 10 while the lowest question in the

group with babies with normal hearing is 12. There were no significant differences between the groups in the ceiling question ($p=0.215$ IMP1 and $p=0.120$ IMP2).

	number of children IMP1	mean IMP1 (SD)	Range IMP1	number of children IMP2	mean IMP2 (SD)	range IMP2
children with hearing loss	13	9.38 (2.293)	4 -13	9	13.33 (1.581)	10 – 16
children with normal hearing	31	10.26 (2.016)	4 -13	28	14.14 (1.239)	12 -16

Table 2: ceiling question

After the analysis of the ceiling question, the raw scores between the groups were calculated. In table 3 the outcome of this test is shown. In the data can be seen that there is a difference in the mean raw score at IMP1 (4.57 points) and IMP2 (5.50 points) between the two groups. Also, that the difference at IMP2 is greater than at IMP1. In the range there is difference is the maximal score at IMP1 of seven points between the groups at IMP2 there is a difference of 9 points at the minimum score. The t-test showed that there were no significant differences ($p=0.063$ IMP1 and $p=0.116$ IMP2) in raw scores between the children with hearing loss and the children with normal hearing.

	number of children IMP1	mean IMP1 (SD)	Range IMP1	number of children IMP2	mean IMP2 (SD)	range IMP2
children with hearing loss	13	26.50 (6.02)	17 - 36	9	37.83 (7.48)	28 - 50
children with normal hearing	31	31.07 (6.65)	16 - 43	28	43.33 (7.24)	17 - 52

Table 3: raw scores

2.3. Discussion

The results indicate that the vocal development of babies who are 6 months of age is comparable to babies with normal hearing, looking at the ceiling question and the raw scores. This is in line with what earlier studies found, and in line with the hypothesis. An important factor might be that the development until approximately 6 months of age is

mainly anatomical driven and the auditory loop is not needed (Iyer and Oller, 2008). In addition, I also found no significant difference in IMP 2 at 9 months of age, in the ceiling question and the raw scores. This is not in line with earlier studies (Cantle Moore, 2014; Davis et al., 2005; Iyer and Oller, 2008; Van Beinum and Doppen, 2010), and not predicted by the hypothesis. One underlying cause for this difference might be that the children in this current study are diagnosed early and received their hearing aid on average at 3;7 months of age, earlier than found in the literature. It is possible that this hearing aid intervention in combination with the family-based intervention start so early that the vocal development is not influenced by the hearing loss. Another possible explanation is that there is no significance found because there were only nine children with hearing loss at IMP2.

Interestingly, the standard deviation of the ceiling question at IMP1 is larger than at IMP2. This means that there is less difference in the vocal development according to the ceiling question when babies are 9 months of age compared to babies of 6 months of age. It would be interesting to see the tendency of the standard deviation when the data from the other IMP interviews are available when the babies are 12, 15 and 18 months of age. In addition, the results are based on a small sample. As mentioned before the scattering at IMP1 is larger than at IMP2, this might have an effect on the significance outcomes. There is more data needed to make the outcome of this study more reliable.

In the data of the raw scores the standard deviation is smaller at IMP1 than at IMP2. This is in contrast with the data of the ceiling question. It would be interesting to see how this data develop when more data can be added and the other IMP interviews can be analyzed. In the data of the raw scores the range of the scores differ between the two groups, the babies with hearing loss have a minimum of 28 points and a maximum of 50 points while the babies with normal hearing have a minimum of 17 points and a maximum of

52 points. Thus, although there is an outlier in the data of the babies with normal hearing the mean score is higher than the babies with hearing loss.

As seen in table 1, the age of the children at IMP2 is more scattered than at IMP1. For the following IMP interviews, it is important to plan the interview as precise as possible at the target age. The scattering of the age might influence the outcome of the interviews. Because, when children are slightly older they might have a higher score.

The reliability of the outcome is stronger because the data is normally distributed, this makes it possible to use a parametric test, the independent sample t-test. Therefore, it makes the little sample more reliable.

One other factor that might influence the outcome is that in this study all babies with hearing loss were analyzed as one group. In future analyses it would be interesting to split the babies with hearing loss according to their level of hearing loss. So, for example split the group into babies with mild, moderate, severe and profound hearing loss. In this study that was not an option because of the limited sample size. If the babies are split into different groups of hearing loss the expectation is that the babies with more severe hearing loss have more delay in their vocal development than babies with a mild hearing loss. This because the babies with mild hearing loss and hearing aid do have auditive input while the babies with severe hearing loss possible do not have auditive input in their first year before they receive their cochlear implant.

Also, it is interesting to further investigate if the IMP is a sufficient instrument to measure the difference in vocal development between children with hearing loss and children with normal hearing. In order to answer this question, all the notes and qualitative data available from the IMP interviews should be included in a future analysis.

3. Study 2

This section is devoted to study 2. In study 2 research questions 2 about the interventions used in the Netherlands and abroad, and question 3 on the needs and limitations about a new intervention in the Netherlands to stimulate the vocal development in children with hearing loss will be discussed. First, the method will be explained, followed by the results and finally the discussion.

3.1. Method

3.1.1. Participants

To investigate research question 2, in study 2 the participants are interviewed Dutch professionals, and respondents of an online survey. For the interviews with national professionals, contacts from the NSDSK were used. All Dutch professionals were experienced SLTs. Two participants work at the NSDSK, one at the audiological center and one as family counsellor. These two respondents, from the NSDSK, were selected due to their experience with children with hearing loss. In addition, one family counsellor and one coordinator of the family-based early intervention department from other national organizations were selected to investigate the interventions given in other organizations in the Netherlands. Of the contacted respondents in the Netherlands all respondents agreed in participation.

For the online survey, the respondents were the international researchers who I have sent an online survey. For this respondents contacts of the NSDSK and further some contacts from international congresses were used. Two of the contacts were already familiar with the larger running project. In total, six researchers were contacted divided over six different countries in different parts of the world.

3.1.2. Materials

For the interviews with the professionals in the Netherlands a semi-structured interview was designed in consultation with Bernadette Vermeij and Lizet Ketelaar. The aim of the interview was to explore the interventions used for children with hearing loss. The interventions used were explored broader than only the vocal development. This means that also other characteristics of the invention such as aims for cognitive development, and hearing aid use monitoring were explored. Finally, the last questions of the interview were about the needs and limitation for a new intervention especially for the vocal development in young children with hearing loss. In a semi-structured interview, the questions are set prior to the interview but there is time during the interview to ask more questions if needed (e.g. to clarify the topic). The interview consists of 11 questions about the current situation and 11 questions about a possible new intervention, the questions were a combination of yes / no questions and open questions. The interview questions are given in appendix 1.

For the online survey we designed a survey using the program thesistools (thesistoolspro.com). With this program it is possible to design an online survey and to skip questions when the prior question is answered "no" for example. In this way it is possible to make a routing based on the answers given before. The online survey (given in appendix 2) consists of 16 questions, some questions were yes / no questions and some were open. The aim of this survey was to get more insight in the interventions give abroad. The link to the survey was sent with an introducing e-mail to six research groups in six different countries, two (Australia and Belgium) of which replied.

3.1.3. Procedure

For the interviews with national professionals the participants were e-mailed to ask if they want to participate. In the e-mail contact a moment for the interview was agreed. One

interview was done face-to-face, the other appointments were by phone due to practical reasons. All interviews were recorded. All questions from the semi-structured interviews were discussed in each interview. The interviews lasted between 30 and 40 minutes.

The survey for the international respondents was sent by an introducing e-mail. After one week and again after two weeks reminders were sent and after approximately three weeks a last reminder was sent by e-mail.

3.1.4. Analysis

After the interviews were taken, they were transcribed orthographically. Four main questions were chosen for further analysis, namely: (1) What are the characteristics of the intervention currently used? (2) Is there a need for an instrument to measure the vocal development of babies with hearing loss? (3) Is there a need for an intervention to stimulate the vocal development in children with hearing loss? (4) What must be the characteristics of a new intervention?

After analyzing these questions in the national interviews, these answers were compared to the online survey sent to international professionals. The analysis was a combination of qualitative and quantitative analysis. So, for example I analyzed how many professionals do use an intervention for specific for the vocal development (quantitative). In addition, I analyzed the characteristics of the intervention used (qualitative).

3.2. Results

First the outcomes of the national interviews are discussed with the four main questions given above. Then, the international online survey is specified.

3.2.1. National interviews

Table 4 gives an overview of the answers given to the four main questions.

	question 1: What are the characteristics of the intervention currently used?	question 2 Is there a need for an instrument to measure the vocal development of babies with hearing loss?	question 3 Is there a need for an intervention to stimulate the vocal development in children with hearing loss?	question 4 What must be the characteristics of a new intervention?
SLT audiological center	every 3 months tests at the audiological center. No intervention used at the audiological center.	yes, more need for structure in the observation	not involved in the intervention	fits in the current situation
Family counselor NSDSK	intervention starts around 3/4 months, family based observation vocal development, family counselors method for first period 'natuurlijk communiceren'	yes, more need for structure in the observation	yes, link with auditive learning structure in sounds	fit in the intervention already given
family counselor organization A	start intervention around 4 / 6 weeks, family based spontaneous language for vocal development family counselors	no	no	parents do not have to become cotherapists
coordinator organization B	intervention start around 3/4 months family based observation vocal development family counselors	yes	yes, more structure in the input of sounds to stimulate the vocal development	indirect therapy family based parents do not have to become cotherapists based on questions parents

Table 4: outcomes of the national interviews.

All respondents reported that there is an intervention to stimulate the development of children with hearing loss. All respondents explained that the intervention is family-based and adapted to the needs of the parents.

As seen in table 4 most organizations do have a need for a more structured instrument to measure the vocal development of young children with hearing loss, only one respondent found the current method sufficient, and that there is no need for a more structured instrument.

The need of a more structured intervention differs between the respondents. The SLT working at the audiological center said that she is not involved in the intervention, only in the diagnosis and testing of the child. One respondent explained that there is no need for a more structured intervention. The other two respondents see the need for a more structured intervention, more specifically, to have more structure in the speech sounds introduced. For the characteristics of the new intervention all respondents said that this must fit in the current intervention. Also, it should not make parents co-therapists.

The effectiveness of the interventions used nationally are not specifically investigated. It is mostly a combination of multiple factors such as stimulating language, social and cognitive development.

3.2.2. International survey

In both Australia and Belgium intervention is given to children with hearing loss. In Australia the intervention starts at 3 - 4 months, the intervention in Belgium start around 9 months of age. Both interventions are family-based and sometimes also at an early intervention center. In Australia an SLT, a teacher of the deaf, and an educational psychologist are involved. In Belgium only the SLT was mentioned.

Australia is investigating the effectiveness of the intervention given, the other country explained that it is hard to measure the effectiveness because many variables can influence the outcome.

3.3. Discussion

The outcomes of the interviews with Dutch professionals and international researchers confirm the hypothesis that intervention is given to children with hearing loss. Also, the intervention is mostly family-centered. This in line with what was found in literature.

The interviews with the national professionals were divided over three national organizations, for a broader overview of the interventions in the Netherlands other organizations can be included. Due to practical reasons and time restrictions only four interviews were planned.

For the online international survey only two international researchers completed the online survey. Therefore, it is difficult to generalize the outcome. In addition to the online survey, some articles about intervention in children with hearing loss were found (Moeller, 2000; Holzinger et al. 2011; Harrison et al. 2016). Unfortunately, the articles did not specifically mention the vocal development of the children. Some characteristics are found to be common between the interviews, survey and literature. For example, the intervention is home based including a family counselor.

The interventions found in the Netherlands start earlier than the interventions found in some of the studies discussed in the introduction (Moeller et al. 2000; Holzinger et al. 2011). The latter studies reported that intervention starts around the age of 11 months. In contrast Meinzen-Derr (2011) did report that the intervention starts when the children are around 3 months of age. The interventions in the Netherlands start even before the age of 3 months, on average when the babies are between 6 to 8 weeks old.

The need for a new instrument to measure the vocal development differs between the organizations. Three out of four organizations would like to have a more structured / standardized instrument to measure the vocal development in young children with hearing loss. Possibly the IMP can fill this gap in the measurement of the vocal development. The results show there are interventions for children with hearing loss. As expected, these interventions are not specified to vocal development, neither in studies discussed in the introduction nor in the interviews performed for the present study. The interview

respondents told that there is no structured intervention specially for the vocal development. In addition, they mentioned that when the vocal or language development of children is found to be delayed, speech language therapy can be given as an intervention.

It was difficult to compare the outcomes, the interviews and online survey of study 2 with the found literature. There are studies that investigate intervention for language development in children with hearing. However, the characteristics of these interventions are not elaborate in the articles found. For further research, it would be interesting to contact the authors of these articles and to ask about the more specified characteristics about intervention specific for the vocal development.

The answer to research question 3; the needs and limitations for a new intervention, differs per organization. One organization does not see the need for a new intervention. Two professionals did name a need for a new, more structured intervention for the vocal development. The professionals also had limitations for a new intervention. The term intervention is experienced as too heavy, the professionals want to do more specific for the vocal development but that must fit in the current intervention. So, they would be interested in a new intervention but this should be integrated with the intervention that is currently given.

4. Conclusion

The results found in study 1 indicate that the vocal development of babies with hearing loss is comparable to babies with normal hearing at 6 and 9 months of age. However, these results are based on a small data sample. A bigger sample is needed to make the data more reliable. The outcome of the vocal development is not in line with other studies found (Cantle Moore, 2014; Davis et al., 2005; Iyer and Oller, 2008; Van Beinum and Doppen, 2010). A factor which might influence the outcome of the study is that Dutch interventions

start earlier than interventions found in the literature (Holzinger, 2011; Moeller 2000). It is possible that an early start of the intervention in the Netherlands is enough to provide the children with hearing loss with as much help as they need for a normal vocal and language development.

In the Netherlands there is family-based intervention for children with hearing loss, the aims of this intervention are broad. For example, monitor hearing aid use, stimulate social development and also stimulate language and vocal development. The need for a new intervention to stimulate the vocal development of children with hearing loss is diverse, some respondents miss an intervention and other respondents said that the intervention given is sufficient.

Based on the outcomes of study 1 the vocal development of children with hearing loss seems comparable with children with normal hearing. This seems to make an intervention specific for the vocal development redundant, not all children with hearing loss will need this intervention. In contrast there will always be children who did show a delay in the vocal development for this group an intervention specific for the vocal development would be it can be argued that there is no need for a new intervention focusing specifically on vocal development. On the other hand, it is possible that there are children who have delayed vocal development and that an intervention specific for vocal development would be necessary for this group of children.

Bibliography

- Cantle Moore, R. (2008). *Infant Monitor of vocal Production*. North Rocks, Australia: RIDBC Renwick Centre.
- Cantle Moore, R. (2014). The infant Monitor of vocal Production: Simple beginnings. *Deafness & Education International*, 16, 218 – 236.
- Davis, B. L., Morrison, H. M., von Hapsburg, D., Warner Czyz, D. (2005). Early Vocal Patterns in Infants with Varied Hearing Levels. *The Volta Review*, 105; (1), 2 – 27.
- Goorhuis, S. M., Schaerlaekens, A. M. (2000). *Handboek taalontwikkeling, taalpathologie en taaltherapie, bij Nederlandssprekende kinderen*. Utrecht: De Tijdstroom.
- Harrison, M., Page, T. A., Oleson, F., Spratford, M., Berry, L. U., Peterson, B., Welhaven, A., Arenas, R. M., Moeller, M. P. (2016). Factors affecting early services for children who are hard of hearing. *Language, Speech, and Hearing Services in Schools*, 47, 16 - 30.
- Holzinger, D., Fellingner, J., Beitel, C. (2011) Early onset of family centred intervention predicts language outcomes in children with hearing loss. *International Journal of Pediatric Otorhinolaryngology*, 75, 256 – 260.
- Iyer, S. N., Oller, D. K. (2008) Prelinguistic vocal development in infants with typical hearing and infants with severe-to-profound hearing loss. *Volta Review*, 108, 115 – 138.
- Lamore, (2010) *screening van het gehoor bij jonge kinderen*. Retrieved from <http://www.audiologieboek.nl/htm/hfd8/8-2-1.htm>
- Meinzen-Derr, J., Wiley, S., Choo, D. I. (2011). Impact of Early Intervention on Expressive and Receptive Language Development Among Young Children with Hearing Loss. *American Annals of the Deaf*, 155; (5), 580 – 591.

Moeller, M.P., (2000). Early intervention and language development in children who are deaf and hard of hearing. *Pediatrics*, 106; (3).

Moeller, M.P., Hoover, B., Putman, C., Arbataitis, K., Bohnenkamp, G., Peterson, B., Stelmachowicz, P. (2007). Vocalizations of infants with hearing loss compared with infants with normal hearing: part I – Phonetic development. *Ear and Hearing*, 28, 605 – 627.

Nederlandse Vereniging voor Keel-Neus-Oorheelkunde en Heelkunde van het Hoofd-Halsgebied (?) *Cochleair implantaat*. Retrieved from <https://www.kno.nl/patienten-informatie/oor/cochleair-implantaat/>

Raeve, L (?) *Wie komt in aanmerking?* Retrieved from

<http://www.onici.be/informatie/ci/wie-komt-in-aanmerking#c-content>

<https://www.thesistoolspro.com>

Uilenburg, N., & Van der Zee, R. B. (2014) *Neonatale gehoorscreening: Aanvang van interventie bij jonge kinderen met een gehoorverlies geboren in 2012*. Onderzoek door de NSDSK in opdracht van het RIVM.

Van Beinum, F., Doppen, L. (2010) *Babybrabbels*. Leuven: Acco.

Zoutenbier, I., Versteegde, L., Sluijmers, J., Singer, I., & Gerrits, E. (2016). *Prevalentie en incidentie van gehoorstoornissen bij kinderen*. Rapport voor NVLF van Lectoraat Logopedie Hogeschool Utrecht.

Appendix 1

De eerste vragen gaan over de huidige situatie. Op welke manier stimuleert u op dit moment de klankontwikkeling van jonge kinderen. De nadruk ligt hierbij op kinderen vanaf de start van de begeleiding, met een leeftijd tussen de 6 en 24 maanden.

1. Hoe vaak ziet u het kind?
 - a. Ziet u het kind op het audiologisch centrum of bij het kind thuis? Als u het kind op beide plekken ziet hoe is dan de verdeling?
 - b. Hoe lang duren deze afspraken gemiddeld?
 - c. Wat is het doel van deze afspraken?
2. Stimuleert u de klankontwikkeling van kinderen?
3. Wat doet u om de klankontwikkeling van een kind te stimuleren?
4. Waar let u op bij het stimuleren van de klankontwikkeling?
5. Is er vanuit de organisatie een methode of handvatten voor het stimuleren van de klankontwikkeling van jonge kinderen?
 - a. Heeft u weleens met anderen overleg over hoe de klankontwikkeling het beste gestimuleerd kan worden?
6. Zijn de adviezen direct gericht op het kind of is het meer indirect, gericht op het verbeteren van de kwaliteiten van de ouders? Of een combinatie?
7. Zijn er ook andere disciplines bij het stimuleren van de klankontwikkeling betrokken?
 - a. Hoe vaak heeft u overleg met andere mogelijk betrokken disciplines?
8. Zijn er (contra)indicaties om de begeleiding te starten?
 - a. Bijkomende stoornissen?
 - b. Mate van gehoorverlies?
 - c. Thuissituatie van het kind?

9. Zijn er (contra)indicaties om de begeleiding te continueren?
 - a. Wordt de begeleiding gecontinueerd na het aansluiten van een CI?
10. Wordt het hoortoestel gebruik nagevraagd?
11. Op welke manier wordt de klankontwikkeling gemeten?
 - a. Is er een protocol om de klankontwikkeling te meten?
 - b. Observeert u de klankontwikkeling?
 - c. Is er een gestandaardiseerd instrument?
 - d. Hoe vaak wordt de klankontwikkeling gemeten?

De volgende vragen zijn om te onderzoeken of u behoefte heeft aan een gestructureerde interventie om de klankontwikkeling van jonge kinderen (vanaf 6 maanden) en aan welke voorwaarde deze mogelijke interventie zou moeten voldoen om haalbaar te zijn voor u.

1. Heeft u behoefte aan een gestructureerde interventie?
2. Wat is er volgens u nodig om een interventie te gaan gebruiken? →
randvoorwaarden?
 - a. Welke professionals zouden erbij betrokken moeten zijn?
 - b. Wat verwacht u van andere professionals?
 - c. Wat heeft u nog meer nodig om een interventie te kunnen implementeren?
3. Bij welke leeftijd zou de interventie volgens u moeten starten?
4. Wat zou de frequentie van de afspraken moeten zijn voor u?
5. Waar zou de interventie moeten plaatsvinden volgens u? Bij het kind thuis of bijvoorbeeld op het audiologisch centrum?
6. Welke effecten verwacht u van de interventie?
7. Wat zou volgens u de invloed zijn van een CI-aansluiting op de interventie?

8. Heeft u behoefte aan het gestandaardiseerd meten van de klankontwikkeling bij jonge kinderen?
9. Wat zou voor u het doel zijn van het meten van de klankontwikkeling?
10. Hoe zou dit instrument volgens u moeten worden afgenomen?
 - a. Door middel van eigen observatie van het kind?
 - b. Een vragenlijst aan ouders over de klankontwikkeling van het kind?
11. Hoe vaak zou dit instrument volgens u moeten worden afgenomen?

Appendix 2

1. Do you/does your organization monitor children's audiological development after a hearing loss has been diagnosed?

Yes

No → question 6

2. Do you/does your organization see children with a hearing loss on a regular basis to adjust the hearing aid(s) if needed?

Yes

If yes, please indicate how often visits take place

no

3. Do you/does your organization monitor the frequency and duration of hearing aid use for each child?

Yes

If yes, please indicate how often this is monitored

no

4. Do you/does your organization monitor any other aspects concerning children's audiological development and/or hearing aid use? If so, please state these below and indicate how often these are monitored.

5. Do you/does your organization monitor the vocal development of children?

yes

If yes, please indicate how often this is monitored and which instrument(s) you use?

No

6. Does your organization have an intervention to stimulate the vocal development of children? By intervention we mean any type of structured program which involves either the children themselves, their parents, and/or other adults involved in the children's lives.

Yes

No

7. When (at which age) does the intervention typically start?

8. What is the typical frequency of the intervention sessions (e.g., weekly, twice a month, etc.)?

9. When is a child eligible to receive the intervention (e.g., minimum level of hearing loss, absence of additional problems/medical conditions)?

10. Who is/are involved in this intervention?

Speech language therapist

Family counselor

Other, namely

11. Where does the intervention take place?

at home

at the audiological centre

other, namely

12. What is the typical duration of the intervention (e.g., from age 2 months until age 18 months)?

13. Are there any reasons to end the intervention earlier than the typical end date (e.g., when the child receives a CI, when a certain level of vocal development is reached)?

14. Could you briefly describe the methods used in this intervention?

15. Has the effectiveness of the intervention you use been established?

yes

If yes what are the outcomes briefly?

No

16. Do you have other suggestions for interventions to improve the vocal development of young children?

You have reached the end of the questionnaire. Please click the submit button below to send it to us. We thank you very much for your cooperation.