Abstract:
Hearing parents of deaf or partially deaf infants are confronted with the complex question of communication with their child. This question is complicated further by conflicting advice on how to address the child: in spoken language only, in spoken language supported by signs, or in signed language. This paper studies the linguistic environment created by one such mother (language input and parental behaviour) and her child's language production longitudinally during the first two years of life of the infant to discover possible relationships. The mother-child dyad was observed when the child was seven, nine, twelve, eighteen, and twenty-four months old. Changes in the mother's approach to communication with her child and their consequent effects on the child's language development will be highlighted.
The infant concerned has a hearing loss of more than 90dB on both ears, which qualified her for cochlear implantation. At the age of ten months she was implanted on her left side (30/04/2010). Five months later she received a second implant (24/09/2010). By means of several assessments instruments the created linguistic environment, the language development of the infant in question and possible causal relationships were investigated before and after implantation. These instruments include: Pragmatics Profile of Everyday Communication; Profile of Actual Linguistic Skills; video-images of interaction analysed in ELAN; MacArthur-Bates Communicative Development Inventory for spoken Dutch and Flemish Sign Language (from nine months onwards). Results for each individual assessment moment are given as well as an overarching interpretation of evolution in the language development.
The child seems to be profiting from a bimodal/bilingual approach to communication up to nine months of age. She is progressing considerably in both spoken Dutch and Flemish Sign Language, with a possible onset of functional code-switch. However, a setback is evidenced in the child's language development, mirrored in a setback in the mother's sensitive behaviour as she moves to a more monolingual approach after cochlear implantation.

Highlights:

- This paper presents a study of communication between hearing mother and deaf child.
- This will be done longitudinally before and after cochlear implantation (CI).
- Benefit from bimodal/bilingual approach is apparent up to 0;9 before CI.
- After CI (0;10) there seems to be a setback in linguistic behaviour of the dyad.

Keywords:

Cochlear implantation; language development; bilingualism.

## 1. Introduction

This paper discusses the results of a longitudinal case study into the linguistic environment a deaf infant is confronted with before and after cochlear implantation (CI)[1] and the effects the interaction between mother and child may have on the deaf child's language development. In 2000 CI was performed for the first time in the world on a child under one year old at Antwerp university hospital[2]. Led by positive results in older children and adults (Spencer, Marschark, 2003; De Raeve & Loots, 2008; Schauwers et al., 2008), it was hoped that implanting a child in the first year of life would improve the beneficial effects on auditory perception and production of spoken language up to the level of hearing children. This would also have a positive influence on the child's development in general (Spencer, Marschark, 2003). These aspirations had their effect on the study of child development within the field of Deaf Studies. Whereas research before the era of CI was mainly concerned with interaction and successful communication (Meadow, 1981; Wedell-Monnig & Lumley, 1980; Lederberg & Mobley, 1990; Koester, 1995; Lederberg & Everhart, 1998; Harris & Mohay, 1997; for a review see Meadow-Orlans, 1997), after the turn of the millennium investigators became primarily interested in describing and detailing the development of *spoken* language as a function of improved auditory perception (Niparko et al., 2010; Nicholas & Geers, 2007; Nikolopoulos et al., 2004; Svirsky, Teoh et al., 2004; Svirsky, Robbins et al., 2000; Geers, 2003, 2004, 2006; for a review see Vlastarakos et al., 2010). More recently still, attention has been focussed on the effect of age of implantation on speech intelligibility and auditory perception (e.g. Tomblin et al., 2005; Spencer, 2002; Schauwers et al., 2008). These studies have shown that CI does indeed improve the auditory abilities of congenitally deaf children. Moreover, it has been shown that children implanted before the age of one year reach the level of hearing children's vocal babbling production after a period of three to eight months of CI experience (Schauwers et al., 2008). This focus on auditory perception and spoken language in research taken together with the clearly medical point of view of treating the deaf ear by means of CI constitutes what is called the medical discourse concerning language development of deaf children.

Although this intensive interest in spoken language development has rendered important insights into the linguistic development of young deaf children with a CI (Berg et al., 2007), we would like to point out that by excluding signed language development one presents only half a story. When Stokoe in 1960 published his paper *Sign Language Structure*, this was the beginning of many studies acknowledging signed languages as equal to spoken languages (Armstrong 2005). Over the years, the growing empirical basis for this acknowledgement lent the Deaf world[3]

[1] A cochlear implant (CI) is a device that is implanted into the cochlea of the child. It is linked to a stimulator of 26 electrodes which transport sound, picked up by a microphone. This microphone is connected to a magnet that is placed on the head of the child and sends the sound waves, digitally transformed, to the stimulator in the brain. In this paper the abbreviation CI stands for both cochlear implant (a CI) and cochlear implantation (CI).

[2] http://www.ua.ac.be/main.aspx?c=*NEWS&n=553 (consulted on 07/04/2011).

[3] It is customary to write *Deaf* with a capital letter *D* for deaf people who regard themselves as members of a linguistic and cultural minority group of sign language users regardless of their degree of hearing loss and to write *deaf* with a small letter *d* when not referring to this linguistic and cultural minority group.

theoretical proof to support the cultural-linguistic approach to the upbringing of deaf children. This promotes the idea of both minority and majority groups respecting cultural differences such as language, rules of conversation, and so forth (i.e., inclusion) instead of the minority group adjusting itself to the majority culture's standards (i.e., integration). With the advent of CI, however, this approach has suffered a decrease of scholarly attention in favour of the medical approach. The few studies that do seem to investigate signed language in deaf children with a CI seem to suffer from several lacks: some are inconclusive, showing great interpersonal differences (Spencer, 2004; Van Deun et al., 2009; Majdak, 2006; Makhdoum et al., 1998), others make use of a poorly defined or limited participant group (Nordqvist & Nelfelt, 2004; Yoshinaga-Itano, 2006; Ruggirello & Mayer, 2010). This makes results hard to interpret or generalize (Schauwers et al., 2008; De Raeve, Loots, 2008; Weisel et al., 2007). Moreover, despite the fact that Flemish Sign Language (Vlaamse Gebarentaal or VGT) was acknowledged as an official language for the deaf by the Flemish government in 2006, we find that Universal Neonatal Hearing Screening (UNHS) referral centres in Flanders dealing with hearing parents of deaf children either do not mention signed language (and Deaf culture) or mention it only in function of the spoken language development (Berg et al., 2000, 2007 on the situation in the United States; Hardonk et al., 2011a, b and c and Matthijs et al. (forthcoming) on the situation in Flanders).

It is our opinion that language is not defined by modality, in this case, the auditory-vocal modality. Language as a philosophical concept should rather be conceived of as a means of communication between human beings which has developed naturally and enables them to construe experiences (including thought and emotion) and enact relationships (Halliday, 2004, 2009). Structurally, it is characterized by a make-up of small components which are combined according to a set of rules. Thus, by shifting the focus to *spoken* language development research underpinning the medical discourse neglects language development as a whole in children with a CI. Moreover, the idea that deaf children can, may and should somehow be "fixed" goes hand in hand with a traditional grammatical notion of language development. Rather than valuing the developing functional, paradigmatic relations in language, this notion emphasizes the structural, syntagmatic relationships in language as approximating adult language (Halliday 2004): in the same way children grow from the imperfect "deaf" to the ideal "hearing", their language is expected to develop from a "wrong" to a "right" use of spoken language (as can be derived from an information leaflet from a Flemish rehabilitation centre[4]). Nevertheless, as Halliday's Systemic Functional theory on child language explains, it is because children want to share with adults their expanding experiences of the world and of themselves that they adapt and expand their language resources (Halliday, 1974). It follows that if the parent does not engage in interaction in a particular mode of communication, this mode will be abandoned for a more successful way of bridging the gap between child and parent. However, it is not the ability to hear or speak that defines successful communication. The developing child is well able to express him/herself in both visual-gestural and auditory-vocal modes of communication. The position of the infant's primary network (i.e. the immediate environment) in the debate on

[4] http://www.rcoverleie.be/folders/pdf/brochure_kinderen_met_een_gehoorstoornis.pdf.

monolingual spoken versus bilingual spoken-signed interaction will have a defining influence on how the child will develop these modes of communication. Therefore in this paper we wanted to look at mother-child interaction *and* at the complete linguistic development of the child, i.e. in a spoken as well as a signed language.

The conflicting points of view on the best way to raise a deaf child with a CI constitute a theoretical context of life for hearing parents of deaf children. However, as Wittgenstein points out (1953), language is not only something to be debated about among scholars but also a form of life. As such, this discussion also resonates in parents' day-to-day, more practical context of life (Bernstein, 1974; Halliday, 2004, 2009). It is this arena parents enter every day when interacting with their implanted child: should I sign? Should I speak? Should I do both? Doubts like these are described to shake parental confidence in abilities to communicate intuitively with their deaf child:

> 'It has been proposed that stress related to the diagnosis of deafness is one reason for repeated research findings describing Hearing mothers with deaf infants as less 'sensitive' than comparable mothers with hearing children [...] In addition to stress created by the diagnosis of deafness, stress for hearing parents may result from a *sense that their usual (vocal/spoken) mode of communication is inadequate* for the communication needs of a child who is deaf.' (Meadow-Orlans, Spencer, 1996: 214; emphasis added)

Intuitive communication is characterized by spontaneous and contingent adjustment of the 'multimodal communicative repertoire [of the parent] to the infant's level of perceptual, integrative and communicative competence' and a knowledge of 'how to read and attribute meaning to their infant's behavior.' (Papousek, 2007: 264; Koester & Lahti-Harper, 2010). However, hearing parents of deaf children are not only unaccustomed to interacting with a person with a hearing loss, rendering their intuitive abilities less functional, they are also unacquainted with and (largely) uninformed about strategies to facilitate communication with a deaf infant (Koester, 1992; Koester & Lahti-Harper, 2010; Waxman & Spencer, 1997; Meadow-Orlans et al., 2004), leaving them with 'feelings of psychological or functional inadequacy, resulting in a self-fulfilling spiral of unsatisfactory interaction' (Meadow-Orlans, Spencer, 1996: 214). This is also confirmed by Weisel & Zandberg (2002), Feher-Prout (1996) and Quittner (1991). Consequently:

> 'there are at least two potential barriers to sensitive parenting for the Hearing mother of a deaf child: feelings about a critical difference between herself and her child, and an absence of the communication skills that contribute to positive interactions.' (Meadow-Orlans, Spencer, 1996: 214).

Moreover, abandoning 'their usual (vocal/spoken) mode of communication' and engaging with a child in a different and knowing, intentional, and conscious fashion requires more energy and time (Koester et al., 1998). Thus, hearing parents of deaf children run the risk of 'becoming worn down due to excessive rational decisions' (Papousek, Papousek, 1987; Koester, 1992, Waxman & Spencer, 1997). These issues of insecurity are not automatically resolved by CI (Hyde et al., 2010; Christiansen & Leigh, 2002; Weisel et al., 2007; Zaidman-Zait & Most, 2006), as discussed by Weisel et al. (2007), who state that

> ‘at the beginning of the process [of cochlear implantation], parents’ expectations from implantation tend to be high (Kampfe et al., 1993), accompanied by anxiety experienced by both parents and child (Bray, Neault, & Kenna, 1997; Russell, Coffin, & Kenna, 1999). Later on, facing the demanding rehabilitation process, the family’s level of stress increases (Beadle, Shores, & Wood, 2000) especially if their high expectations are not met.’ (Weisel et al., 2007: 55)

Moreover, research on the relationship between CI and stress seems to suggest that the level of development in communicative behaviour on the child’s part is related to the degree of stress for the parents (Weisel et al., 2007; Incesulu et al., 2003; Knussen & Sloper, 1992). This is especially the case when the child’s development is slower than expected after implantation (Nicholas & Geers, 2003; Pipp-Siegel et al., 2002).

The challenge of satisfactory communication also largely defines the implanted child’s language development. For, as Papousek (2007: 264) states, ‘infants’ communicative development depends on previously experienced patterns of parent-infant interactions, on their own regulatory capacities and on factors which inhibit, block or override the parent’s intuitive communicative competence.’ Undermined intuitive parenting and a troublesome interactional relationship between parent and child is not advantageous for ‘social cognition, new levels of intersubjectivity, *intentional communication*, and attachment toward the end of the first year, and for self-recognition, empathy as well as *symbolic and verbal integration* beginning around the middle of the second year.’ (Papousek, 2007: 260; emphasis added). The link between intersubjective development and language development has been discussed in Loots 2003a, 2003b, and 2005.

Therefore, in this paper we are interested to study longitudinally what the linguistic environment (linguistic input and parental behaviour) one hearing mother creates for her deaf daughter looks like, what this daughter’s linguistic productions look like and what the possible interactive relationships are between this particular linguistic environment and the girl’s language development. As the dyad under investigation appears to be facing the barriers put forward by Meadow-Orlans & Spencer (1997) before CI, it would be reasonable to assume that they will have equal difficulty to establish an interactive communicative relationship with one another. This, it can be expected, will impact negatively on the child’s (signed and spoken) language development. However, after CI, the expectations are that these barriers to sensitive parenting and intuitive communication will be lifted. As a consequence, it may be expected that the interactive communicative relationship between mother and child will restore itself. This in turn will impact positively on the child’s (signed and spoken) language development. Moreover, in line with studies on changing communication patterns (Watson, Archbold et al., 2006; Watson, Hardie et al., 2008), we expect the dyad to adopt a more spoken communication after CI to the disadvantage of the signed language development.

## 2. Methodology

### 2.1. Participant Profile

This study is part of a larger longitudinal project investigating the intersubjective and language development of young deaf children with a CI in the first two years of life. Inclusion criteria for the project were the following: the children needed to be six months old at the time of the first data gathering moment and have a hearing loss of at least 40dB. The mothers were required to have Dutch or VGT as their mother tongue. To recruit participants, we disseminated leaflets through UNHS referral centres in Flanders. We were able to recruit 13 children via this route, 8 of whom received a CI in the course of the project. Half of the implanted children were also fitted with a second implant. This paper provides a first explorative analysis of the data gathered in the project.

The family involved in the study was contacted through one of the major referral centres in Flanders, consisting of a home-based early intervention and support team as well as a rehabilitation centre with close relations to a university hospital. "Eva" is the code name we adopted for the child and "Sophia" for the mother. Eva was born on the 26$^{th}$ of June, 2009, as the second child of a middle class family. On the basis of the conversations we had with her mother and the observations made during data gathering moments, we summarized events with respect to the UNHS programme (Table 1) and other events relevant to her development (Table 2).

**Table 1: dates of steps in medico-diagnostic process as detailed in UNHS programme.**

**Table 2: Dates related to language development.**

During these conversations the mother also mentioned that Eva's nursery nurse had suggested to the mother to take part in the Federation of Flemish Deaf Organisations' course in VGT, together with her. As such, Eva was provided with two sources of bimodal input: the home environment and the nursery environment. However, the mother reports that the nursery nurse uses signs primarily to support spoken language communication. With respect to her own language strategies, she expresses the intention to communicate through signed language with Eva when she is not wearing assistive technology (for instance, in the swimming pool) and to support her spoken language with signs when Eva is wearing assistive technology. This intention remains unchanged throughout the study.

### 2.2. Instruments

#### 2.2.1. Video

The family was visited at their home when the child was 6, 9, 12, 18 and 24 months old. During every data gathering moment seven minutes of care were videotaped to accustom mother and child to the presence of cameras, and seven minutes of free play between mother and child with standardized, age-appropriate toys. Two cameras operated by the first and the second authors were used, one focussing on the mother and one on the infant. The images recorded were

analyzed by means of a computerized analysis system: EUDICO Linguistic Annotator (hereafter ELAN). They were transferred from camera to computer in *.wav format, after which they could be imported into ELAN. This allowed us to view the images made with a focus on the mother simultaneously with those made with a focus on the infant. Reasons why this could be required are: unclear images, ambiguous eye gaze direction, uncertainty concerning a particular gesture, etc. For the current study twelve independent tiers of analysis have been identified (for mother [i.e., M] and child [i.e., C]), as shown in Table 3.

**Table 3: Annotation tiers in ELAN for M (mother) and C (child).**

- In order to address the issue of the continuum of conventionalisation we divided "bodily action" in three tiers: (1) signs, i.e., bodily action with a high level of conventionalisation belonging to VGT (tiers 2 and 8), (2) standardized gestures, i.e., bodily action with some level of conventionalisation[5] (tiers 3 and 9), and (3) bodily action without conventionalisation which is of a more idiosyncratic nature (tiers 5 and 11). After the video images had been annotated in this way, interpretation of the results was formulated by the first author. This analysis paid attention to parental behaviour (attention to eye gaze, signs of stress, structuring the interaction or rather letting the child take charge), linguistic input and linguistic output in the communication mode tier. The codes are given in Table 4[6]. They are based on Van den Bogaerde & Baker (2008) and Emmorey et al. (2005).

**Table 4: Codes used in communication mode tier, their definition and an illustration.**

Moreover, development was charted longitudinally in terms of Halliday's framework of Systemic Functional Linguistics (SFL). Systemic Functional theory is defined as 'a theory of meaning as choice, by which a language, or any other semiotic system, is interpreted as networks of interlocking options' (Halliday, 1994: xiv). In this paper we are concerned with the development of these 'interlocking options' (ibid.). According to Halliday (2004, 2009), children in the first 18 months of life construct a two-levelled system, mapping meaning directly onto expression. This he calls Phase I Child Language. The meaning-expression pairs develop from a basic semiotic system containing the options action and reflection into a system of six microfunctions: instrumental, regulative, interactional, personal, heuristic, and imaginative. In this two-levelled system it is not yet possible for children to combine meanings or functions into one expression. It is only when they have developed this capacity that they are able to combine microfunctions into either the pragmatic (a combination of any one of the first three microfunctions) or the mathetic macrofunction (a combination of the personal and the heuristic microfunction). At this point they have also developed the sense of being able to share something

[5] By conventionalized gestures we mean 'standardized gestures with names which can appear without speech, and which often replace speech (such as the sign for 'ok').' McNeill 1986: 107.
[6] A complete book of codes is available from the first author.

*in and through language* which is unknown to their interlocutor. This is called the informational microfunction. These achievements characterize the transitional phase between child language and adult language. From the two macrofunctions and the informational microfunction the child pushes through to this last phase of child language development by combining all three in one expression at about two years of age. This is called the metafunctional use of language: ideational, interpersonal and textual meanings are combined in one expression. In Table 5 a schematic overview of child language development in terms of SFL is given on the basis of Halliday (2004, 2009) and Taverniers (2002).

**Table 5: Schematic overview of child language development in terms of Halliday's Systemic Functional theory.**

#### 2.2.2. Interview

During data gathering moments the mother was interviewed by the first and the second authors, two female interviewers of different academic backgrounds. Thus we aimed at reducing possible focus on one specific subject and opening up the conversation to several issues. With respect to the experiences the mother has had since diagnosis, a semi-structured interview was administered. However, this is not part of the current study. With respect to language development, a structured interview scheme was used, the Pragmatics Profile of Everyday Communication Skills (Dewart, Summers 1995). The interview was audio recorded only.

##### 2.2.2.1. The Pragmatics Profile of Everyday Communication Skills (PPECS)

As parents are experts at knowing what their children can and cannot do, it is paramount to involve mothers in as active a way as possible, which is why it was decided to use the Pragmatics Profile of Everyday Communicative Skills (PPECS) (Dewart & Summers 1995). The PPECS is ideal as 'a means of enabling [the parents] to share their knowledge about communicating with the child and to do so in a structured way' (Dewart, Summers, 1995: 3). This structured interview was administered every six months. First, these reports of communicative behaviour were summarized in a descriptive, qualitative form (see http://wwwedit.wmin.ac.uk/psychology/pp/documents/Instructions%20Children.pdf). Second, the reports were compared to the Systemic Functional model of child language development (Halliday 1974, 2004, 2009; Taverniers 2002: 176-179). This was done by the first and the fourth authors. The data thus present an overview of the *mother's experience* of the overall communicative behaviour and, more specifically, of the development of linguistic functions.

#### 2.2.3. The MacArthur Bates Communicative Development Inventory for Dutch and VGT

A next step in assessing developing communication is the introduction of the MacArthur-Bates Communicative Development Inventories for Dutch (N-CDI) and an adaption of the CDI to Flemish Sign Language (VGT-cdi) from the age of nine months onwards. The mother was asked to return the N-CDI and the VGT-cdi to the first author by mail within a week. For a full description of the N-CDI, we refer to Zink & Lejaegere (2002). The N-CDI has been norm-validated for monolingual Dutch normally developing children matched for age and consists of two separate lists: one for the ages 8-16 months, called the N-CDI/Words and Gestures, and one for 16-30 months, called the N-CDI/Words and Sentences. The N-CDI/Words and Gestures probes early signs of reaction to language, comprehension of 31 sentences, and comprehension and production of 434 lexical items. It also evaluates the 'communicative and representational abilities, which do not rely on verbal expression' (Zink & Lejaegere 2002: 15). The N-CDI/Words and Sentences assesses comprehension and production of 702 lexical items and how children use these items. It also probes the morphological and syntactic development of the child. Although there is a published adaptation of the CDI to American Sign Language or ASL (Anderson, Reilly 2002) and British Sign Language or BSL (Woolfe et. al 2010) and an adaptation to Sign Language of the Netherlands (SLN) is under development, no such adaptation exists for VGT. Nonetheless, we found it was important to be able to assess children's development of spoken language *as well as* their development of signed language, to find out how these two languages develop. Therefore, an adaptation was devised on the basis of the resources available closest to VGT: N-CDI and ASL-CDI by the first and the last authors. The N-CDI on the one hand did not need much cultural adaptation as it is used for the same population. The ASL-CDI[7] on the other hand probes development of an Old French Sign Language-based signed language, more similar to VGT than BSL which is not based on Old French Sign Language. This version, called VGT-cdi, has not been norm-validated. Hence, the results are tentative and are handled as such.

## 3. Results

### 3.1. Video

Results for maternal language input and child language output are summarized in Figures 1-2. Figure 1 shows the number of expressions uttered by Eva's mother that were categorized as semantically equivalent code-blends, semantically complementing code-blends, Dutch based code blends, VGT based code blends, monolingual Dutch and monolingual VGT, as compared to the total number of her expressions.

[7] The first author was able to discuss this issue with Diane Anderson who developed the American Sign Language CDI. Although Anderson is convinced that the grammar of ASL and VGT are essentially different, she also acknowledges the lack of studies into how children develop the grammar of VGT. Therefore, she was so kind as to let us have a look at the grammar assessment test of the ASL-CDI. This part of the test makes use of video images of a native signer, who signs grammatically correct sentences, grammatically incorrect sentences and grammatically correct, but less fluent sentences. Parents are asked to select the video that best resembles their child's utterances. (personal communication)

**Figure 1: Maternal language input.**

The total number of expressions is largely determined by the portion of monolingual Dutch expressions. When Eva is 0;9, there is a considerable drop in monolingual Dutch expressions (116 to 76), corresponding to a drop in total communicative input. After the first CI we see this number rise again (130) to peak after bilateral CI (143). When Eva is two years old, however, the number of expressions in monolingual Dutch drops again to 77. This is not the case for the number of expressions in monolingual VGT. These equally drop between 0;6 and 0;9 (from 31 to 5), but in Eva's second year of life the use of monolingual VGT experiences a steady increase (from 2 over 10 to 21). Eva's mother's Dutch based code blends remain quite constant (around 20 expressions), except when Eva is 9 and 18 months old. Here we see the number of Dutch based code blends rise to 38 and 40 respectively. This is mirrored in her VGT based code blends. These equally remain quite constant (around 5 expressions), except when Eva is 18 months old at which time they rise to 12. Semantically equivalent code blends appear to be quite constant as well in the first year of life (around 30). The number of semantically equivalent code blends is more than halved, however, at 1;6 (to 12), only to be almost tripled when Eva is two (39). Semantically complementing code blends, on the other hand, diminish over time. During Eva's first year of life her mother expresses about 2 semantically complementing code blends (3 at 0;6, 2 at 0;9 and 2 at 1;0) but hardly uses such code blends in the second year of life (0 at 1;6 and 1 and 2;0).

Figure 2 shows how many of Eva's expressions were categorized as semantically equivalent code blends, semantically complementing code blends, Dutch based code blends, VGT based code blends, monolingual Dutch, monolingual VGT, visual/vocal, vocal and visual, as compared to the total number of her expressions.

**Figure 2: Child language output.**

Eva's total communicative output steadily decreases in her first year of life, and then more than triples at age 18 months (from 29 to 95). However, at age 24 months it drops again (65). At the age of 0;6, Eva is not acknowledged to use Dutch, VGT or any combination of those. Instead, she uses the visual-gestural modality more than she does the auditory-vocal modality. Three months later, her mother acknowledges 8 of her expressions as monolingual VGT and 7 as VGT based code blends. At the age of 12 months, she appears to be predominantly using the visual-gestural modality. At the age of 18 months, however, Eva uses the auditory-vocal modality more than she does the visual-gestural modality. We also see that she uses Dutch in her communication from the age of 18 months onwards. Six months later, we see she has one semantically equivalent code blend, 13 monolingual Dutch expressions, 7 monolingual VGT expressions, 4 visual/vocal expressions, 11 vocal expressions and 26 visual expressions.

Figure 3 summarizes the distribution of functions across the modalities used by Eva.

**Figure 3: Distribution of functions across modality.**

In the first year of life, Eva expresses more functions in the visual-gestural modality than she does in the auditory-vocal modality or in a combination of modalities, both in number of functions and in number of expressions. In the second year of life, however, we see that at the age of 18 months she expresses more functions in the auditory-vocal modality (both in number of functions and in number of expressions). This equals out at the age of 24 months.
Results for the tier "eye gaze" are summarized in Figure 4. It shows the time during which Eva and her mother's eye gazes are coded to be directed towards each other ("matched"); during which the mother's eye gaze is coded to be directed towards Eva with no corresponding code for Eva's gaze being directed towards her ("unmatched"); during which Eva's mother is offering a sign with Eva watching ("successful offer of visual linguistic information"); and the time during which Eva's mother is offering a sign without Eva watching ("failed offer of visual linguistic information"). The total number of seconds during which Eva's mother is coded to watch the child and during which the child is coded to watch her mother is also shown in the chart. The time during which Eva's mother is offering monolingual Dutch information is indicated as well. This gives us an indication of the mother's attentiveness to eye gaze as well as the amount of visual linguistic information that is offered to and received by the child.

**Figure 4: Results for number of seconds of successful establishment of eye contact, successful offer of visual linguistic information and offer of monolingual Dutch.**

The time during which the mother's eye gaze is directed towards Eva decreases in the first 18 months of life. This rises slightly at the age of 24 months. This corresponds to the time during which Eva and her mother make eye contact. Although the number of unmatched directions of eye gaze rises between 0;6 and 0;9, this decreases from 0;9 onwards. The number of successful offers of visual linguistic information (a VGT sign) equally increases between 0;6 and 0;9. This drops at the age of 1;0. In the second year of life, however, the number of signs that are picked up by Eva rises again, although never reaching the level of 0;9. The number of unsuccessful offers of linguistic information rises between 0;6 and 0;9 as well, but decreases between 0;9 and 1;6. At 2;0 the number of signs not picked up by Eva rises again. The time during which Eva is watching her mother also decreases during the first year of life but rises again during the second year. The time during which her mother offers monolingual Dutch information fluctuates: when Eva is six months 122.090 seconds of monolingual Dutch are offered. This drops to 90.620 seconds when she is nine months. Three months later it has risen again to 150.640 seconds. After bilateral CI, this amount decreases slightly to 127.392 seconds. This trend continues when Eva is two years old, when her mother offers 70.910 seconds of monolingual Dutch.

### 3.2. The Pragmatics Profile of Everyday Communication Skills (PPECS)

Table 6 summarizes the results of the maternal report of Eva's communicative behaviour longitudinally by means of the Pragmatics Profile of Everyday Communication Skills. The codes used are those suggested by the authors of the PPECS[8], except for the section "Communicative functions: range of communicative functions expressed". For this section, SFL terminology was chosen as summarized by Taverniers (2002: 176-179).

**Table 6: Longitudinal results for maternal report of Eva's communicative behaviour by means of PPECS.**

### 3.3. The MacArthur Bates Communicative Development Inventory for Dutch and VGT

Results for the N-CDI and the adapted version VGT-cdi are summarized below (Tables 7-10). Averages (pc 50) for monolingual Dutch hearing children, native BSL deaf children and native ASL deaf children are given. It should be noted that averages for BSL deaf children span ages from 8-11, 12-15, 16-19, 20-23, and 24-27 months and only provide averages for comprehension and production (Woolfe et al. 2010). Averages for ASL deaf children span ages from 8-11, 12-17, 18-24, and 24-29 months and only provide averages for production (Anderson & Reilly 2002). The total number of concepts Eva is able to express is also presented. This number was calculated by combining the N-CDI and the VGT-cdi. Lemmas which appeared in both lists counted as one item for the total score. Lemmas which only appeared in one of either lists were also counted once.

**Table 7: Results for N-CDI and VGT-cdi for Eva at 9m compared to monolingual Dutch hearing peers, native BSL deaf peers and native ASL deaf peers.**

**Table 8: Results for N-CDI and VGT-cdi for Eva at 12m compared to monolingual Dutch hearing peers, native BSL deaf peers and native ASL deaf peers.**

**Table 9: Results for N-CDI and VGT-cdi for Eva at 18m compared to monolingual Dutch hearing peers, native BSL deaf peers and native ASL deaf peers.**

**Table 10: Results for N-CDI and VGT-cdi for Eva at 24m compared to monolingual Dutch hearing peers, native BSL deaf peers and native ASL deaf peers.**

## 4. Discussion

In this paper we are interested to study longitudinally the language development of a young deaf girl with bilateral CIs. In order to do so, we studied the linguistic environment (linguistic input and maternal behaviour) and the girl's linguistic productions. Possible interactive relationships between this particular linguistic environment and the girl's language development were also taken into account. After presenting the results of the data gathered when the girl was 6, 9, 12, 18

[8] See http://wwwedit.wmin.ac.uk/psychology/pp/documents/Instructions%20Children.pdf.

and 24 months old, we would now like to discuss these results. We will first focus on the videos and the Pragmatics Profiles of Everyday Communication Skills, after which we will put forward an SFL account of the language development for the child in question. This will be complemented by a discussion of the results of the N-CDI and the VGT-cdi.

### 4.1. Video

Taking a look at Eva's language production longitudinally, we see that she is expressing herself quite a lot at the age of six months. These expressions are predominantly in the visual-gestural modality (42.70% compared to 32.58% in the auditory-vocal modality and 24.72% visual/vocal). She is able to make known that she wants something done or something stopped (action semiotic, 47.37% of which expressed vocally and 52.63% of which expressed visually) and that she likes something or not (reflection semiotic, 37.93% of which expressed vocally and 62.07% of which expressed visually).

Three months later, Eva seems to be expressing herself somewhat less (71 in comparison to 89). This lower score is predominantly caused by a decrease in the use of the auditory-vocal modality (26.76%) and the combination of modalities (14.08%). The use of the visual-gestural modality also decreases (38.03%), but this is compensated by her mother's acknowledgment of her expressions as monolingual VGT (11.27%) or VGT based code blends (9.86%). However, this seems to be a slight underestimation of Eva's abilities, as more of her expressions in the visual-gestural modality or in the combination of modalities can be understood to be signs. Nevertheless, these are not picked up by her mother. She is able to express four microfunctions: instrumental, regulative, interactional, and personal. All four find expression in the visual-gestural modality and the combination of modalities. All but the regulative function are also expressed in the auditory-vocal modality.

Two months after the first CI, at the age of twelve months, Eva seems to suffer from a communicative setback. This result is surprising as we would expect some notion of functional use of voice two months after CI (Schauwers et al., 2008: 628). Her general communicative production has decreased from 71 to 29 expressions, 79.31% of which are in the visual-gestural modality. The acknowledgment of use of VGT (monolingual or in combination with voice) has disappeared altogether. This is reflected in the expression of microfunctions: whereas Eva expressed four microfunctions in both the visual-gestural modality and the combination of modalities and three microfunctions in the auditory-vocal modality at the age of six months, we now find she expresses only three visually (instrumental, regulative and interactional), one bimodal (regulative), and two vocally (regulative and personal). Combined, however, Eva is still expressing four microfunctions.

Six months later, at the age of 18 months (three months after bilateral implantation), we see that Eva has become more communicative (95 expressions). The distribution of modalities, however, seems to have changed somewhat. Whereas she was expressing herself predominantly in the visual-gestural modality in the first year of life, we now see she is expressing herself more

vocally (43.16%) than visually (36.84%) or visual/vocally (17.89%). We also see that her mother acknowledges two of her expressions as monolingual Dutch. However, this appears to be an underestimation of Eva's abilities, as more of her expressions in the auditory-vocal modality or in the combination of modalities could be understood to be Dutch. Nevertheless, these are not picked up by her mother. This increase in the use of the auditory-vocal modality is reflected in her expression of microfunctions. She is now able to express six microfunctions vocally (instrumental, regulative, interactional, personal, heuristic, and imaginative), whereas she is still expressing the same four microfunctions (instrumental, regulative, interactional, and personal) visually as she did six months earlier. Bimodally, she is expressing three of the same microfunctions (instrumental, interactional, and personal) but also one different microfunction (imaginative). In other words, at the age of 18 months Eva has developed six microfunctions which she expresses predominantly vocally or with a vocal element attached to it.

At the age of two years, however, her communicative situation seems to have changed again. Her expressions solely in the auditory-vocal modality have decreased (17.74% vocal and 29.97% monolingual Dutch) as well as her expressions in both modalities (6.45% visual/vocal and 1.61% semantically equivalent code blend) in favour of the visual-gestural modality (41.94% visual and 11.29% monolingual VGT). This is reflected in her expression of microfunctions. She is now expressing only five microfunctions vocally (instrumental, interactional, personal, heuristic, and imaginative). She expresses four of these visually and bimodally as well (instrumental, interactional, personal, and heuristic) but also expresses the regulative function visually. However, she seems to be developing bifunctional use of language bimodally, although this is restricted to the pragmatic macrofunction (more specifically, a combination of the regulative microfunction in the visual-gestural modality and interactional microfunction in the auditory-vocal modality, and a combination of the instrumental microfunction and interactional microfunction, both in the auditory-vocal modality).

As stated in the introduction of this paper, it is because children want to share with adults their expanding experiences of the world and of themselves that they adapt and expand their language resources (Halliday, 1974). In other words, the linguistic environment created for Eva is equally important to take into consideration as her production. Figure 1 has shown that Eva's mother uses a range of communication methods concurrently. The amount of input, however, varies quite considerably. We see that this is mainly due to a varied offer of monolingual Dutch, the principal part of her input. That Sophia relies on spoken language more than she does on other communication methods is in line with our expectations. Spoken Dutch is her usual and thus more intuitive way of communicating (Papousek, 2007; Koester, 1992, 1998; Waxman & Spencer, 1997; Meadow-Orlans & Spencer, 1996). The other communication methods remain more or less stable during the study. When Eva is six months old, more than half (56.59%) of her mother's input consists of spoken language only (i.e. monolingual Dutch). This corresponds to 122.090 seconds (see Figure 4). It is not possible at this point of Eva's development to assess how much of this she is able to pick up. Her mother furnishes the linguistic environment further with 15.12% monolingual VGT, 9.76% Dutch based code blends, 2.44% VGT based code

blends, 14.63% semantically equivalent code blends and 1.46% semantically complementing code blended communication. Of the communication that is transmitted through the visual modality, Eva sees 44.080 seconds. Only 10.880 seconds of the visual communication that is offered are lost on Eva. In other words, her mother is offering her a total of 54.960 seconds of VGT information. During the seven minutes of taping, she is attentive to Eva, establishing eye contact and for 33.39% of the time her eye gaze is directed towards the child. Furthermore, Eva's mother interpreted one visual cue as an attempt on Eva's part to sign "SPELEN" (play) (see Figure 5). Important in this part of the interaction was the fact that her mother not only interpreted her movement as indicating "SPELEN" (play), she also changed the shape of Eva's hand to resemble the correct sign (commonly referred to as "moulding").

**Figure 5: Interactional analysis in ELAN at six months. We see how Eva's mother interprets Eva's hand movements as the sign PLAY.**

Three months later, her use of monolingual Dutch has dropped (from 116 to 76), but remains a large part of her communication (48.10%). Her use of monolingual VGT has decreased as well (from 31 to 5, 3.16%). However, at this point she seems to be combining modalities more often (Dutch based code blends have risen to 24.05% of all communication, VGT based code blends have slightly increased to 3.80% and semantically equivalent code blends to 20.25%). Her use of semantically complementing code blends have remained stable (1.27%). Therefore, communication with a visual element to it now totals 51.89% of all communication. Of this type of communication (more specifically, communication with a VGT sign) 64.370 seconds are picked up by Eva. 50.140 seconds of VGT communication are lost on Eva. As such, it appears her mother is offering her more signs, as the total number of seconds of sign use directed to Eva has risen to 114.510 seconds. In other words, at nine months of age, Eva's mother is offering more visual communication (though not necessarily signed language) than purely spoken communication. There is another notable difference with the results at six months. She does not seem to be more successful in establishing eye contact (21.995% of the total amount of seconds her eye gaze is directed towards Eva). However, 88.35% of the time when there is matched eye contact Eva's mother is also offering a piece of linguistic information, compared to 35.78% of the time when Eva is six months old. This means that she has become sensitive to Eva's linguistic needs (taking visual attention in account when offering a sign) as well as more familiar with how to insert visual communication in the interaction with her deaf daughter. This is reflected in Eva's language production as well.

Three months later, after CI, the communicative situation seems to have changed for Eva's mother. The use of monolingual Dutch has risen substantially from 76 to 130 (proportionally, from 48.10% to 71.04% of all communication, spanning 150.640 seconds in total). Simultaneously with this increase of monolingual Dutch communication, semantically equivalent and Dutch based code blends have decreased (23 or 12.57% and 17 or 9.29% respectively). VGT based code blends have decreased slightly (5 or 2.73%) and monolingual VGT communication has halved (2 or 1.09%). Semantically complementing code blends have remained stable in

number but continue to decrease proportionally (1.09%). Moreover, mother and child establish eye contact only 5.98% of the time the mother is watching the child. Furthermore, we see that Eva's mother is offering signs for 49.020 seconds. This is less than half of the time she offered signs three months earlier (114.510 seconds). Of this total amount of time, Eva is picking up on the signs for 23.750 seconds or 48.45% of the time. This finding is somewhat surprising, as deaf infants of hearing parents are described to be least likely to avert eye gaze from the parent (Koester et al., 1998). But, if we take eye gaze aversion to be the infant's means to regulate overstimulation from a social partner (Brazelton et al., 1974; Koester & Lahti-Harper, 2010), we would expect the sensitive parent to pick up on the considerable amount of time the deaf infant is looking away from her mother. However, Sophia increases (vocal) stimulation. Moreover, Eva's language production shows a general decrease but 79.31% of her expressions are in the visual-gestural modality. Her mother, on the other hand, displays an increase in general production, consisting of an increase in monolingual Dutch communication but a decrease in all types of communication with a visual element. During this time, the proportion of unreciprocated eye gaze makes up 94.02% of the total amount of the mother's eye gaze directed towards Eva. In other words, around Eva's first birthday the mother-child dyad has experienced a change resulting in a communicative disruption, evidenced in both production by mother and child and maternal behaviour (more specifically, establishment of eye contact). Such a decline in communicative relationship may have negative effects on an infant's intellectual, linguistic and emotional development (Schilling & DeJesus, 1993; Steinberg, 2000).

This trend towards more monolingual Dutch communication and less matched eye gaze seems to have persisted six months later. Eva's mother is now using even more monolingual Dutch (143 expressions). However, this is a slight decrease proportionally (65.90%) and in time (127.392 seconds). The combination of modalities has gained some ground in comparison with six months earlier. Dutch based code blends and VGT based code blends have increased substantially, both in number of expressions and proportionally (40 expressions, 18.43% of all communication, and 12 expressions, 5.53% of all communication respectively). However, semantically equivalent code blended communication has decreased from 23 to 15 expressions (6.91% of all communication). Semantically complementing code blends have disappeared altogether. This is in contradiction to the findings of Koester & Lahti-Harper (2010). They found a considerable decrease between the infant ages of twelve and eighteen months in mothers' use of the auditory-vocal and visual-gestural modality respectively to attract attention. Furthermore, consistent with the increase of monolingual Dutch communication, the time during which Eva's mother offers signs in her communication has decreased slightly (from 49.020 seconds to 45.920 seconds). Of these offers, 28.300 seconds or 61.63% of the time during which signs are offered are picked up by Eva. This is a slight increase in time in comparison to six months earlier, but a considerable increase proportionally. However, the proportion of unreciprocated eye gaze still makes up 91.86% of the total amount of the mother's eye gaze directed towards Eva. This seeming discrepancy is mainly explained by the fact that Eva's mother is producing signs in Eva's field of vision, i.e. on the objects of play (see Figure 6) instead of in the space between them (see Figure

7). This is consistent with findings from Waxman & Spencer (1997), who report that hearing mothers of deaf children make increasing use of objects to attain attention in comparison to deaf mothers of deaf children. This is confirmed by Koester et al. (1998: 6) who also state that these mothers may be 'less effective at eliciting the child's attention to the social environment or to the primary source of communication and language input, the social partner.' The maternal input is reflected in the child's language use as well: at the age of 18 months Eva is making use of the auditory-vocal modality to express herself more than she did before. This is to be expected. The mother's eye gaze is directed towards Eva much less (83.510 seconds in total). As a consequence, she cannot respond to solely visual cues as much as she does to vocal cues. As has been stated in the introduction to this paper, if the parent does not engage in interaction in a particular mode of communication, this mode will be abandoned for a more successful way of bridging the gap between child and parent. This may in part explain the increase in the use of the auditory-vocal modality on Eva's part.

**Figure 6: Eva's mother signing on the objects of play rather than in the space between them.**

**Figure 7: Eva's mother signing in the space between them rather than on the objects of play.**

Six months later, the communicative situation seems to have changed again. The total number of expressions has diminished from 217 to 168, mainly due to a decrease in use of monolingual Dutch (77 or 45.83%, spanning 70.910 seconds in total) and the combination of modalities. Dutch based code blends have diminished with approximately one third in number of expressions (24) but decreased only slightly in proportion (14.29%), whereas VGT based code blends have halved in number of expressions (6) but also decreased only slightly proportionally (3.57%). Semantically equivalent code blended communication, on the other hand, has increased from 15 to 39 expressions (23.21%). Moreover, monolingual VGT communication has more than doubled in number of expressions (from 10 to 21, 12.50%). Semantically complementing code blends have reappeared as well, although making up only 0.60% of all communication. Simultaneously with this increase of communication with a visual element, the total amount of time the mother's eye gaze is directed towards Eva has also increased (from 83.510 seconds to 146.200 seconds). Of this time, 67.26% is reciprocal. Moreover, Eva's mother is offering signs for 83.490 seconds, 41.44% of which is picked up by Eva. This is reflected in Eva's language production, insofar as her productions in the auditory-vocal modality have decreased in favour of her productions in the visual-gestural modality.

### 4.2. The Pragmatics Profile of Everyday Communication Skills (PPECS)

The analysis of the video material only gives us a snapshot of Eva's actual communicative behaviour. Therefore, we feel it is important to supplement these results with parental reports to corroborate the findings of the video analysis. However, it is paramount to keep in mind the risks of the observer's paradox. Depending on the view Eva's mother has of the researchers and their

aims, it is possible she might be exaggerating or underestimating Eva's communicative abilities. Because of this, the results of the maternal reports need to be handled with considerable care. Moreover, it is important to relate discrepancies and similarities to the results of the video analysis in order to attempt explaining apparent differences.

Eva's mother reports that her daughter is able to make known when she wants something done or something stopped at age six months (action semiotic). Eva is said to do this intentionally by means of facial expression, gesture and vocalization. In reaction to interaction she attends and responds by means of face and body movement. Her mother states she is sociable in all contexts. She herself addresses Eva mainly through touch, gesture, sign, or words in context. This description of Eva's communicative abilities is supportive of the findings of the video analysis. However, these also showed that Eva is able to make known that she likes something or not (reflection semiotic).

Six months later, the maternal report seems not to have changed much. Although the mother reports her daughter has developed four microfunctions (the instrumental, regulative, interactional and personal microfunction), she indicates Eva expresses these through the same means as six months earlier: facial expression, gesture and vocalization. In reaction to interaction the mother also reports Eva is now responding with interest. She has remained sociable in all contexts. The mother reports she still uses touch, gesture, sign, or words in context to communicate with Eva. This description of Eva's communicative development is supportive of the findings of the video analysis. Indeed, this analysis also showed that Eva has developed the four microfunctions reported by her mother by the time of her first birthday. Moreover, the analysis has shown that, although Eva developed communication by means of VGT based code blends and monolingual VGT at age nine months, her expressive abilities at age twelve months have decreased again beyond the level she had at age six months. However, the maternal self-report seems in sharp contrast to the decrease of all types of communication we see her use in the video, with the exception of monolingual Dutch.

At the age of 18 months, Eva's mother reports that her daughter has developed six microfunctions (the instrumental, regulative, interactional, personal, heuristic and imaginative microfunction). She indicates these are expressed through facial expression, gesture, vocalization, face and body movement and sign (although in imitation). She also states that, interactionally, Eva now starts to take initiative and is more auditory-vocal than visual-gestural around children. The mother reports addressing Eva with touch, gesture, sign, words in context and questions (more specifically, "what"). This description of the girl's communicative abilities is supportive of the findings of the video analysis. However, here too the maternal report seems not to do justice to the amount of monolingual Dutch input to the child or to the use of the auditory-vocal modality by the child to express herself.

At the age of 24 months, Eva is reported to convey five microfunctions (the instrumental, regulative, interactional, personal, and heuristic microfunction). These are expressed by means of facial expression, gesture, vocalization, words, and signs. Eva now takes initiative to start interaction and then takes the lead. Her mother also reports she is still sociable, but shies away

from strangers. Finally, she indicates she communicates with Eva through touch, gesture, sign, words in context, and direct requests. This description of communicative development is only partially supportive of the findings of the video analysis. These show that Eva has developed five microfunctions vocally (instrumental, interactional, personal, heuristic, and imaginative), only four of which correspond with the microfunctions indicated by her mother. She expresses these four reported microfunctions visually and bimodally as well. However, apart from the four microfunctions Eva expresses on the video vocally, visually and bimodally, she also expresses one microfunction in the auditory-vocal modality (i.e., the imaginative microfunction) and one microfunction in the visual-gestural modality only (i.e., the regulative microfunction). It is these functions which are missing from the mother's account of Eva's linguistic behaviour. In other words, the video analysis shows she has developed six microfunctions across modalities whereas her mother only reports four. Moreover, the video analysis showed that Eva seems to be developing bifunctional use of language bimodally, although restricted to the pragmatic macrofunction (more specifically, a combination of the regulative microfunction in the visual-gestural modality and interactional microfunction in the auditory-vocal modality, and a combination of the instrumental microfunction and interactional microfunction, both in the auditory-vocal modality).

### 4.3.SFL account of language development

On the basis of the analysis of the videos and the analysis of the structured PPECS interview we will now present a Systemic Functional account of Eva's language development (Table 11).

**Table 11: Eva's development between six and twenty-four months of age in terms of Systemic Functional theory.**

Compared to the Systemic Functional developmental theory as hypothesized by Halliday (1974; 2004; see also Taverniers 2002), Eva develops her linguistic system at a slower pace. We would expect Eva to have developed four microfunctions by age 9 months (instrumental, regulative, interactional, and personal). However, there is no evidence for the development of the interactional microfunction. By her first birthday, Eva seems to have indeed developed the four microfunctions hypothesized by Halliday. Nevertheless, the degree of choice she has within her linguistic system is still limited. This is especially the case with respect to the interactional and the personal microfunctions. At this point it is important to keep in mind the decreased linguistic output on Eva's part, which may in part explain why no evidence could be found for more specialized systemic choice. Six months later, after bilateral CI, we see Eva has developed two more microfunctions (imaginative and heuristic) as well as more systemic choice within her existing microfunctions. However, we would expect her to be able to combine microfunctional use of language into one content-expression pair (i.e. macrofunction) by the age of 18 months. Nevertheless, we see that she is only starting to do this at the age of 24 months. Metafunctional

use of language (integrating ideational, interpersonal and textual aspects of language in one utterance) is beyond her reach at the end of the study.
Clear influence of the linguistic environment may be observed in *how* Eva develops systemic choice. If we take a look at how Eva attracts attention, we see that she cries at age six months but is using tapping on the arm as a functional strategy by age eighteen months. This tapping, the mother comments, is probably something she took over from her, as the mother was taught that tapping is the Deaf way of asking attention. In details like these we see how cultural influences – namely Deaf culture passed down through the mother – have come to play a role in Eva's way of reflecting on the world and acting on the people in it. As such, Eva's reflecting and acting upon her environment – her acts of meaning (Halliday, 2004: 20; Halliday, 2009: 1) – can be said to be an intersubjective co-creation of a social process (Halliday, 2004: 112, 142, 143; Voloshinov, 1973: 21, 22). In other words, guided by her mother Eva develops a more effective mode of communication.

### 4.4. The MacArthur Bates Communicative Development Inventory for Dutch and VGT

We now have a view of Eva's general communicative development. However, in order to better understand how she develops language-specific lexicogrammar to bring this functional development to expression, the findings were supplemented with the MacArthur Bates Communicative Development Inventory for Dutch (N-CDI) and its adaptation to VGT (VGT-cdi). As these are parental reports, like the PPECS is, it is equally important to keep in mind how the mother views the researchers and their aims. In the same way as we have done for the PPECS, the results of the N-CDI and the VGT-cdi need to be handled carefully. Furthermore, we feel it is important to relate discrepancies and similarities to the results of the video analysis in order to attempt explaining apparent differences.
The N-CDI results for Eva at nine months show she is scoring below average in comparison to her monolingual Dutch hearing peers with respect to production and comprehension of Dutch. Interestingly, she seems to be above average in comparison to the same group with respect to the section "gestures". The VGT-cdi results for Eva at the same age show she scores above average in comparison with native BSL deaf peers as far as comprehension and production are concerned. In comparison to native ASL deaf peers, however, she scores below average with respect to production. Her total linguistic system (the number of concepts Eva knows in either language) compared to the average of hearing peers shows she has similar scores with an advantage in the "gesture" section. In comparison to BSL deaf peers her total linguistic system scores higher, but she scores lower in comparison to ASL deaf peers. These results are supportive of the findings of the video analysis. These, too, showed that Eva at nine months was communicating primarily through the visual-gestural modality. This is reflected in her scores for the section "gesture" in the N-CDI and her VGT-cdi scores as compared to the average of BSL deaf peers.

Three months later, at the age of twelve months, the results for the N-CDI show that Eva is now scoring slightly above the average of her hearing peers with respect to the section “sentences” and comprehension. She scores below the average of the same group with respect to production and scores equally for the section “gestures”. The results for the VGT-cdi show that Eva scores considerably above the average of BSL deaf peers with respect to comprehension and slightly above for production in comparison to this group. However, she scores considerably below the average of ASL deaf peers for production. Her total linguistic system shows she is scoring appreciably above the average of monolingual Dutch hearing peers with respect to the sections “sentences”, comprehension and production, but equally as far as the section “gestures” is concerned. Compared to the average of BSL deaf peers, Eva’s total linguistic system scores appreciably higher with regard to comprehension, but only slightly higher with respect to production. Compared to the average of ASL deaf peers, Eva scores notably lower. These results are surprising, compared to the findings of the video analysis and the structured interview (PPECS) analysis. The video analysis showed Eva at age twelve months was producing less language than she did at age nine months. Moreover, her mother reported her to be communicating primarily by means of touch, gesture and vocalization. Nevertheless, these findings concern mainly language production. Nothing conclusive could be said about language comprehension.

At the age of 18 months, after bilateral CI, the N-CDI and the VGT-cdi probing both vocabulary and grammar development are administered. The results for the N-CDI show that Eva is scoring considerably lower than the average of hearing peers with respect to comprehension and production. The results for the VGT-cdi show that Eva is scoring higher than the average of BSL deaf peers, but drastically lower than the average of ASL deaf peers regarding production. It appears she is also scoring higher than the average of BSL deaf peers with respect to comprehension. Eva’s total linguistic system scores notably lower than the average of hearing peers with respect to comprehension, but appreciably higher than BSL deaf peers. With respect to production, she scores only slightly lower than the average of hearing peer, slightly higher than the average of BSL deaf peers, but considerably lower than the average of ASL deaf peers. These results are unexpected. At the age of nine and twelve months, Eva was reported to be scoring higher than the average of hearing peers. Now, after bilateral CI, we see she is falling behind this average quite considerably in her spoken language output. Her signed language output, on the other hand, is still scoring higher than the average of BSL deaf peers (though notably lower than the average of ASL deaf peers). However, this is not supported by the video analysis. This showed that Eva was making use of the auditory-vocal modality more than the visual-gestural modality at this point of the study. Moreover, her mother acknowledged two of her expressions as Dutch (making up 33.33% of the words indicated as words Eva produces on the N-CDI), but none as VGT.

When Eva reaches the age of two years, the N-CDI results show she is scoring appreciably lower than the average of hearing peers. The results of the VGT-cdi, however, show she is scoring considerably higher than the average of BSL deaf peers with respect to comprehension. As far as

production is concerned, the results show she scores higher than the average of BSL peers but lower than ASL peers. Interestingly, the results for the VGT-cdi also tell us that she uses "AF" ("finished") to indicate past tense. This is a grammatical development beyond what seems to be expected of her at two years old. Eva's total linguistic system at age two shows she scores below the average of hearing peers, but above the average of BSL deaf peers with regard to comprehension. As far as the scores for production are concerned, she scores lower than the average of hearing peers and ASL deaf peers, but higher than BSL deaf peers. Strikingly, her total linguistic system at age two as far as comprehension and production is concerned consists of only one more meaning than she has developed in VGT. This is in line with the results from the N-CDI and the VGT-cdi at eighteen months. However, it is not supported by the video analysis. This showed that Eva was using more monolingual Dutch than she was using monolingual VGT. It did, however, show that 79.03% of her communication contained a visual element.

It may be considered that the gradual increase of purely spoken maternal input between nine and twelve months of age followed by a gradual decrease of purely spoken maternal input in the second year of life is reflected in the N-CDI and VGT-cdi results with respect to what is acknowledged and validated as spoken and signed language.

## 5. Conclusions

In this paper we were interested to study what the linguistic environment (linguistic input and parental behaviour) one hearing mother creates for her deaf daughter (Eva) looks like, what Eva's linguistic productions look like and what the possible interactive relationships are between this particular linguistic environment and the girl's language development. By means of analyses of videos, structured interviews (PPECS) and N-CDI and VGT-cdi results gathered during the first two years of life, we were able to present the development of the communicative process of this particular mother-child dyad.

These findings showed that at age two, Eva's lexicon in Dutch, VGT and the two combined is smaller than the average of monolingual Dutch hearing peers and in between the averages of native BSL deaf peers and native ASL peers. However, Eva's lexicon is not developing more slowly throughout the study. On the contrary, we showed that Eva's results for N-CDI and VGT-cdi surpassed the average of hearing peers and BSL deaf peers between 9 and 12 months. It is from 18 months onwards – after bilateral CI – that her Dutch and combined lexicon development scores below the average of hearing peers. Moreover, the discrepancy between her scores and the average of BSL deaf peers is diminishing. This seeming disruption in communicative development was also apparent from the video analysis, albeit six months earlier. Around the time of her first birthday (after the first CI) we saw Eva experiencing a communicative setback during which her production fell dramatically. During this time, she appeared to be communicating primarily through the visual-gestural modality. This longitudinal use of the visual-gestural modality by Eva may in part explain why her VGT lexicon (and, as a

consequence, her total lexicon) remains to grow steadily, whereas her Dutch lexicon appears to fall behind. In response to this decrease in Eva's language production her mother, on the other hand, displays an increase in general production, consisting of an increase in monolingual Dutch communication but a decrease in all types of communication with a visual element. This is in line with studies on changing communication patterns after CI (Watson, Archbold et al., 2006; Watson, Hardie et al., 2008) as well as with findings that hearing mothers of deaf children rely on the auditory-vocal modality more than deaf mothers of deaf children (Koester, 1992; Koester et al., 1998; Waxman & Spencer, 1997). Moreover, during this time, the proportion of unreciprocated eye gaze makes up 94.02% of the total amount of the mother's eye gaze directed towards Eva. Although we do expect that with increased mobility Eva starts to explore the environment (Leung & Rheingold, 1981; Adamson, 1995; Swisher, 1992), we also expect the dyad to be able to 'coordinate or systematically divide attention between objects and social partners' which would allow mother and child 'to establish a joint focus on an object or event while also allowing the infant to receive communicative information produced by the mother' (Waxman & Spencer, 1997: 105). However, this is not the case for Eva and Sophia. Sophia does indeed increase use of objects to attain attention, but she does not succeed in regaining the attention to herself, the social partner and source of communication (Waxman & Spencer, 1997; Koester, 1992; Koester et al., 1998). In other words, around Eva's first birthday the mother-child dyad has experienced a change resulting in a communicative disruption. This may be the cause of Eva's slowed-down language development (Schilling & DeJesus, 1993, Steinberg, 2000). At the end of the study (2;0) she is performing at an early transitional stage between Child Language and Adult Language: she is starting to combine microfunctions into one expression, whereas we would expect her to combine the ideational, interpersonal, and textual metafunctions of language into one expression. This slower development is also evident in the results of N-CDI and VGT-cdi. This change in communicative relationship is consistent with other studies on the relationship between mother and child after CI (Weisel et al., 2007).

As was discussed in the introduction to this paper, a setback in parental intuition may result in a troublesome intersubjective relationship towards the end of the first year of life as well as in a difficult symbolic and verbal integration around eighteen months (Papousek, 2007). We see that this is indeed the case for Eva. A specific cause for this matching setback and resumption in language development in mother and daughter is hard to define and most likely multi-factored. However, it is conspicuous that the change in interaction becomes apparent *after* CI. Such a hypothesis is further supported by the fact that, at twelve months, we saw natural interaction before the device is switched on and interactional mismatches afterwards. While we were accustoming mother and child to the cameras by taping a moment of care, Eva's CI was switched on. Her vocalizations (crying and the like) came to a sudden halt. After the attachment of the outer piece of the implant the nature of the interaction seemed to change altogether. Whereas we saw Eva taking the lead in the interaction before the adjustment of the device, we saw she became more passive after the adjustment, which prompted her mother to take initiatives and to dominate the interaction. The development of this controlling interactional dynamic between

hearing mothers and their deaf infants has been described by Loots et al. (2003b) as an expression of problems in the development of intersubjectivity and an attempt of the hearing mother to counter this stagnation. It could be argued that, as she was falling through the rabbit hole of looking for a successful mode of communication with her deaf daughter, the introduction of the CI changed the mother's feelings of trust in her own parental intuition towards her daughter. This is further supported by studies on the relationship between CI and parental stress (Hyde et al., 2010; Christiansen & Leigh, 2002; Weisel et al., 2007; Zaidman-Zait & Most, 2006; Incesulu et al., 2003; Knussen & Sloper, 1992; Nicholas & Geers, 2003; Pipp-Siegel et al., 2002). Before implantation she and her daughter had begun a process of communication based on the visual-gestural modality. Contrary to what was expected, by age nine months they had succeeded in establishing an interactive communicative relationship with one another. However, after implantation, the mother may have experienced the potential barriers to sensitive parenting Meadow-Orlans & Spencer (1996:214) mention much more acutely. She may have felt urged to close the gap between them in the auditory-vocal modality, which prompted a more monolingual approach to communication. This evolution in turn resulted in a 'self-fulfilling spiral of unsatisfactory interaction' (Meadow-Orlans, Spencer, 1996: 214), as Eva's language production dropped dramatically, specifically in the auditory-vocal modality. This discrepancy between expected outcome and actual outcome from CI may also have resulted in higher stress levels on the part of the mother. Six months and a second implant later, we see that this shift in emphasis towards a monolingual upbringing has indeed brought on the development of spoken language in the child. However, this seems to have undone the established interactive communicative relationship between mother and child in the visual-gestural modality.

Interestingly, as Eva reaches her second birthday, her mother seems to have switched back to a more bimodal-bilingual approach to communication with Eva. We also see an increase in time mother and daughter are attending to each other. Apparently the 'self-fulfilling spiral of unsatisfactory interaction' (Meadow-Orlans, Spencer, 1996:214) can be broken by supplementing the interaction with communication in the visual-gestural modality, which has reinstituted the interactive communicative relationship mother and child had established before CI. This may also have reduced the possible increase of stress after bilateral CI. Moreover, it is reasonable to assume that further nourishing communication in both the visual-gestural and the auditory-vocal modality would be beneficial as Eva appears to be developing bilingual bimodal macrofunctional use of language (more specifically, a combination of the regulative microfunction in the visual-gestural modality and interactional microfunction in the auditory-vocal modality, and a combination of the instrumental microfunction and interactional microfunction, both in the auditory-vocal modality). In order for her to develop to their fullest potential the systemic choices now available to her, we believe it is paramount not to deprive her of communication in one of the modalities as this might trigger another setback in her linguistic development.

As this is merely a case study and therefore idiosyncratic by nature, it is difficult to make general claims about interaction between hearing mothers and deaf implanted children. Moreover, it is

impossible to cancel out the influence exerted on behaviour and maternal reports by the presence of researchers. More research on this topic, taking into consideration the limits inherent to this study, is needed to validate the conclusions we have made. Nevertheless, this case study does point to several important issues in the contemporary discussion about CI. Wittgenstein described language as a form of life (1953). Indeed, this case study showed that the introduction of CI into the interaction between mother and child has effects well beyond the child's development of spoken language alone. After CI, the mother changed her communicative approach towards the child inasmuch as she increased her use of monolingual Dutch and decreased the use of all other types of communication. The child herself, on the other hand, had moved to a less communicative stage in which she apparently preferred to communicate through the visual-gestural modality. These conflicting evolutions may have added to the mother's stress with respect to communication with her child, leading to even more emphasis on spoken language development. However, the disruption in their established visual communicative relationship resulted in a slowing down in linguistic development which continues even after the mother engages in bimodal-bilingual communication again. What this case study reveals, in other words, is that the mother appeared to be unaware of the quality of communication she and her daughter had already reached before CI. Moreover, the importance of being able to speak and hear seemed to outweigh this established communicative bond between them. Therefore, we believe it is important for service providers during the *entire* care trajectory to be sensitive to all types of established communicative relationships without apparent precedence of communication in one modality over another at a certain point of development. It is paramount to make hearing parents aware of the fact that a deaf baby is able to communicate without hearing and before CI, to help them learn how to interact with a deaf baby, and to point parents to already developed strengths. As such, they can build further abilities and skills instead of abandoning these strengths and trying to build others from scratch. This would not only benefit the language development of the child in question, but also the interactional relationship between mother and child.

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