THE CLINICAL RELEVANCE OF AN ASSESSMENT PROTOCOL ADMINISTERED ON CHILDREN WITH COCHLEAR IMPLANTS

By

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ABSTRACT

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Some children with severe to profound hearing loss are implanted with a cochlear implant on the hypothesis that short-term outcomes in auditory receptive skills can be utilized into greater social independence and quality of life. In order to measure the outcomes and progress achieved from cochlear implants, effective assessment protocols are vital. The purpose of assessment after cochlear implantation, is to monitor an individual child's rate of progress in speech and language acquisition, with reference to other cochlear implant users; to collect data on the range of linguistic benefits observed against cochlear implant users over time and to investigate and amend unforeseen difficulties. Furthermore, the outcome measures provide concrete information to the multidisciplinary team, and parents, and for collection of prevalence data for further research, which is crucial for funding purposes. The dynamic and natural approach to assessment has been recommended as the most effective, to ensure a holistic assessment in young children with cochlear implants.

The aim of the current study was to determine the relevance of an assessment protocol proposed by the Pretoria Cochlear Implant Programme. The protocol was administered on eight children in the transitional stage of spoken language development, within an inclusive educational setting. A descriptive research design was selected in order to describe the qualitative results obtained during the study. The following assessments were included in the protocol: A questionnaire on background information, an aided audiogram (with cochlear implants and hearing aids), speech discrimination, Speech in Noise Test; Developmental Assessment Schema (Auditory Communication), Developmental Assessment Schema (General Development), Rossetti Infant-Toddler Language Scale, Reynell Developmental Language Scales III (Verbal Comprehension), Speech Intelligibility Rating, Voice Skills Assessment, Preschool Literacy Assessment, Mother Infant Communication Scale, Caregiver-Child Interaction, Meaningful Auditory Integration Scale, Meaningful Use of Speech Scale and Profile of Actual Linguistic Skills.

The results indicated that all the vital areas of assessment are included in the protocol, and under-evaluation is not a concern. Some of the areas of assessment overlap in the protocol, ensuring that the cross-check principle is being applied. The information gained from the assessment protocol can be used effectively for future intervention planning and adaptations can be made where necessary. Moreover, it was concluded that the administration and interpretation of the assessment protocol is time efficient and can be used effectively within a clinical setting. Cultural barriers did not have an effect on the administration and interpretation of the assessment protocol, however, linguistic barriers can influence the outcome of the results obtained. In summary, the assessment protocol has been found to be innovative, time effective, user-friendly, informative and relevant for the assessment of young cochlear implant users in the transitional stage of verbal linguistic development. Recommended changes for the assessment protocol were suggested, as well as recommendations for the educational setting. It was suggested that the questionnaires be available in all South African languages and that some of the protocols only be used if age-appropriate. Another recommendation was that the Listening Progress (LiP) and a pragmatic profile should be included in the protocol. Furthermore, it was suggested that an assistant audiologist could be involved to ensure more accurate and quicker hearing assessments.

Keywords: *Cochlear implants, relevance, assessment, protocol, multidisciplinary team, outcomes, intervention, cross-check principle, paediatrics, cultural and linguistic barriers, inclusive educational setting.*

OPSOMMING

DIE KLINIESE TOEPASLIKHEID VAN 'N ASSESSERINGSPROTOKOL UITGEVOER OP KINDERS MET KOGLEêRE INPLANTINGS

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Kogleêre inplantings is verskaf aan kinders met erge en uitermatige of totale gehoorverliese, op grond van die hipotese dat kort-termyn uitkomste in ouditiewe reseptiewe vaardighede benut kan word en verder ook kan lei na uitkomste wat aan hierdie kinders groter sosiale onafhanklikheid en 'n beter lewenskwaliteit kan gee. Effektiewe evalueringsprotokolle is essensieel om die uitkomste en vordering van kinders met kogleêre inplantings te meet. Die doel van evaluering na kogleêre inplantings is om 'n individuele kind se tempo van vordering in spraak- en taalontwikkeling te meet, in vergelyking met ander kinders met kogleêre inplantings. Verder om data oor die linguistiese voordele wat waargeneem is in kinders met kogleêre inplantings, in te samel oor 'n tydperk en om laastens in die posisie te wees om onverwagte probleme te ondersoek en dadelik aan te spreek. Wêreldwyd doen alle programme wat kinders met kogleêre inplantings het, navorsing. Die uitkomste van navorsing word aangewend vir verdere motivering vir fondse vir toekomstige kandidate. Die dinamiese en natuurlike benadering tot evaluering is voorgestel as die mees effektiewe benadering om 'n holistiese evaluering van jong kinders met kogleêre inplantings te verseker.

Die doel van die huidige studie was om die toepaslikheid van 'n evalueringsprotokol, wat ontwikkel is deur die Pretoria Kogleêre-Inplantingsprogram, te bepaal. Die

evalueringsprotokol is op agt kinders in die oorgangs-stadium van verbale taalontwikkeling toegepas, in ’n instansie vir inklusiewe onderwys. ‘n Beskrywende navorsingsontwerp is geselekteer om die kwalitatiewe resultate wat verkry is, te beskryf. Die volgende evaluerings is in die protokol ingesluit: ‘n vraelys met agtergrondsinligting, ‘n oudiogram van versterkte drempels (met kogleêre inplantings en gehoorapparate), spraakdiskriminasie, Spraak in Geraas Toets; “Developmental Assessment Schema” (Ouditiewe Kommunikasie), “Developmental Assessment Schema” (Algemene Ontwikkeling), “Rossetti Infant-Toddler Language Scale”, “Reynell Developmental Language Scales III” (Verbale Begrip), “Speech Intelligibilty Rating”, “Voice Skills Assessment”, “Preschool Literacy Assessment”, “Mother Infant Communication Scale”, Ouer-Kind Interaksie, “Meaningful Auditory Integration Scale”, “Meaningful Use of Speech Scale” en die “Profile of Actual Linguistic Skills”.

Die resultate het aangedui dat al die essensiële areas van evaluering ingesluit is by die protokol, wat aandui dat onder-evaluering nie ‘n bekommernis is nie. Party van die areas van evaluasie oorvleuel, wat verseker dat die kruis-kontrole beginsel toegepas is. Verder, kan die afleiding gemaak word dat die toepassing en interpretasie van die evalueringsprotokol tyd-effektief is, en dat dit ook effektief in ‘n kliniese instansie gebruik kan word. Kulturele aspekte het nie ‘n invloed op die toepassing en interpretasie van die evalueringsprotokol gehad nie, alhoewel linguistiese aspekte die uitkomste van die resultate kan beïnvloed. Ter opsomming, is die evalueringsprotokol kreatief, tyds-effektief, gebruikers-vriendelik, insiggewend en relevant vir die evaluering van jong kinders met kogleêre inplantings in die oorgangsstadium van verbale taalontwikkeling. Veranderinge vir die evalueringsprotokol is aanbeveel, asook aanbevelings vir die opvoedkundige instansie. ‘n Aanbeveling is gemaak dat die vraelyste in alle Suid-Afrikaanse tale beskikbaar behoort te wees, asook dat sekere van die evaluasies net gebuik moet word as dit ouderdomstoepaslik is. ‘n Verdere aanbeveling was dat die “Listening Profile” (LiP) en ‘n pragmatiese profiel ingesluit moet word by die protokol. Verder was dit aanbeveel dat meer akkurate en vinnige gehoortoetse moontlik sal wees indien ‘n hulpoudioloog betrokke kan wees.

<u>Sleutelwoorde</u>: *Kogleêre inplantings, toepaslikheid, evaluering, protokol, multi-disiplinêrespan, uitkomste, intervensie, kruis-kontrole beginsel, pediatrie, kulturele en linguistiese aspekte, instansie vir inklusiewe onderwys.*

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ABBREVIATIONS

Abbreviations used in the text are as follows.

ABBREVIATION	TERM
ABR	Auditory Brainstem Response
CDI	Child Development Inventory
CIAI	Cochlear Implant Association, Inc
DAS	Developmental Assessment Schema
EBP	Evidence-Based-Practise
EURO-CIU	European Association for Cochlear Implant Users
FSST	Fundamental Speech Skills Test
GSI	Grason-Stadler, Inc
LiP	Listening Progress
MAIS	Meaningful Auditory Integration Scale
MICS	Mother-Infant Communication Screening
MLU	Mean Length of Utterance
MUSS	Meaningful Use of Speech Scale
PALS	Profile of Actual Linguistic Skills
PASS	Profile of Actual Speech Skills
PBHL	Phonetically-Balanced Hearing Level
PB-max	Maximum score for phonetically-balanced words
SALT	Systematic Analysis of Language Transcripts
SIR	Speech Intelligibility Rating
VSA	Voice Skills Assessment
WIPI	Word Intelligibility Picture Identification Test

CHAPTER 1

ORIENTATION AND RATIONALE OF THE STUDY

"It is so exciting to discover that wherever in the world residual hearing is being used to the full, in an environment in which parents and professionals work as partners to motivate children to communicate, hearing impaired children are learning to listen and to develop spoken language of a quality that is functional for life in society at large."

(Clark, 1997:271)

1.1 INTRODUCTION

Cochlear implantation is one of the fastest developing fields within audiology (Nikolopoulos, Dyar & Gibbin, 2003:127; Nikolopoulos, Archbold & O'Donoghue, 1999:189; O'Donoghue, Nikolopoulos, Archbold & Tait, 1999:419; Archbold, O'Donoghue & Nikolopoulos, 1998:328; Nikolopoulos & O'Donoghue, 1998:46; Waltzman, Cohen, Gomolin, Green, Shapiro, Hoffman & Roland, 1997:342). Furthermore, the performance of cochlear implant users differs drastically from hearing aid users. Large differences are seen in their capability to identify environmental sounds, differentiate between voices, use auditory and lip reading cues, and in the comprehension of speech without the assistance of visual cues. Persons with a hearing loss, who are able to receive these auditory signals through the use of a cochlear implant, experience an abrupt change from a 'world of silence' to a 'world of sound'. In addition to the special characteristics mentioned above, cochlear implant users have similar problems and needs, which are comparable to hearing-impaired individuals who are fitted with conventional hearing aids. It is vital that both cochlear implant and hearing aid users become skilled at making use of their auditory cues, in combination with all other visual, kinaesthetic and tactile cues, as well as communication abilities in order to cope successfully in the everyday environment of the real world (Estabrooks, 1998:79; Eisenwort, Baumgartner, Willinger & Gstöttner, 1996:243). Therefore, paediatric implantation involves long-term financial implications as well as a commitment in terms of time (Archbold, 1994:57). Today it is widely recognised that experienced professionals are required to implement well-managed paediatric programmes to ensure future viability for all implanted children. Given the indications of the long-term benefits which are emerging from implant programmes throughout the world; this is a field which deserves more research due to the expansion possibilities which exist in it.

This chapter will provide an overview and perspectives on cochlear implants. The importance of obtaining outcome measures will be discussed, as well as the challenges faced when assessing a heterogeneous population. The recommended areas of assessment will be outlined. This delineates the purpose of the study: to determine the clinical relevance of the assessment protocol proposed by the Pretoria Cochlear Implant Programme.

1.2 PERSPECTIVES ON COCHLEAR IMPLANTS, PROBLEM STATEMENT AND RATIONALE OF THE STUDY

Profound or severe hearing impairments in young children often result in poor speech perception and production skills (Mondain, Sillon, Vieu, Levi, Reuillard-Artieres, Deguine, Fraysse, Cochard, Truy & Uziel, 2002:91). However, an issue, which remains problematic, is that of children who receive little or no benefits from conventional hearing aids. Firstly, when a hearing loss is so severe, it results in little or no usable residual hearing, and no benefit can be derived from the hearing aids. Secondly, a certain percentage of these patients are unable to bear the vibrotactile sensations of the hearing aid, and lastly, severe recruitment makes the use of the hearing aid intolerable. Thus, "research involving cochlear implants originated in an attempt to provide these children with an alternative sensory device" (Cummings, 1993:1).

Therefore, cochlear implants are provided to severely and profoundly hearing impaired children on the hypothesis that short-term outcomes in auditory receptive skills will translate, via a cascade of medium-term outcomes, into greater social independence and richer quality of life. In order to measure the outcomes and progress achieved from cochlear implants, effective assessment protocols are vital (Sanderson & Nash, 2001:1).

Cochlear implants differ from hearing aids in that they bypass the damaged inner ear and directly stimulate the residual auditory nerve fibres in the cochlea. A cochlear implant system consists of two components: (a) an external part worn on the body or behind the ear, and (b) an internal receiver that is surgically implanted into the cochlea. The speech processor, which is either worn on the body or behind the ear, converts sounds into electronic signals, and a transmitter coil sends these signals to the implanted receiver package. The receiver package then carries electronic signals along several electrodes that can selectively stimulate the auditory nerve fibres within the cochlea (O'Donoghue, Nikolopoulos & Archbold, 2000:466).

Since the clinical application of cochlear implants started in the 1970's, the number of stimulating electrodes within the implant has been increased to improve its performance and the design has shifted from a single channel to a multi-channel system, which improves speech perception abilities. Vast research also includes miniaturization of the electronic circuitry (Ertmer, 2002:218; Naito, Okazawa, Honjo, Hirano, Takahashi, Shiomi, Hoji, Kawano, Ishizu & Yonekura, 1995:207; Cummings, 1993:1). These advancements in technology resulted in cochlear implantation now being an established method of management for profound deafness (Nikolopoulos, et.al, 2003:127; Nikolopoulos, et.al, 1999:189; O'Donoghue, et.al, 1999:419; Archbold, et.al, 1998:328; Nikolopoulos & O'Donoghue, 1998:46; Waltzman, et.al, 1997:342).

The advent of cochlear implants has had a dramatic effect on the achievements of young profoundly deaf children. Children who receive an implant early on in life, followed by a period of appropriate intervention, can achieve speech and language skills that exceed levels observed in profoundly deaf children with hearing aids (Geers, Brenner, Nicholas, Tye-Murray & Tobey, 2003:307). Children who receive an implant early also become less dependant on lip-reading. In addition, improved speech perception skills and awareness of environmental sounds, and improvement of speech production and voice monitoring occurs (Calmels, Saliba, Wanna, Cochard, Fillaux, Deguine & Fraysse, 2003:1; Mondain et.al, 2002:91; Richter, Eibele, Laszig & Löhle, 2002:111; Cummings, 1993:2).

As with hearing aids, children who receive cochlear implants do not perform in a uniform fashion. This is not an unusual finding, given the heterogeneous nature of the hearing-impaired population. Factors which contribute to the success of cochlear implantation, include etiology of deafness, age of onset of deafness, duration of deafness, age at implantation, primary mode of communication, parental and educational settings, skills of professionals, as well as the child's learning style, intelligence, hearing and listening abilities (Estabrooks, 1998:79; Sheppard, 1993:423). There may be other contributing factors, which may be physiological in nature, such as neural supply and central processing abilities. Product factors which may also affect the outcomes of cochlear implantation are the number of electrodes implanted, speech coding strategies used, comfort, cosmetics and the availability of clinical and service support (Geers et.al, 2003:307). Furthermore, research has verified that access to good quality auditory training or learning also results in improved performance (Nevins & Chute, 1996:173). Additionally, post-operative success is highly dependant on close collaboration with parents (Bertram, 1996:61).

Cochlear implantation is therefore a beginning, not an end. It is a process, which involves decision-making, irreversible surgery and highly demanding intervention (Most & Zaidman-Zait, 2003:99). As a result, cochlear implantation requires a team of professionals committed to the long-term care of the children who receive the device (Nevins & Chute, 1996:21). An involved family is another crucial element in the success of an implant, especially if one takes into consideration that a decision for cochlear implant surgery involves a long-term, and most likely also a life-long commitment to intervention, auditory training, acquisition of spoken language skills and follow-up appointments (NAD Position Statement, 2004; DesJardin, 2003:391; Nevins & Chute, 1996:21). Outcome measures are successfully used for counselling purposes in order to foster realistic expectations in parents and to ensure that they are fully committed to the rehabilitation programme if long-term intervention is indicated by the outcomes (Tye-Murray, 2004:735; Estabrooks, 1998:20). As the parents are one of the main members within the Cochlear Implant Programme, family-orientated intervention programmes are commonly utilized. Family-centred intervention proposes that when professionals provide information, guidance and support to parents, it should empower the parents to build collaborative partnerships, in order to develop competence and involvement in their child's speech, language and educational development. Research proves that increased effectiveness of intervention programmes is evident if a family-centred approach is followed (Most & Zaidman-Zait, 2003:100).

In order to facilitate a successful implantation and intervention process, it is important that all the professionals involved understand the range of progress implanted children will display, how their level of functioning may change over time, and how to make the most of the available support services. The most commonly occurring challenges, which exist when assessing the outcomes of children with cochlear implants, are the following (Dyar, 2003; Nevins & Chute, 1996:173):

- The measurement of outcomes in extremely young children.
- The assessment and monitoring of progress in hearing-impaired children with complex linguistic or learning needs.
- The effectiveness of the cochlear implant device, i.e. mapping procedures in young children with cochlear implants is often difficult. Mapping procedures entail establishing electrical thresholds and maximum comfort levels, as well as loudness balancing of the electrodes (Weinstein, 2000:596)

As mentioned above, there are many challenges which are present when working with young cochlear implant recipients. Considering cochlear implantation is provided to children who are younger than 18-months at some cochlear implant programmes, and it is highly likely that this trend will continue towards children being implanted closer to birth or diagnosis, it is essential to ensure that mapping procedures and progress monitoring procedures are adapted to accommodate children with little or no spoken language. Many of the traditional assessments for auditory, speech perception, expressive and receptive language are inappropriate, as young children often do not have the necessary baseline skills (Weinstein, 2000:596). Furthermore, traditional assessments are also inappropriate for children with additional handicaps (which is present in approximately 40% of children with cochlear implants), as they also do not comply with the necessary baseline skills of the assessments due to the presence of a general developmental delay (Young, 1994:522). The subjects in this research study were in the transitional stage of spoken language development. The specific challenges that were identified were that the children had minimal spoken language, which resulted in slight adaptations to the assessment procedures (e.g. visual cues), and a large amount of observational techniques were used. Although a section of a standardised assessment was included in the proposed protocol, standardised assessments at this linguistic level are still very limited, especially regarding formal expressive language assessments.

"The purposes of a communication assessment after cochlear implantation are (1) to monitor an individual child's rate of progress in speech and language acquisition - with reference to other cochlear implant users, (2) to collect data on the range of linguistic benefits observed across cochlear implant users over time and (3) to investigate and amend diagnosed or unforeseen communication difficulties - especially in the case of children who seem to progress at a slower rate" (Dyar, 2003:2). Thus, outcome measures are vital and provide important information for the intervention programme. The information gained from an assessment includes deviations from the expected pattern of development, which would involve adjustments to the device (also known as *mapping*) or changes to the intervention programme. Furthermore, accumulation of the assessment information over time, and as a function of age, provides the background to which future cochlear implant users can be compared. In summary, assessments provide information in order to monitor progress over time, to provide concrete feedback to the multidisciplinary team members, especially to the parents, and lastly to monitor any changes in performance. Outcome measures are also needed for the collection of prevalence data for research, which is crucial for funding purposes, and for collaborative research to occur across all Cochlear Implant Clinics in South Africa (Lutman, Archbold, Gibbin, McCormick & O'Donoghue, 1996:39).

Professionals working within cochlear implant programmes are still finding the best measures on how to assess and report changes in hearing-impaired children's communicative competence, following cochlear implantation, and how to overcome the barriers of measuring progress in young implanted children (Dyar, 2003). This challenge is increasing as a result of changes in the candidacy criteria and secondly one must bear in mind that children are being implanted when they are younger (Chester-Brown, 2004).

Currently, children's linguistic skills are divided into three categories, namely, preverbal, transitional and functional language. During the preverbal stage, "children are functioning at a pre-lexical stage of spoken language acquisition." Characteristics of the transitional stage are, "recognisable words and simple formulaic expressions" reported by caregivers or professionals (Allen & Dyar, 1997:127). "Some single words or phrase patterns may be elicited on a minimum of two occasions in an assessment context" (Allen & Dyar, 1997:127). By this stage, awareness of voice and sounds in meaningful situations is present, and there is an idea of the use of language, and of the fundamental rules of communication (Archbold & Tait, 1994:178). During the functional language stage, the hearing-impaired child, "demonstrates the ability to use language spontaneously and in a systematic way. Knowledge of meaning, morphological and syntactical rules of the language is apparent, and the child has started to 'self-generate' language patterns" (Allen & Dyar, 1997:127).

In order to obtain sufficient outcomes and a holistic overview regarding the speech perception, and the speech-, language and literacy development of children with cochlear implants, certain areas need to be assessed. The following areas of assessment have been recommended as essential, and should be included in all assessment protocols (Dyar, 2003):

- *General development.* Approximately 40% of children with a hearing impairment have additional handicaps (i.e. mental retardation, learning disability, emotional or behavioural problem, uncorrected visual problem, cerebral palsy, orthopaedic problem, brain damage, heart disorder, legal blindness and epilepsy). Considering that additional handicaps are likely to interfere with the performance of a child with a cochlear implant, an assessment of general development is crucial (Young, 1994:522). Assessment of general development also provides an indication of the type and degree of support needed pre- and post-implant.
- *Parent-child interaction.* Parents demonstrate a wide range of strategies and behaviours that may serve to support and facilitate a child's communicative development, or in some cases hinder communicative development. For young children, the parents' style and degree of match or mismatch with the child's abilities are of primary importance. It is therefore crucial to document the strengths and weaknesses of parent-child interaction during observation of familiar daily living or play activities (Prizant & Wetherby, 1995:162).
- *General socialization.* Social integration into society is one of the long-term aims of cochlear implantation. Assessment of general socialisation is essential to determine if the child with a cochlear implant is displaying age- appropriate social behaviours, and if he/she is aware of the social language and conversational rules that govern verbal exchanges (Ross, Brackett & Maxon, 1991:148).
- *Emerging literacy skills.* It is important to promote literacy skills in children at the transitional stage of linguistic development, as the presence of a hearing loss may inadvertently limit the child's access to print. This places the child at risk for later reading and language-learning difficulties at school (Mahshie, Moseley, Lee & Scott, 2006:84).
- *Auditory ability* (including pure-tone audiometry, listening skills, auditory attention span and memory, phonological awareness, speech perception and speech discrimination). It is crucial to evaluate the extent to which a child can receive auditory information from the environment. The auditory information will indicate what type of sounds or words the child is aware of and what sounds or words can be discriminated or identified. This information also provides an indication of the stage

of auditory development, which is essential for intervention planning and auditory training (Mahshie, et.al, 2006:128).

- *Language skills* (including receptive and expressive skills). Children's receptive and expressive language abilities must be evaluated in order to be able to set appropriate intervention goals according to language skills. Results from language assessments also help determine which tests or methods to use in evaluations or during intervention (Mahshie, et.al, 2006:108)
- *Speech production* (including speech repertoire, intelligibility and voice use). "Spoken language is the pathway for expressive communication" (Mahshie, et.al, 2006:155). As a result it is important to constantly assess progress and provide appropriate intervention in order to maximise the child's speech production skills.
- *Everyday communication skills.* Evaluation of everyday communication skills is crucial to determine if the child is receiving appropriate access to communication, as it is an essential prerequisite for communication development. Evaluating the child's environment ensures that the intervention goals are aimed at providing the maximum support for everyday communication (Mahshie, et.al, 2006:104).

Various assessment protocols for children on different linguistic levels exist, however, for the purpose of this research study, a protocol for children in the transitional stage of spoken language development will be applied in an inclusive educational setting (Mahshie, et.al, 2006:81).

The above-mentioned areas of assessment have been included in the assessment protocol suggested by the Pretoria Cochlear Implant Programme, to obtain outcomes regarding the holistic development of children with cochlear implants. Previous research regarding the frequency of assessment, suggests that recipients should be assessed once every six months until the children are within the functional language stage of linguistic acquisition. Thereafter, assessment should occur annually for the next five years, and then every two years (Tye-Murray, 2004:751). According to the Nottingham Cochlear Implant Programme, a child with a cochlear implant is monitored annually by a trained teacher, and at one, three, five, seven, ten and fifteen years after cochlear implantation, by a speech-language therapist involved in a Cochlear Implant Programme (Dyar, 2003). Serial assessments are important because it provides the only way in which rate of development can be monitored and patterns of developmental change can be identified. This is crucial for clinical management and decision-making regarding the support needed (Mahshie, 2006:104).

It is essential for all the multidisciplinary team members to work together to achieve enhanced performance and outcomes. The individual members of a Cochlear Implant Programme may contribute professional or clinical insights in different ways and at different stages after the cochlear implantation.

In an attempt to overcome the challenges mentioned when assessing a young child with a cochlear implant, it seems feasible to determine the clinical relevance of the assessment protocol suggested by the Pretoria Cochlear Implant Programme. In order to establish the value of the proposed assessment protocol, a descriptive study was selected.

The aim of the descriptive study is firstly to determine the feasibility of using the proposed protocol in children with cochlear implants, and secondly and simultaneously to refine the protocol. By addressing the issues regarding assessment of young children with cochlear implants, the researcher can ensure that all the vital areas are assessed, and that all the information needed about the children's communicative and general development is obtained in a time and cost efficient manner. "Neither unaudited experience nor logical thought can replace controlled clinical trials, so until documentation of a procedure's effectiveness can be demonstrated, it should be considered a false idol and worship withheld," (Wilson, 2004:3).

This study will therefore provide answers to the research question by investigating the relevance of the proposed protocol, by administering the transitional stage assessment protocol on children in an educational setting.

1.3 DEFINITIONS OF TERMINLOGY

In order to prevent concept misinterpretation the following key concepts are defined as follows for the purposes of this study:

1.3.1 *Assessment*: n. Estimate the size or quality of (Thompson, 1995:74).

1.3.2 *Cochlear implant*: "A device to improve the hearing of profoundly deaf people who derive no benefit from conventional hearing aids. It consists of an electrode that is permanently implanted into the inner ear (cochlea). An external device with a microphone and an external processing unit passes information to the electrode using radio frequency waves. The implant is powered by batteries in the external part of the device" (Thompson, 1998:135).

1.3.3 *Formal assessments:* Tests usually standardised and normed. Standardised means that there is a consistent manner in which items are to be presented and child responses equated. Normed means that the test has been given to a group of children that supposedly represent all children for whom the test was designed and scores determined for typical functioning (Owens, 1999:59).

1.3.4 *Habilitation:* Suggests that a person never functioned normally. Services are designed to help individuals overcome the challenges posed by a disability (Soer, 2001:17).

1.3.5 *Inclusive educational setting:* An educational philosophy that proposes one integrated educational system – versus the two-tierced regular and special education – based on each classroom becoming a supportive environment for all its members (Owens, 1999:486).

1.3.6 *Informal assessments:* A descriptive approach to assessment based on observation and conversational sampling. The clinician can apply his/her own theoretical model to the assessment process and can probe and assess areas that seem most handicapping to the child (Owens, 1999:68).

1.3.7 *Intervention:* Intervention is a directed, purposeful process. It is the intentional application of resources with the aim of developing, improving, or changing conditions within an individual, environment, or interactions between an individual and the environment. Intervention always results in both intended and unexpected outcomes, which may be either positive or negative in nature (Smith & Kane, 1998:374).

1.3.8 *Multidisciplinary team:* Representatives from many professionals that function in a co-operative and interactive manner (Shprintzen & Bardach, 1995:14).

1.3.9 *Outcome:* n. a result; a visible effect (Thompson, 1995:968).

1.3.10 *Paediatrics:* The general medicine of childhood. Handling a child requires a special approach at every age from birth (or premature birth) to adolescence and also a proper understanding of parents (Martin, 1998:479).

1.3.11 *Protocol:* official formality observed; the rules, formalities, etc. of any procedure, group etc. (Thompson, 1995:1101).

1.3.12 *Relevance*: n. Bearing on or having reference to the matter in hand (Thompson, 1995:1161).

1.3.13 *Rehabilitation:* Restore to effectiveness or normal life by training etc. especially after illness (The Concise Oxford Dictionary, Ninth Edition, Clarendon Press: Oxford, 1995:1158). Rehabilitation services are designed to help individuals overcome the challenges posed by a disability. Rehabilitation implies that the individual had normal function and lost it (Soer, 2001:17).

1.4 RESEARCH PROGRAMME

The study will be presented according to the following layout.

1.4.1 Chapter One: Orientation and rationale of the study

Chapter one will provide an introductory orientation to the study. The trends in current research will be described, from which a rationale for the study will be formulated. Following this, a specific research question will be asked, namely, what is the validity and functionality of the Pretoria Cochlear Implant Programme Assessment Protocol administered on children functioning within the transitional stage of spoken linguistic development. Definitions of the most important terms to be used in this study will also be included.

1.4.2 Chapter Two and Three: Cochlear implant programmes and assessment of a young child in South Africa

Chapter two and three will contain the theoretical part of the study. The literature survey will discuss the different assessment protocols used at other Cochlear Implant Programmes, in comparison to the protocol suggested by the Pretoria Cochlear Implant Programme members. The focus will be on the value and validity of the different existing cochlear implant assessment protocols, compared to the current protocol. Theoretical concepts regarding the assessment of a young child with a cochlear implant in South Africa will also be included.

1.4.3 Chapter Four: Research methodology

This chapter describes the research design in order to provide answers to the research question. The main aim and sub-aims of the study will be stated. The Pretoria Cochlear Implant Assessment Protocol will be administered on eight children with cochlear implants functioning within the transitional stage of spoken linguistic development, in an attempt to answer the proposed research question. A descriptive research design will be utilised. A description of the subjects, material and apparatus used, data collection procedures, as well as the manner in which the results will be statistically analysed, will also be included in this chapter.

1.4.4 Chapter Five: Results and discussion

Chapter five mentions the research results and findings, followed by a detailed discussion and interpretation of the results. The extent to which the results are able to provide answers to the problem statement and sub-questions, will then be discussed. Recommendations for the educational setting and assessment protocol will be made.

1.4.5 Chapter Six: Conclusions, implications and recommendations

The summary of the research results will be discussed in this chapter. This will be followed by conclusions made regarding the findings of the study, as well as the implications for clinical practise and further research. Shortcomings and advantages of the study will also be identified.

1.5 SUMMARY

This chapter aims to provide the relevant background information on cochlear implants in order to clarify the topic of the study and to create a broad perspective on the importance of the rationale for this study. Cochlear implants are provided to severely and profoundly hearing-impaired children on the hypothesis that short-term outcomes in auditory receptive skills, will translate via a cascade of medium-term outcomes into greater independence and quality of life. In order to measure the outcomes and progress achieved from cochlear implants, effective assessment protocols are vital. The factors contributing to the success of cochlear implantation are discussed as well as the challenges when assessing this heterogeneous population. Outcome measures were outlined, explaining the importance of providing information for the intervention programme and for funding of cochlear implants. An assessment protocol suggested by the Pretoria Cochlear Implant Programme was recommended in order to overcome the challenges mentioned. This study will determine the relevance of the assessment protocol proposed by the Pretoria Cochlear Implant Programme. Additionally, the current study aims to provide professionals with a better understanding of the clinical aspects of measuring progress in the paediatric cochlear implant population.

CHAPTER 2

THEORECTICAL BACKGROUND: COCHLEAR IMPLANT PROGRAMMES

2.1 INTRODUCTION

"Communication is one of the major characteristics that separates man from other living entities on the planet," says Allum (1996:XV). Cochlear implantation has a direct impact on communication skills. Due to the heterogeneous nature of cochlear implant users, no single approach is better than another, and it is not possible to devise an approach or technique that will be successfully used in all cochlear implant users. What we learn in the end is that rehabilitation is an art, as well as a method that requires the skills of motivated, informed and competent teams of health care professionals (Allum, 1996:XVi). Most cochlear implant programmes follow a similar approach, i.e. pre-operative selection, evaluation of performance, device programming, and post-operative evaluation and monitoring of progress. For successful cochlear implantation to occur, holistic assessment and intervention programmes are warranted. Outcome measures provide support to the intervention goals, motivates families and helps to provide evidence on the effectiveness of cochlear implants. Cochlear implant programmes from Nottingham, Montepellier, St. Louis and Moscow make use of evaluation tools which can be adapted for use at other cochlear implant programmes, and aspects that can be helpful for intervention goal setting and expectations are described (Allum, 1996:XV).

The purpose of this chapter is to provide a theoretical framework for this study through a critical evaluation and interpretation of relevant literature. This will be achieved by discussing various existing cochlear implant centres and the outcome measures used at each cochlear implant programme will be highlighted.

2.2 COCHLEAR IMPLANT PROGRAMMES

Professionals working in cochlear implant programmes are still determining the best methods for documenting changes in communication abilities after cochlear implantation. "Language and speech outcomes that are evidenced-based and have been collected in a systematic way, can assist professionals from different professional backgrounds, to contribute to the ongoing debates in the field of cochlear implantation" (Dyar, 2003:2). Common issues regarding cochlear implantation usually include those of candidacy trends (lower and upper age limits), bilateral cochlear implantation, the role of sign language before and after cochlear implantation and ways of involving school-aged cochlear implant users in the decision making process (Dyar, 2003).

To ensure that holistic assessments of the paediatric cochlear implant recipients occur, a multidisciplinary team is essential in all cochlear implant programmes. Professional experience reveals an increasing awareness of the complexities involved in cochlear implantation in children. Some of these complexities include the following:

- The inconsistency in outcomes is greater in implanted children compared to the adult hearing impaired population.
- The challenges present in the pre-implant assessment and prediction of benefit is greater.
- The larger number of factors that influence cochlear implant outcomes: age of onset, aetiology, and length of deafness, parental influence and educational management.
- The greater length of time taken to show benefit in children compared the adult hearing impaired population.
- The long-term commitment needed to be given by the cochlear implant programme professionals.
- The parental responsibility in making informed decisions and the commitment to a long-term relationship with the cochlear implant programme.
- The different professionals involved are often based in various geographical areas and are required to work together as a team.
- The time-consuming characteristic of paediatric implantation.

Any paediatric implant team should consider the above-mentioned issues and the way in which they will meet the particular needs of the child, family and professionals involved with the child. A paediatric cochlear implant team generally consists of the child and his/her family, a team co-ordinator, an Ear-Nose-and-Throat-Surgeon, an Audiologist, a Speech-Language Therapist, a Psychologist, a teacher and cochlear implant and hearing aid technicians (Archbold, 1994:28).

Historically paediatric cochlear implant recipients have been assessed post-operatively through audiometric testing, which is conducted in a soundproof booth by trained audiologists. Assessment of functional outcomes after cochlear implantation must also consider a number of other factors including speech perception, speech intelligibility, and mode of communication, educational placement, as well as the social and psychological factors that affect one's ability to function in the mainstream environment. No uniform tool for assessing effective functional outcomes in the daily lives of cochlear implant recipients has been developed due to the heterogeneity of the hearing-impaired population and the variable populations served by existing cochlear implant programmes (Stern, Sie, Kenney, Yuen & Norton; 2004:157).

The Nottingham Paediatric Cochlear Implant Programme was formed in 1989 and remains extraordinary in many respects, because it focuses on young children mainly below the age of five years, it covers a large geographical area and conducts rehabilitation primarily via an outreach programme, in which skills sharing takes place between families and a large range of support professionals. Limited emphasis is placed on direct individual training of auditory and speech skills. The preference is to enable the implanted child to acquire and develop spoken language in their natural everyday contexts. The programme also engages in research, including the development of a computer database devised specifically to monitor the functioning of the device and to monitor the progress of communication skills in these young children (Lutman et.al, 1996:31).

Outcome measures which provide information on the functioning of the device, as well as the performance of the cochlear implant user, provide vital input for the intervention programme. Deviations from the expected pattern of development (based on the current experience of the Nottingham Cochlear Implant Programme), would usually result in re-programming of the device or adjustments to the intervention goals. Furthermore, collection of outcome measures across children of similar ages over time provides a general baseline against which future cochlear implant users can be compared. (Lutman, 1996:39).

Although current cochlear implant devices are reliable, failures do occur. Total or sudden failures are relatively easy to detect, even in young children. However, some failures may be partial and intermittent, and can therefore be extremely difficult to detect, especially in children with little or no verbal language. Professionals agree that consistent use of the cochlear implant is vital for the child to adapt to the device, and it is especially important for young children who require the auditory input for spoken language development. Behavioural audiometric tests are used for the evaluation of device performance. When behavioural checks suggest a problem, further objective tests are conducted to establish device performance. Electrophysiological measures such as Auditory Brainstem Responses (ABR) and Electrical ABR's are mostly used. Checks of conventional contralateral hearing aids and cochlear implants should occur daily at home or at school. As a parent or teacher is unable to listen to the output of a cochlear implant, a practical means of measuring the quality of the cochlear implant device is needed. One way in which this can be achieved is to use Ling's Five Sounds (oo, ah, ee, sh, ss) to assess the ability of the child to respond to, and discriminate between, the phonemes across the most important frequency range (Ling, 1976:157; Lutman et.al, 1996:39).

The primary outcome of cochlear implantation in young hearing impaired children is verbal language development. Dyar (2003) classifies language development and examines language skills at five interconnected levels: communication, receptive language, expressive language, voice and speech production. These five levels result in an overall classification of preverbal, transitional and functional linguistic development. One of the main long-term goals of paediatric cochlear implantation is functional language development. Classification into one of the above-mentioned categories also confirms the results obtained from traditional speech and language assessments. Skills of bilingual children using sign language and minimal verbal language can also be categorised into one of the three language development categories. Furthermore, the classification system can identify potential non-sensory complications which may result in verbal language deterioration. Therefore, the classification system can monitor language development on a broader level, after which specific assessments can identify exact problem areas in order to adjust intervention goals accordingly (Lutman et.al, 1996:41).

Threshold determination in a sound-proof booth using warble tones is the most common audiometric measure of sound detection. In general, if children are able to participate in the mapping process, they will be able to successfully participate in pure tone audiometry. This is because similar tasks are used to determine the upper and lower limits of the dynamic range during mapping. The thresholds obtained during mapping are simply a reflection of the sensitivity of the microphone and the input circuitry of the speech processor. On the other hand, pure tone thresholds provide information on the functioning of the device, as well as the softest sound the child responds to voluntarily, which assists in setting realistic expectations for parents and teachers. Furthermore, a baseline is provided in order to perform quick checks of the device functioning on a daily basis (Lutman et.al, 1996:42).

One of the challenges in assessing young cochlear implant users is that the children are often unable to participate in speech discrimination evaluations until they have acquired sufficient spoken language, which may only occur 2-3 years following implantation. Nonetheless, speech discrimination is one of the primary goals of cochlear implantation and is vital for spoken language development. Therefore, it is necessary to perform speech discrimination on an appropriate level for children with little or no spoken language. The Automated McCormick Toy Discrimination Test (Ousey, Sheppard, Twomey & Palmer, 1989:245) presents digitally stored target words at precisely calibrated levels in order to determine the speech discrimination thresholds using a standard adaptive algorithm. No verbal response is expected as the child simply points to the corresponding toy. The threshold obtained gives a measure of auditory sensitivity, as well as information regarding the child's ability to organise the auditory information into a meaningful word (Lutman et.al, 1996:43).

Some children are unfortunately unable to perform speech discrimination or speech detection tasks in the first 18-months after implantation. Observation of listening skills can be useful when speech discrimination thresholds cannot be obtained. The Listening Progress (LiP) is a profile of initial listening development which includes listening to environmental and speech sounds. The child is expected to respond to and identify sounds in play situations. Responses to environmental, instrumental and speech sounds are documented by encouraging the child to discriminate between two sounds and sounds in isolation. Discrimination of Ling's five sounds is also included in the profile. The LiP is especially useful in children with minimal verbal language, or in children who are unable to report what they hear. Furthermore, the LiP has proven to identify problems in the functioning of the device, the need for mapping and the appropriateness of the auditory learning environment (Archbold, 1994:55).

Video analysis is another observational tool often used at the Nottingham Cochlear Implant Programme. Behaviours such as turn-taking and eye contact, which are precursors of language development, can be observed in young children before they are able to understand or use spoken language (Wetherby, 1991:250). Video analysis also verifies and quantifies observations of a child with a cochlear implant. The Nottingham Cochlear Implant Programme has adapted the video recording procedure to suit their population of cochlear implant users. Video recordings of the child interacting with someone known to them are made at regular intervals in the first five years after implantation. Results of the video recording analysis provides the earliest formal indication of benefit from the implant (Lutman et.al, 1996:44).

Formal evaluations are mostly not appropriate for young cochlear implant users. As a result observational measures are commonly used. Many profiles have proved to be useful during observation. The Profile of Actual Speech Skills (PASS) has been adapted by the Nottingham Cochlear Implant Programme from a video analysis procedure used by the by the Indianapolis Cochlear Implant Programme (Osberger, Robbins, Berry, Todd, Hesketh & Sedey, 1991:151). The PASS documents the quality, quantity and variety of speech production in children with cochlear implants. The utterances are categorised as actual phonemes or speech sounds, speech-like sounds, non-speech vocalisations and silent speech posture. After the initial profile is determined, any three procedures can be used to investigate consonants and vowels, place of articulation, as well as place, manner and voice features. Valuable information is obtained on the ever-changing status of speech and voice skills following implantation; especially in children who do not have established spoken language. As the PASS is an observational tool, it can be applied in a natural, relaxing setting at specific assessment intervals (Lutman et.al, 1996:46).

The Speech Intelligibility Rating (SIR) is a practical assessment tool used to document emerging speech and voice skills in children with cochlear implants. The scale consists of a set of six categories. At the Nottingham Cochlear Implant Programme, the scale is completed based on video recordings and live assessments. Based on the results achieved during application of the SIR, it has been found that children implanted at a preschool stage, will produce intelligible speech within five years after implantation. This data is useful for setting appropriate expectations for those professionals involved in cochlear implant rehabilitation (Lutman et.al, 1996:47).

To complement the observational methods described above, alternative measures of the child's performance and benefit from the implant are obtained through formal questionnaires. The questionnaires are completed by parents and teachers. The Meaningful Auditory

Integration Scale (MAIS) was developed in Indianapolis by Robbins (1990). All parents and teachers complete the MAIS at the Nottingham Cochlear Implant Programme, with the aim of monitoring the child's use and reliance on the implant. Focus is also placed on reliance on audition and increasing ability to attach meaning to sound (Lutman et.al, 1996:48).

Awareness of environmental sounds is one of the major aims of implantation to ensure the safety of the child. Parents are asked to comment on their child's responses to a range of fifty common environmental sounds and the increasing ability to identify these sounds. Completing the questionnaires enables parents to document listening progress when their child may be unable to co-operate with more formal tests (Lutman et.al, 1996:48).

Questionnaires often limit parental responses. Therefore, structured interviews are commonly used in order to allow parents to elaborate more on certain topics. The Nottingham Cochlear Implant Programme makes use of parental interviews prior to implantation, and annually after implantation. The interview investigates information regarding the child's communication skills, spoken language, listening skills for speech and environmental sounds and general behaviour (Lutman et.al, 1996:48).

The Nottingham Cochlear Implant Programme functions according to the principle that the management of paediatric cochlear implant users is an extension of management provided to hearing aid users. Monitoring progress over a period of at least five years after implantation is viewed as a vital part of the programme. Adequate device functioning, identification of problems, and appropriate expectations are set for parents and professionals. A wide range of assessments are used as children are being implanted at a younger age and their linguistic performance varies from preverbal to functional language development. Measures of sound perception, word discrimination, speech production and vocalisations are included in the assessment tools. Many of the assessments used, were specifically developed by the Nottingham Cochlear Implant team due to the heterogeneous population they serve. Results from the Nottingham Cochlear Implant Programme indicate that children implanted below the age of five years, whether congenitally deaf or deafened after a period of normal hearing, will develop spoken language to communicate effectively within a hearing world. In general, this level of spoken language development is reached after approximately five years following implantation (Lutman et.al, 1996:49).

The Children's Hospital of Eastern Ontario in Canada assesses the functioning of cochlear-implanted children by using parent reports and standardised tests. The areas of speech perception, language, general development and psychosocial functioning are assessed. Assessment of language includes articulation (Goldman Fristoe Test of Articulation – second edition), vocabulary (Peabody Picture Vocabulary Test – third edition) and expressive and receptive language (Preschool Language Scale – fourth edition). The parental developmental report is obtained through the Child Development Inventory (CDI). The Eastern Ontario cochlear implant programme therefore focuses on the development of the children from an interdisciplinary perspective, including speech and language, motor skills, cognition and psychosocial functioning (Olds, Fitzpatrick, Durieux-Smith & Schramm, 2004:350).

At the Hospital for Sick Children in Toronto, Canada, audiological and speech and language assessments occur at six and twelve months post-implant, and annually thereafter. Combinations of formal and informal assessments are used in combination with auditory-verbal rehabilitation (Sick Kids, 2004:11-18).

The Alexander Graham Bell Association for the Deaf and Hard of Hearing together with the Cochlear Implant Association, Inc (CIAI) situated in Washington, DC made it possible for cochlear implant programmes to exist in many of the states in America. Therefore, similar approaches are followed at the various cochlear implant programmes in America (Alexander Graham Bell Association for the Deaf and Hard of Hearing; 2005:1).

The primary goal of the cochlear implant programme at the University of Iowa Hospitals in America is to provide clinical services to profoundly hearing-impaired individuals and to conduct research related to cochlear implant efficacy. As many of the cochlear implant recipients do not live in Iowa City, the rehabilitation services provided, were designed for use in the child's home, school or community. The team members, therefore serve as consultants for parents and teachers. The rehabilitation has two main focuses, namely parent-centred intervention and child-centred intervention. Assessment and training occurs for both the parents and the child (Tye-Murray, Spencer, Witt & Bedia, 1996:65).

In the assessment component of the parent intervention programme, the primary caregiver's communication skills and conversation styles are assessed with both a unstructured play session and a sign language test battery, which includes a sixty one sentence expressive test and an open set adaptation of the Carolina Picture Vocabulary Test (Layton & Holmes, 1985). Video recordings are made and transcribed according to the criteria of Fey's Coding System (1986:72). The parent-child interaction video samples are analysed according to the following aspects: mode of communication used, assertive-responsive utterance profile and grammatical measures. Grammatical measures are defined as the total number of words used, the total number of unique words used, the percentage of errors made in sign, type/token ratio, the mean length of utterance in morphemes, bound morphemes, and whether utterances are signed, voiced, or signed and voiced. The results obtained from the analysis provide information about the parent and the child and what adjustments need to be made to the intervention goals (Tye-Murray et.al, 1996:68).

The key to developing a successful intervention plan begins with assessment. Assessment occurs in three key areas during child-centred intervention, i.e. speech production, speech perception and language expression and comprehension (Tye-Murray et.al, 1996:71). Evaluation tools therefore include standardised assessments that evaluate speech perception, expressive and receptive language, vocabulary, basic concepts and communication modality. Informal evaluation methods include language sampling and analysis, probing of functional auditory skills, stimulability of sounds, and the observation of communication repair strategies as well as the documentation of communication preferences. Assessment of speech perception evaluates a child's speech reading skills and recognition of the auditory signal. According to the Iowa Cochlear Implant Programme, three tests are generally included in the speech perception test battery. The Audiovisual Speech Feature Test (Tyler, Fryauf-Bertschy & Kelsay, 1991) assesses how well a child can utilise five consonantal features of articulation (i.e. nasality, voicing, frication, place of articulation and duration) for speech recognition. The Word Intelligibility Picture Identification Test (WIPI) (Ross & Lerman, 1971) assesses a closed set recognition. The Repeated Frame Sentence Test (Tye-Murray, 1993:87-143) assesses the sentence level speech recognition skills. Speech production assessment includes tasks that measure the accuracy of phoneme production, and intelligibility of words, phonemes and narratives. Supra-segmental aspects of speech are also assessed. A phonetic transcription of elicited and spontaneous speech is done. The analyses are then categorised by traditional error analysis, which provides an inventory of the sounds produced, and phonological pattern error analysis, which identifies phonological processes (Tye-Murray et.al, 1996:71).

The Fundamental Speech Skills Test (FSST) (Levitt, Youdelman & Head, 1990) is used to assess breath stream capacity, elementary articulation, pitch control, syllabification, stress and intonation contour. Group data from the Iowa University implanted children, provides a basis for comparison between individual children. The average performance of the children whose implants were done at Iowa University serve as a guide for suggesting therapy goals. The language test battery provides a comprehensive assessment of receptive and expressive semantic and syntactic skills. Spontaneous language sampling analysis is used. A language sample is elicited during a play activity. The sample is video recorded and transcribed using the Systematic Analysis of language Transcripts (SALT) (Miller & Chapman, 1991). A measure of total utterances produced by the child, their type/token ratio, the mean length of utterance (MLU), and how they use questions, negatives, conjunctions, model auxiliary forms and pronouns is also obtained. Information regarding incomplete, unintelligible and non-verbal utterances, number and length of pauses, as well as the rate of speaking, lists and frequencies of word roots and morphemes is obtained from the SALT. Language goals are encouraged through stimulation of language in naturalistic settings during story-telling or during play activities (Tye-Murray et.al, 1996:70). Ongoing assessment is an important part of daily therapy. Continual attention helps to ensure that the quality of services serves as a means by which to measure progress (Boys Town National Research Hospital, 2005:1). Assessment results and suggestions for therapy goals are provided to the school personnel and local speech language therapist. Discussions regarding the children with cochlear implants are often held over the telephone, in order to ensure that everyone involved is informed about the progress or adjustments to the intervention programme (Tye-Murray et.al, 1996:74).

At the Children's Hospital of Philadelphia, in the United States of America, bi-weekly auditory therapy is recommended for each child. Therapy may take place either by team therapists or by other professionals in the school or community. Annual evaluations with the Audiologist, Speech-Language Pathologist and Social Worker document the child's progress and allow for various concerns that become apparent to these professionals, to be addressed (The Children's Hospital of Philadelphia, 1996-2005:1).

The Rainbow Babies and Children's Hospital in Cleveland, USA has an extraordinary paediatric cochlear implant programme. Parents can be sure that their child is receiving the best possible care and most advanced treatment. The paediatric programme includes comprehensive evaluations, individual aural habilitation, education, family support services and surgical collaboration with the specialist doctors post-implant. A "team approach" to care is an important part of the programme (Rainbow Babies and Children's Hospital, 2005:1).

The cochlear implant programme at the University of Virginia in America focuses holistically on the child and his/her family. Long-term support services are provided. Post-operative evaluations include the assessment of speech, language, auditory and cognitive development. The auditory-verbal approach to therapy is applied in rehabilitation (Virginia Health System, 2005:4).

The University of Texas in Dallas in the USA, also has a cochlear implant programme. This university has a team of specialised professionals who provide comprehensive cochlear implant services. An educational and rehabilitation programme that emphasises the development of auditory skills is followed (UT Dallas/Callier Advanced Hearing Research Centre, 2005:1). Evaluation and monitoring of progress occurs on an ongoing basis. In addition to the expertise offered by the professional staff, the child and his/her family play a critical role in optimizing benefit: they do so by maintaining an auditory learning environment at home, fulfilling the home programme goals and updating the staff on the children's performance in the manner in which they engage in daily living activities. Although individual performance outcomes vary widely form child to child, satisfaction with the device is generally high due to the extensive assessment and family counselling programme. The team maintains one philosophical goal, namely maximal use of sound for verbal communication and environmental monitoring (Daniel, 2004:1).

The cochlear implant programme in Arizona, also in the USA functions in a similar way to most of the above-mentioned programmes underway elsewhere in America. A large focus is placed on the rehabilitation post-implant (Mayo Clinic, 2001-2005:2).

The "whole child" philosophy defines the Beth Israel/New York Eye and Ear Cochlear Implant Centre as a model of its type. Ongoing support services enable children with cochlear implants to develop normal speech and language skills and to succeed in complex acoustic environments. Services include diagnosis and therapies including auditory-verbal/auditory-oral therapy for auditory processing disorders and educational consultation. Speech-Language Pathologists evaluate speech, language and hearing skills for infants and children and they provide speech, language and hearing therapy to children both pre- and post-implant. The centre also offers the only comprehensive, hospital-based bilingual programme (Spanish or English services are provided) for communication disorders in the New York metropolitan area (The Beth Israel/New York Eye and Ear Cochlear Implant Centre, 2005:1).

The University of Michigan Cochlear Implant Programme aims to provide extensive support services post-implant to the children and their families. Audiological monitoring occurs to ensure optimal device use. Evaluation of speech perception abilities are completed in conjunction with speech and language assessments to ensure proper device functioning and to monitor a child's performance. Progress is measured annually through interval evaluations with the Speech-Language Pathologist and Audiologist. During these evaluations, a child's speech recognition abilities, speech intelligibility and language abilities are formally re-assessed through the administration of various speech perception and speech-language measures. The re-assessment of a child's skills occurs after the first six months post-implant and annually thereafter. The purpose of these evaluations is to monitor a child's performance over time and to provide the family and educational staff with recommendations. Monitoring is also essential in order to ensure device functioning and to provide the Audiologist with feedback regarding possible audiological needs. Additionally, the auditory-verbal approach to therapy is followed (University of Michigan Health System, 2005:2-7).

The Montepellier Paediatric Cochlear Implant Programme in France began in 1989. Their main emphasis is on selecting children below the age of five years for implantation. Assessments take place every three months for the first year, at six-month intervals for the next two years, and annually thereafter. The assessment results, form a picture showing the child's progress and is used to adapt the rehabilitation approach (Sillon, Vieu, Piron, Rougier, Broche, Artieres-Reuillard, Mondain & Uziel, 1996:83). Video analysis is an important part of monitoring the progress of children implanted at a young age (Tait, 1994:234).

The Montepellier children's test battery assesses two main areas, namely speech perception and speech production. The following tests are used to assess speech perception: Perception of nonsense syllables (closed set) using high and low frequency syllables; discrimination of duration (closed set); discrimination of pitch and onomatopoeic words (closed set) using three different animal sounds; syllable rhythm identification (closed set); identification of words (closed set); identification of sentences (closed set); integration of visual and auditory input test or lip reading (closed set) using phonetic discrimination between two monosyllabic words; recognition of short sentences in everyday life (open set); recognition of monosyllable words test (open set); speech tracking (open set) using short stories from picture books and environmental sounds (open set). Tests of speech production include onomatopoeic imitation using everyday life sounds, repetition of words using mono-, bi- or tri-syllabic words and repetition of short sentences. General data is obtained from a questionnaire given to the caregivers to complete. It contains valuable information about the child's use of the implant, their reaction to sound and their general behaviour since the implant. Results from the above-mentioned test battery together with the questionnaire completed by the caregivers and analysis of the video recordings are used at each assessment interval at the Montepellier Cochlear Implant Programme. The psychological impact shown by cochlear implant recipients is believed to be an important aspect of the assessments. The psychological data is collected in an informal way through contact with the family, the child's teachers and the observation of the children themselves. At Montepellier, working in close collaboration with a team is of the utmost importance. The team consists of two otologic surgeons, three speech therapists and audiologists, an electrophysiologist and a psychologist. Radiologists are involved to rule out any morphologic abnormalities during the selection process. Local teachers and rehabilitation members are all seen as valuable members of the Montepellier Cochlear Implant Programme (Sillon, et.al, 1996: 83-100).

The cochlear implant programme at Avicenne's Hospital in Bobigny in France emphasises the importance of evaluation protocols for device adjustments and to adapt the training from observed results. Comparing pre- and post-operative results also provides valuable information about the effectiveness of the rehabilitation programme, and more importantly, this includes the comparison of scores with normal-hearing children of the same age. The assessment protocol assesses four main areas (for children under 6 years): comprehension, auditory perception, expressive abilities and behaviour (Fugain, Ouayoun, Monneron & Chouard, 1996:300).

The evaluation of language reception consists of the following categories: knowledge of body parts, colour recognition, space notion (where?), quantity notion (how much?), property notion (whom?), tactile notion (soft or rough), word identification using objects and pictures, recognition of simple commands (from pictures) and complex sentence recognition (using pictures as clues). Furthermore, visual cues such as lip reading are permitted during the evaluation of comprehension abilities (Borel-Maisonny, 1967; Lege & Dague, 1978; Fugain et.al, 1996:307).

Visual cues such as lip reading are not permitted during the evaluation of auditory perception. The test material includes an alerting function, i.e. reaction to sound, sound localisation, noise/no noise, voice/no voice and familiar sounds (rings, voice, engine, etc.); intensity differentiation (tape-recorded familiar sounds and synthesiser-produced sounds); prosodic identification (live-voice and synthesiser-produced); pitch reproduction (live-voice); intonation differentiation (live-voice and tape-recorded materials); and phonetic differentiation using simple and complex sentences, vowels and consonants (Fugain et.al, 1996:307).

Language expression is evaluated by comparing the child with a cochlear implant with children that have normal hearing and are in a similar age group (Fugain, et.al, 1996:308). The scores obtained are variable and range between one and five months for early language skills, to four years, where functional language abilities are present (Chouard & McLeod, 1973:12-58; Lafon, 1966:57-61).

The quality of cochlear implant effectiveness is evident in behavioural and interpersonal relationships, and therefore psychosocial issues are seen as an important aspect in the rehabilitation programme. Questionnaires, interviews and subjective observations are used to elicit information from all the team members involved. Aspects such as communication attitude (pleasure or disinterest in communication), mode of communication (oral, sign or mixed) and parent-child interaction are considered. The quality of the communication is also considered, whereby adjustments are made to the intervention goals if necessary (Fugain et.al, 1996:307).

The main aim of the cochlear implant programme at Avicenne's Hospital in Bobigny is to "provide speech communication that is as close as possible to the communication of normal-hearing individuals" (Fugain et.al, 1996:309). It is also vital to establish close relationships with the child and parents to ensure follow-up contact and progress monitoring (Fugain et.al, 1996:309).

In Sweden, the Cochlear Implant Programme in Stockholm uses a battery of assessments for pre- and post-operative evaluation. The speech perception assessments used include the three-digit test, consonant confusions, vowel confusions, everyday sentences, spondee words and speech tracking. The Raven's Progressive Matrices (Raven, J.C., Court & Raven, J., 1986) is used to obtain an idea of the patient's intellectual resources. The Westrin Intelligence Test III (Westrin, 1966) is used to measure verbal capability. A personality questionnaire is completed to determine the cochlear implant candidate's likelihood to benefit from the training programme. The training programme consists of three days intensive training and home training programmes are provided. One-day training done on a monthly basis is provided, if necessary. Assessments occur at six months, one year and two years post-implant (Cook, 1991:242).

Research at the Stockholm Cochlear Implant Programme indicates that a formal training programme, individually tailored to each child's needs and abilities, in combination with monitored practical usage helps implanted children increase their self-confidence, adapt to their new artificial hearing and more rapidly obtain the maximum possible benefit from their implants (Cook, 1991:240). Other cochlear implant programmes in Sweden focus on bilingualism (sign language and oral/aural approach) and sees sign language as an important part of the rehabilitation process (Bredberg & Martony, 1996:289).

The cochlear implant programme at the Hospital of Basal in Zurich, Switzerland approaches rehabilitation with an emphasis on educational and audiological issues. "The ultimate goal is to provide a service that help the cochlear implant user become integrated into a hearing community" (Muller, Allum, D.J. & Allum, H.J., 1996:102). The centre strives to improve continual support systems or services that must take place outside the programme. A part of the in-service care is the assessment of how the child uses the information sent through the implants. Post-operative evaluations of a variety of commonly assessed auditory skills for children are conducted (Boothroyd, 1991:67-72; Reid & Lehnhardt, 1993:241-247; Archbold, 1994:197-213; Allum, 1995:23-24). In terms of the network service, selected educators are trained in the method of assessment administration and they are able to co-ordinate with the testing done in hospital. The final interpretation of the data takes place within the cochlear implant programme at the hospital in conjunction with the rehabilitation counsellor (Muller, et.al, 1996:102).

The Melbourne post-operative programme for children with cochlear implants targets children under five years and encourages the oral/aural communication option for young cochlear-implanted children. The aims of a rehabilitation programme become more complex for a child receiving a cochlear implant. The device needs to provide speech perception abilities to facilitate the development of the entire linguistic system, to develop a range of speech sounds, to enable speech monitoring via auditory feedback and to access the shared knowledge available in the world. The rehabilitation programme is divided into five components. Medicals take place monthly for the first six months and then at least every six months thereafter. Programming of the speech processor occurs on a weekly basis for the first month, monthly for the next six months and every six months thereafter. The habilitation component consists of learning language through listening, developing speech sounds and self-monitoring, guidance to parents to optimise listening and consultation with the other professionals involved. The assessment component consists of sound detection/sound imitation performed on a daily basis, video analysis of parent-child interaction performed monthly and speech perception testing and speech and language analysis done every six or twelve months. Technical support is also provided to complete minor repairs, provide spare parts, and to guide parents in checking and maintaining the speech processor and headset on a daily basis (Dettman, Barker, Rance, Dowell, Galvin, Sarant, Cowan, Skok, Hollow, Larrat & Clark, 1996:149).

The rehabilitation cochlear implant programme at the III ENT Clinic of Rome University in Italy focuses on speech-language therapy sessions for speech, language and listening development. Monthly video-recorded sessions are made in order to provide parent guidance and to monitor the child's progress (Tait, 1993:378). The rehabilitation process, even though based on well-defined procedures, must be flexible enough to adjust to the various needs of the individual, and should also consider the social and cultural environment in which the individual interacts (Bosco, Ballantyne & Argir, 1996:195).

The Cochlear Implant Centre in Hannover, Germany follows a twelve-week rehabilitation programme that involves the child who has undergone a cochlear implant and his/her parents. The programme can be completed within two years, depending on the scheduling. The programme involves special hearing training and the development of spoken language and communication skills. The child's cognitive, emotional and social development is also incorporated in the programme. Additionally, the children also receive rhythm and movement training. The Cochlear Implant Centre serves as a link between the local teachers and therapists, and the parents as the teachers/therapists are expected to attend discussions and training sessions to ensure ongoing auditory rehabilitation of the children with cochlear implants. No emphasis is placed on the role of assessment and monitoring of progress, and the centre does not seem to use a standard assessment protocol to assess the children with cochlear implants post-operatively on an annual basis. However, ongoing assessment of the achievement of short-term goals occurs during the training sessions, to ensure that the long-term goal of functional spoken language and development of articulation skills is achieved. The ongoing assessment results bring immediate changes to the rehabilitation programme. The mission of the Cochlear Implant Centre is to provide holistic treatment and real-world experiences for each implanted child. The programme strives to provide special support for the children, parents, teachers and other individuals involved. Cochlear implantation is only the initial step to a new world of sound. The centre has an ongoing programme that continues to provide information and services to cochlear implant users and their families, and ensures that a life-time of support is available (Bertram, 1996:58).

The Vienna cochlear implant programme in Austria offers post-operative rehabilitation once or twice weekly for auditory, speech reading and communication training. According to the literature that pertains to the Vienna cochlear implant programme, no emphasis is placed on assessments for the monitoring of progress. This could lead to a problem on providing feedback to parents and professionals. (Eisenwort, Baumgartner, Willinger & Gstöttner, 1996:245).

Cochlear implant programmes in Europe (e.g. Spain, Greece, Denmark, Norway, Poland, Finland, etc.) belong to the European Association for Cochlear Implant users and these countries all follow a similar approach. Literature indicates that very little emphasis is placed on post-implant assessment and progress monitoring using tried-and-tested assessment protocols (EURO-CIU, 1995-2005:1-2).

It is clear that the European Cochlear Implant Programmes follow intense language and auditory training programmes. However, little emphasis is placed on the use of assessment protocols on an annual or bi-annual basis. Ongoing assessments at each training session are used, whereby immediate adjustments can be made in order to reach their long-term goals. Ongoing assessments are often very valuable in young children to determine change in their behaviour and to identify subtle progress made (Nelson, 1998:235). Therefore, although tried-and-tested assessment protocols are not a focus, monitoring progress remains an important aspect of the rehabilitation programme.

The Iran Cochlear Implant Centre values post-operative evaluations. Regular speech perception and speech-language skills assessments are an important part of the post-operative follow-up, as it allows monitoring of the user's performance and progress over time, which can be compared to pre-operative levels. Specific error patterns obtained in different assessments may identify a need for remapping or replacement of faulty external equipment. Results are used to target specific intervention required for habilitation or educational purposes (Iran Cochlear Implant Centre, 2005:2).

The cochlear implant programme at the Magrabi Eye and Ear Hospital in Dubai offers cochlear implant surgery followed up by a rigorous programme, which includes audiology sessions followed by speech therapy. Rehabilitation is provided in Arabic, English as well as French (Stensgaard, 2003:1).

Research has proven that the success of a cochlear implant not only depends on the device itself, but also on good patient selection, superior surgical skills and well-monitored post-surgical rehabilitation (Tye-Murray, 2004:726). Infrastructure provision is generally less than satisfactory in developing countries (e.g. China, Egypt, Arabic countries, Argentina, Mexico, and Columbia, etc.). A review done of published materials indicates that in the following countries: China, Egypt and Saudi Arabia, patient selection and pre-surgical screening procedures have been standardised for cochlear implants and in many ways these procedures are similar to the standards which have been adopted in many Western countries. However, there are some distinct differences in patient selection criteria. An additional problem is that there is a lack of adequate training for professionals involved in cochlear implant programmes. Therefore, developing countries still receive a large amount of support from established cochlear implant programmes in the United Kingdom and United States of America (Zeng, 1996:5).

It is evident that paediatric cochlear implantation is a complex process that is constantly changing. In order to ensure a comprehensive rehabilitation programme, the cochlear implant programmes must ensure that educational issues are included and managed appropriately.

Chute, Nevins & Parisier (1996:129) believe that "attending to the needs of the whole deaf child, rather than simply the audiological aspects of hearing loss, will result in a comprehensive management plan which emphasizes the importance of monitoring progress and providing educational support by making substantial contributions to the future academic and economic success of these children".

The cochlear implant centres mentioned above follow a multidisciplinary approach, and view the parent involvement as crucial (Allum, 1996:35, 55, 116, 245). Furthermore, the assessment protocols at most of the cochlear implant programmes discussed, include assessments of auditory ability, speech perception, expressive and receptive language, speech production, communication skills and psychosocial issues. A combination of formal and informal assessments, seem to be the trend. It is therefore clear that the general philosophy of holistic treatment and attending to the whole child with a hearing impairment is a key aspect, and the focus on only audiological abilities has shifted in most cochlear implant programmes. As a result, the goals of cochlear implant centres cannot be met without the support of a multifaceted and multi-professional team. It is clear that assessments are an important part of a cochlear implant programme and not one assessment protocol is identical at the different cochlear implant centres mentioned. Assessment protocols need to be specific to the needs of each cochlear implant centre and the population they serve. A universal assessment protocol will not be the answer to monitor progress in young cochlear implanted children.

Ideally cochlear implant centres should be able to select a group of efficient tests to quantify speech perception, recognition and understanding adequately, but in many instances they simply do not exist. This means that the centre will have to select these materials, test children and modify the materials in an evolving process (Müller, et.al, 1996:114). This process serves to validate assessment protocols by making use of a scientific method. Furthermore, the results from the assessment protocols can clearly prove the efficacy of cochlear implantation, and the outcomes and progress can be provided to parents, teachers, medical aids, and other individuals involved.

2.3 SUMMARY

The goal of this chapter was to describe and discuss existing cochlear implant centres, with a focus on post-operative assessments and progress monitoring within the variable cochlear implant programmes. Research indicates that each cochlear implant programme functions in a unique manner, depending on their circumstances, resources and the hearing impaired population they serve. Not one identical assessment protocol is used at the various cochlear implant centres mentioned. It is clear that a universal assessment protocol will not be the solution to monitoring progress in young children with cochlear implants, but rather that unique assessment protocols should meet the needs of each individual centre.

CHAPTER 3

THEORETICAL BACKGROUND: ASSESSMENT OF A YOUNG CHILD IN SOUTH AFRICA

3.1 INTRODUCTION

Assessing young children with cochlear implants is a necessary and fundamental activity for teachers, therapists, and other professionals involved. Assessments can be used to identify children who need further evaluations (screening), or to determine the nature and extent of the difficulties experienced, to determine eligibility for services, to identify the most appropriate placement, to identify goals, therapeutic and instructional strategies, to evaluate the effects of the intervention programme and to monitor effects of instructional programmes (Bailey & Wolery, 1998:18). Another issue is how to best provide assessment and intervention in an environment that is hostile to variable cultures. This topic is discussed and guidelines are provided in order to adapt programmes to meet the demands of a multi-cultural and multi-lingual society (Allum, 1996:XV).

This chapter aims to provide a theoretical background by critically evaluating and interpreting relevant literature on effective assessment of a young child, as well as discussing the cultural and language barriers faced in South Africa.

3.2 ASSESSMENT OF A YOUNG CHILD IN SOUTH AFRICA

Professionals understanding the value of measuring the effects of interventions use one or more objective or subjective outcome measures available. One of the advantages of measuring outcomes is to identify and adopt effective clinical processes and reject ineffective ones. While on the surface, this may seem like a good idea and easy to administer, however it is more difficult than it appears when done in young children (Abrams, 2004:1). Medicine has struggled with the issue of determining the most effective course of treatment for years. There is increasing reliance on Evidence-Based-Practise (EBP) to assist clinicians in making informed decisions when confronted with a particular clinical problem. EBP is described as the “conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients. The practise of evidence-based practise means integrating individual clinical expertise with the best available external evidence from systematic research," (Sackett, Rosenberg, Gray, Haynes & Richardson, 1996:71).

Thus, the rationale for assessment in a hearing impaired preschooler is to gather information essential for decisions about placement and appropriate education planning. Planning determines which individualised service is suited to the particular case; and because children grow and develop, the constantly changing needs of a child and its family mean that evaluation is in effect an ongoing process of assessment to ensure progress and growth in the individual child (Bailey & Wolery, 1998:2).

Assessment methods should be acceptable to all the participants in this process and should therefore be selected and implemented with sensitivity and responsibility. The challenge for all therapists lies in the appropriate choice of assessment materials, in eliciting those behaviours to be evaluated and in obtaining a general overview of the child's strengths and weaknesses as well as current performance status. Thorough assessment involves the observation of a child's current and unique status in order to make fundamental decisions regarding intervention and school placement. As summarized by Umansky and Hooper (1998:341), "assessment is a goal-oriented problem-solving process that utilizes various measures within a theoretical framework". It is a variable process that depends on the questions being asked, the type of problems encountered by the child, and a myriad of social, developmental and contextual factors (Umansky & Hooper, 1998:341).

The most valid and comprehensive assessments of children in the earliest stages of language acquisition are based on multiple methods of data gathering, including observations of communication interactions in multiple contexts with more than one partner. Neisworth and Bagnato (1988:23-50) argues that outcomes are more comprehensive, reliable and valid when based on a multidimensional assessment that employs multiple measures, derives data from multiple sources, surveys multiple domains and fulfils multiple purposes (Nelson, 1998:235).

According to Shipley and McAfee (1998:191), no one method of assessment is better than the other – an appropriate choice of method depends on the client, the circumstances as well as the client's environment. This statement is especially appropriate in the South African context because of our unique circumstances and environment. Assessment presents significant challenges to the therapist during the process of appropriate subsequent intervention. The communication skills of the young child with a hearing loss are affected from the day the child is born. Linguistic, sensory, social and cognitive information is received by the newborn from the environment immediately following birth (Mahshie, et.al, 2006:5). It is also known that early amplification and intervention, is not only essential to the child's development and progress, but without early intervention, the child could experience continued failure and ultimately develop a poor self-concept. Additionally, children with communication deficits are at risk for a deficient spoken language system and this may lead to an inability to use language to aid learning (Butler, 1999:14). The level of linguistic competence ultimately determines academic performance at school level.

Therapists require the ability to interpret the information and choose the applicable intervention strategies and make correct decisions and projections. The emphasis of the assessment will differ depending on the child, the child's history and his/her setting. It is an art to gather and interpret the information received, but the process has to be conducted in a short space of time, as teachers and parents expect prompt feedback on the assessment and need to act on the suggested recommendations (Gerald & Carson, 1990:61). In addition, therapists must also consider the financial constraints, which are currently felt across all sectors of the population. Efficient time management and effective programmes are the essence of accountable practise and outstanding service.

Young children generally have to be evaluated over a period of time, as well as continuously in order to determine progress and change in their behaviour. It is emphasized again that thorough assessment implies affordability, time efficiency and accurate decision-making regarding intervention (Nelson, 1998:235). Assessment must be flexible to accommodate the environments of the child as well as the child's individual needs. Therapists have realized that young children must be assessed within the context of their language acquisition and the assessment must take into account the stimulation that they have been exposed to (Butler, 1999:21). According to Duchan (2000:189), the therapist must obtain answers to the questions regarding the child's problem, "as these answers often lie beyond the walls of the clinician's office and rather in everyday life contexts". Evaluation is often referred to as "dynamic assessment", which implies that the therapist's role is to be that of a neutral observer and to effect change (Gutièrrez-Cellen, 2000:217).

Dynamic assessment evokes a further controversy, namely the use of formal testing versus informal assessment. It is often still common practise to use formal tests as the main tool for assessment. However, most formal tests are not appropriate for the South African context and have limited use. The reason is that many formal tests have been translated, but not standardised for the South African population. In the second place, original formal South African tests have been standardised only for certain cultural groups in the country. Currently the requirements for formal tests are:

- Tests must not contain any racial or cultural bias,
- Tests must be valid for their intended purpose and can only be administered by trained professionals,
- Test procedures should address a variety of educational and developmental needs,
- Tests cannot be the sole contributor to the intervention plan; multidisciplinary contributions are also needed, and
- All educational and developmental areas should be addressed (Umansky & Hooper, 1998:341).

Formal tests are culturally, linguistically and socially biased and not relevant to the South African situation, which is unique and socially very different. Other barriers to assessment are the limitations of our understanding of the manner in which children grow and develop. Norms for various areas of development are available, but there is still a lack of a comprehensive view of the synergism of the developmental process. It is important to keep in mind that tables of norms present a fragmented view and not a picture of the whole child. However, tables of norms do provide valuable information. Developmental norms should be used as guidelines in the assessment process. Globally, there is a lack of appropriate assessment instruments and tests. Assessment is also affected by the child to be evaluated. The performance of the child can be inconsistent, the child might be distractible, or specific environmental and health factors may influence the assessment (Zsilavecz & Naude, 2000:21).

For these reasons, informal assessments have become more popular when assessing a young child. The therapist can observe the child in various contexts and more natural settings over a suitable period of time. The assessment is informal, and done in as natural a setting as possible, and the assessment incorporates various developmental facets. Using informal techniques as well as observation in evaluation does not affect the accountability factor of the assessment. Observation provides the therapist with an appraisal of the child's all round skills. The situation must be non-threatening to the child to ensure that they act normally within their environment and so that an accurate assessment can be made. The aspects mentioned above emphasize that in a "test situation" the child is under pressure, and there is always the underlying urge to get the test done in as short a period of time as possible, and the parents might also feel anxious and unsure. These factors will eventually influence the end product and final findings (Shipley & McAfee, 1998:184). Assessment should therefore always be handled with great sensitivity and care.

The complexity of the challenge is compounded by the fact that in the South African context, therapists work with a diverse population in which communication skills and needs differ substantially; allowance must be made for these variables in the assessment, says Pakendorf (1998:4). In South Africa, children from all cultures are receiving cochlear implants (i.e. Black, Asian, and White). Additionally, many cochlear implant users' first language is not English or Afrikaans, but rather one of the other official South African languages, i.e. Tswana, Zulu, Northern Sotho, Southern Sotho, Xhosa, Swazi, Ndebele, Tsonga, Venda, or one of the eight unofficial languages (Dictionary.LaborLawTalk.com, 2006). For a child that may have several language influences in his/her life, it is important for the clinician to try and get an overview of what language the child knows, i.e. the child may be able to use a second language for conversational interaction; however, this does not mean that the child is able to understand or use the language well enough to participate in the classroom situation or learn new information in a timely manner (Mahshie, et.al, 2006:89). Differentiating between interpersonal and school language is an important aspect of assessing the child's abilities and will probably be achieved through intensive intervention and ongoing evaluations.

The natural approach to assessment involves seven principles that are essential in the assessment process (Brenner 1992, 1993:67):

- Formal to informal;
- Norm-referenced to criterion-referenced;
- Standardised to adaptive;
- Direct to indirect;
- Naturalistic to clinical observation;

- Product orientated to process orientated
- Unidisciplinary to team approach.

During the assessment process, the therapist will use certain principles more than others, but it is recommended that the emphasis be on a naturalistic setting where the therapist observes the child during play. Observation includes sampling of various developmental behaviours, and recording of these behaviours. The recorded information is then made available to all those involved (Zsilavecz & Naude, 2000:23).

The natural setting empowers the therapist to assess different behaviours the child may exhibit, validate formal tests if they were conducted, carry the assessment over to other situations, identify how the child reacts to particular stimuli in the environment and monitor intervention effects on a regular basis (Zsilavecz & Naude, 2000:23).

Bailey and Wolery (1989:11-18) mention seven important characteristics of assessment:

- Important developmental and behavioural facets are included;
- Parents and caregivers are involved;
- It includes the use of various sources and multiple tasks;
- Various disciplines should be involved in a collaborative manner;
- Ecological validity is ensured – that is, considering the child's "strange behaviour in strange circumstances with strange adults";
- Non-discriminatory assessment methods are employed;
- It provides the opportunity for ongoing assessment of the child's progress.

Therapists must therefore reduce cultural bias, and assessments should have salient implications for the intervention plan so that the child can derive the maximum benefit. Consequently, the Pretoria Cochlear Implant Programme compiled an assessment protocol by drawing from various sources (specifically from protocols used in other cochlear implant programmes) to comply by the principles of assessment and to ensure that no bias occurs during the assessment of the population they serve. A vital part of cochlear implant programmes is to evaluate expected changes, which may occur after cochlear implantation. Changes in communication, spoken language skills, educational achievements, social and emotional development are monitored (Archbold, 1994:197).

Many children with cochlear implants are referred to private therapists for intervention; it would be ideal if all speech therapists and audiologists use a similar assessment protocol, because this will help the team to obtain appropriate records for each child and enable researchers to make comparisons (Venter, 2000:90).

Monitoring progress in real life, as well as in a clinical test situation provides a more comprehensive report of a child's functioning, and ensures that the child's parents, therapists and educators are actively involved in the process. There are many areas in which a therapist, teacher or parent can help make certain observations concerning the progress of the child as they spend more time with the child compared to the members of the cochlear implant programme (Venter, 2000:90).

Many prescribed evaluation tools are available to assess the speech production and language skills of hearing-impaired children. Formal tests of phonetic repertoire, articulation, speech intelligibility, receptive and expressive language, vocabulary and other speech and language skills are commonly used. However, these assessments are not only indicative when candidacy of a child is to be decided, but the results can be used as baseline information for further post-operative assessments. The linguistic needs of children are also determined in order to provide realistic expectations regarding the outcomes of cochlear implantation to the parents. On the other hand, many of these tests are time intensive and provide limited useful information in terms of clinical management functions and in some instances the information has had to be discarded (Clark, Cowan & Dowell, 1997:89).

The major issue highlighted is that for speech therapists and audiologists to ensure effective and efficient evaluations, better assessments are required. A systemic and systematic assessment battery is needed in which the information gained from questionnaires, observations, informal assessments and formal assessments can be related to each other and to the intervention process. As the child's natural environment is incorporated into the intervention procedure, other types of assessments are needed, such as a standard method of assessing the child's communicative environment, to determine how well it provides the type of input that is specifically required for the child. Guidelines for making predictive statements should be produced in order to monitor the effectiveness of therapy. Therefore, an assessment tool should not only consider normative information, but should also consider the rate of development. This will ensure that objective; predictive statements can be made (Gerald & Carson, 1990:74).

To provide more relevant information and to overcome the barriers of assessment in young children, naturalistic sampling of interactive play has begun to replace many of the formal tests. Video-recorded samples can be structured to provide maximum opportunities for meaningful interactions. Analysis of such conversational samples can provide direct information about problems in a communicative context, which can be used within habilitation programmes. Therefore, assessments are important in establishing the goals of habilitation programmes both pre- and post-operatively (Cummings, 1997:4).

As young children with cochlear implants may have little or no spoken language and few of the communication skills that form the precursors of speech and language development, assessment can be a daunting task. Not many assessment measures exist for children who are often unable to carry out the simplest imitative task, but there are certain general observations that are crucial to monitoring the progress of a young child. The first changes noticed in child who has received a cochlear implant, is usually behavioural, i.e. often these children seem less frustrated or anxious, because they are more in touch with the hearing world. Negative behaviour changes may indicate a problem with the device or its settings, or possible emotional problems while adapting to the implant. The second observation has indicated that there are changes in listening skills, as the child gradually starts to hear more sounds (environmental sounds and speech). Negative changes in listening skills usually indicate the need for a map. Change in the child's voice quality can also alert the people involved that the map needs fine-tuning. Changes in speech abilities are also a good indicator on how the device is functioning. Speech may become unintelligible or children may lose speech sounds that were previously used consistently. The final aspect that can indicate a problem is the child's dependence on lip reading. Sudden dependence on lip reading could indicate a problem (Venter, 2000:90).

Assessment of speech perception in the paediatric population is important for several reasons. First, results on speech perception measures help to determine whether a child is benefiting from a cochlear implant. Secondly, follow-up assessments help track performance over time. Lastly, speech perception data in combination with speech and language outcomes are essential for establishing guidelines for habilitation. A number of factors must be taken into account when assessing speech perception in young children. These include a combination of the child, task, tester and environmental influences on test outcomes (Boothroyd, 2004:292-295). Child factors include the state of the child during testing, such as their attentiveness to the task. Moreover, children must demonstrate the requisite motor skills to perform the response task being asked of them (e.g. head turn, manipulation of objects, picture pointing, pushing a button), as well as the phonological, receptive and expressive language skills needed to participate in speech perception testing. Tester and environmental factors include the audiologist's aptitude to work with the paediatric hearing-impaired population, the feel of the facility, and caregiver attitudes and behaviours (Eisenberg, Johnson & Martinez, 2005:1).

Assessing speech understanding in the presence of competition or background noise also expands the options used in speech perception testing – as does testing under multimodal conditions (auditory-only, visual-only, and auditory-visual). With regard to the type of administration, live-voice affords the clinician greater efficiency and flexibility than the use of recorded stimuli, particularly when working with young children. However, inter-talker variability makes it difficult to compare results obtained with live voice across different clinicians, let alone paediatric centres. Use of recorded stimuli provides greater consistency in signal delivery across test sessions and test centres (Eisenberg et.al, 2005:2).

An attempt to monitor progress by enforced repetition of specific sounds disrupts the normal patterns of adult-child interaction and may not give an accurate representation of the child's progress (Archbold, 1994:198). It is therefore necessary to use different assessments to obtain a progress profile of the child. Repeating the same assessment protocols over time allows therapists to monitor the progress of a young child with a cochlear implant. Monitoring progress over a period of at least five years after implantation ensures adequate device performance, identifies problems and sets suitable expectations for parents and local professionals (Cummings, 1997:11).

By taking into account the principles of assessing a preschooler, the natural approach to assessment, the unique South African context and guidelines from assessment at other cochlear implant programmes, the Pretoria Cochlear Implant Programme developed a protocol to assess a young child with a cochlear implant within their programme.

The assessment protocol consists of informal measures, checklists and one formal assessment for receptive language. All aspects of development must be addressed, but the most important aspect is the child's listening progress. To monitor the child's auditory ability, two assessments are suggested:

- *Aided sound field audiometry* to obtain pure tone thresholds between 125 and 8000Hz, *speech discrimination* abilities and *Speech in Noise* abilities. As most hearing-impaired children have limited speech abilities and their speech is often unintelligible, it may be necessary to discriminate between common objects as in the Toy Discrimination Test (McCormick, 1994:81).
- Although aided sound field audiometry gives a measure of sensitivity (the ability to detect an auditory signal through the implant), there is also a need to measure the child's developing ability to listen and interpret the signal. A child who is suitable for implantation would have been unable to respond to spoken language presented auditorily in conversational settings. The pattern of social interaction in which a child develops the precursors to language may have been disrupted. Following implantation, the child should be able to respond to auditory stimuli within the familiar, repetitive settings that are found to promote linguistic skills. Consequently the *Developmental Assessment Schema (auditory ability)* is a checklist used to monitor a child's response to auditory stimuli (environmental and speech) and listening progress within his/her home or school environment.

As parents and teachers know the children best, it makes sense to involve them in the assessment process. Questionnaires about the children's listening and spoken language progress are included in the protocol. The *Meaning Auditory Integration Scale (MAIS)* is used to monitor a child's use of and reliance on the implant and focuses on the dependence on audition and increasing ability to attach meaning to sound. Parents and teachers are asked to respond to questions about the child's wearing of the device, awareness of environmental sounds and ability to deduce more subtle meaning from sound (Robbins, 1990:361-370). The *Meaningful Use of Speech (MUSS)* is a scale given to parents and teachers to respond to questions about the child's vocal control, communication and the child's use of speech (Robins & Osberger, 1991).

In a natural approach to assessment, less direct techniques of assessment are required. Progress towards the understanding and use of spoken language through audition can be predicted before implantation, and relevant research in this area can be performed through video analysis (Tait, 1993). Vocal turn-taking, vocal autonomy and non-looking turns in particular are sensitive indicators regarding the use of the implant system. Video recordings of each child interacting with an adult made at regular intervals, will enable the monitoring of small changes over time in conversational turn-taking and auditory processing. Auditory awareness and processing skills can also be monitored through video analysis, which allows one to observe how a child reacts to speech when not looking at the speaker. "The analysis provides objective evidence, before children are able to undertake formal speech and language evaluations, that there is, or there is not, progress in the preverbal skills which are the prerequisite of spoken language" (Tait, 1994:235). Video recordings allow for repeated viewing for in-depth analysis and these recordings provide a more complete picture of communication than formal assessments. Research has indicated that the use of meaningful contexts, familiar settings, non-contrived situations, and age-appropriate motivating activities will result in more representative communication samples (Cummings, 1997:4; Venter, 2000:93).

Video analysis of parent-child interaction and therapist-child interaction was included in the protocol. Before starting with specific assessments it is always appropriate to obtain an idea of the child's general development. For this purpose, the *Developmental Assessment Schema (DAS)* and *Rossetti Infant-Toddler Language Scale* (Anderson, Nelson & Fowler, 1978; Rossetti, 1990:196) were included in the protocol. The *Voice Skills Assessment* (VSA) battery can also be completed as part of a video sample analysis to highlight specific prosodic strengths or difficulties (Dyar, 1994:257). The *Speech Intelligibility Rating* (SIR) form can be used to rate speech intelligibility during the video analysis (Dyar, 1994:258). The *Profile of Actual Linguistic Skills* (PALS) completed during the video analysis can serve as a cross-check for the other checklists and questionnaires completed, to assess effectiveness of spoken language abilities (Dyar, 2003).

A formal measure of receptive language, the *Reynell Developmental Language Scales III* (Verbal Comprehension) is included in the protocol (Edwards, Fletcher, Garman, Hughes, Letts & Sinkra, 1997). Many programmes, such as the Nottingham Cochlear Implant

Programme and the University of Stellenbosch/Tygerberg Hospital Cochlear Implant Programme include this assessment in their protocol.

As previously discussed, assessment protocols should include three key areas, i.e. speech perception, speech production, communication and language development (Tye-Murray, et.al, 1996:71). Furthermore, assessment protocols should be selected according to the child's linguistic status, i.e. preverbal, transitional or functional language development (Dyar, 2003). Hence, the proposed assessment protocol can be organised as follows for children with cochlear implants in the transitional stage of linguistic development:

Table 3.1 Proposed assessment protocol for children with cochlear implants in the transitional stage of linguistic development

Speech perception	Communication and language development	Speech production development
Aided sound field audiometry Speech discrimination Speech in Noise MAIS MUSS	PALS Video-analysis Rossetti Infant Toddler Language Scale Reynell Developmental Language Scales III (Verbal comprehension) Preschool Literacy Assessment	SIR VSA PALS

The Pretoria Cochlear Implant Programme included quantitative (Reynell Developmental Language Scales III) and qualitative (MAIS, MUSS, DAS, Rossetti-Infant Toddler Language Scale, Preschool Literacy Assessment, SIR, VSA, and PALS) measures in order to facilitate the descriptions of the communication interactions and general progress of a young cochlear implant user. The protocol also ensures that the principle of the whole deaf child is applied, by evaluating all aspects that could interfere with optimal communication and spoken language development.

3.3 CONCLUSIONS

From the preceding overview on the assessment of a young child in South Africa, certain implications for research can be deduced and implemented in the current study. Firstly, it was confirmed that assessment is an empirical part of a cochlear implant programme. Secondly, all the participants involved should accept the assessments and implement them with sensitivity and responsibility. Thirdly, a battery of tests was suggested in order to obtain an accurate overview of a child's abilities. Assessments in multiple contexts are also vital, as children may feel threatened in a test situation, resulting in inaccurate assumptions regarding their abilities. Young children generally have to be evaluated over a period of time as well as continuously in order to determine progress and changes in their behaviour.

Lastly, the dynamic and natural approach to assessment commonly used in young children implies that informal assessments in naturalistic settings, provides the most accurate and unbiased results.

By taking into account the principles of assessing a young child, the natural and dynamic approach to assessment, the multi-lingual and multi-cultural South African context, and guidelines from assessment protocols used at other cochlear implant centres, the Pretoria Cochlear Implant Programme proposed an assessment protocol for young cochlear implant users which applies in particular to their context.

3.4 SUMMARY

This chapter aimed to describe and discuss issues relating to assessment of a young child within the challenging South African context. This was followed by a discussion of the dynamic and natural approach to assessment, which implies the use of informal assessments in naturalistic settings. Outlining the type of assessments included and areas assessed, as well as providing rationales for the various assessments included in the protocol explained the assessment protocol proposed by the Pretoria Cochlear Implant Programme.

CHAPTER 4

RESEARCH METHODOLOGY

4.1 INTRODUCTION

It is evident from the previous three chapters that post-operative assessments and outcome measurements form a vital part of a cochlear implant programme. It was illustrated that although post-operative assessments are common at most cochlear implant centres; a universal assessment protocol does not exist and would not be feasible. It has been theoretically suggested that an assessment protocol specific to the needs of a cochlear implant centre, would be most effective during for the assessment of progress in young children with cochlear implants.

The purpose of this chapter is to describe the research method implemented during the current study. The research method was compiled to meet the theoretical and critical needs previously identified as essential during the monitoring of progress in young children with cochlear implants. The assessment protocol designed by the Pretoria Cochlear Implant Programme was administered on young children in the transitional stage of language development, to determine if the protocol meets the theoretical and clinical needs of the Pretoria Cochlear Implant Programme.

4.2 MAIN AIM

The aim of this research is to determine the clinical relevance of an assessment protocol designed by the Pretoria University Cochlear Implant Team.

As this aim represents a complex problem incorporating a variety of facets to be investigated, it is necessary to formulate a number of sub-aims through which the main aim can be realized.

4.3 SUB-AIMS

4.3.1 To establish what type of results are obtained from the different assessment areas within the protocol, in order to determine if over- or under-evaluation is occurring.

4.3.2 To critically evaluate and describe the type of information gained from the proposed assessment protocol.

4.3.3 To determine the duration for administering and interpreting the assessment protocol.

4.3.4 To determine the cultural and language barriers affecting the administration and interpretation of the assessment protocol.

4.3.5 To establish the value of the assessment protocol by critically evaluating the protocol, in an inclusive educational setting.

4.4 RESEARCH DESIGN

The goal of descriptive research is to seek accurate observations, which focuses on the validity (accuracy) and reliability (consistency) of the observations (Terre Blanche & Durrheim, 1999:40). This study will therefore be descriptive in nature, as it aims to describe the information gained from the assessment protocol, and to determine the relevance of the protocol.

Descriptive studies are usually qualitative in nature and they aim to provide an in-depth description of a small number of cases (Mouton, 2001:149). For this study, the researcher aims to determine the relevance and to refine an assessment protocol proposed by the Pretoria Cochlear Implant Programme, by administering the protocol on a small number of subjects. The strengths of this type of research are high validity, in-depth insights and the establishment of rapport with the research subjects (Mouton, 2001:150).

Due to the heterogeneity of the hearing-impaired population, certain limitations exist in the research design, which may result in lack of generalisability of the results, and data collection and analysis can be extremely time-consuming (Mouton, 2001:150).

4.5 SAMPLE

4.5.1 Selection criteria

The following criteria for subject selection were chosen in order to decrease the amount of variables between the subjects, and to increase the reliability (i.e. dependability or consistency) and the validity (i.e. truthfulness, how well an idea "fits" with reality) of the research study (Neuman, 2006:188):

- The subjects must be fitted with bimodal amplification, i.e. unilateral cochlear implants and contralateral behind-the-ear hearing aids.
- The subjects must be in the transitional stage of speech and language acquisition, as determined by the therapists and teachers at the school. The Profile of Actual Linguistic Skills (PALS) Individual Profile checklist containing the characteristics of the different stages of linguistic development (refer to Appendix C) was be provided to the teachers and therapists (Allen & Dyar, 1997:127-128). Children between the age of 3 and 7 years were targeted.
- The subjects must be registered students in the selected school, to ensure that all the subjects are day scholars in an inclusive educational setting. Additionally all subjects receive daily individual conversation sessions and all parents receive parent guidance. The context is critical in qualitative research to ensure that all the factors, which may influence the results, are taken into account during the assessment.
- The subjects must have been mapped within three to four weeks prior to the assessment to ensure that their cochlear implant is functioning optimally.
- The subjects must come from different cultural backgrounds, so that the effect of cultural and language diversity can be examined.
- The subjects must be able to speak either English or Afrikaans.

- The subject's parents must be able to speak, understand and read English and/or Afrikaans.
- The subjects must have no additional physical or cognitive handicaps.

4.5.2 Sample size and selection procedure

Eight children with bimodal amplification were used as subjects for this study. As this study is more concerned with detailed and an in-depth analysis, purposeful (i.e. non-random) sampling was followed for the selection of the subjects. The subjects were selected in a predetermined group at the school, once the researcher had contacted the teachers and therapists (Terre Blanche & Durrheim, 1999:45; Neuman, 1997:205). The Profile of Actual Linguistic Skills (PALS) individual profile checklist containing the characteristics of the different stages of linguistic development was provided to the teachers and therapists in order to determine who the possible candidates for the study were (Allen & Dyar, 1997:127-128). This sample is characteristic of qualitative research, as the researcher gathered a larger amount of information on a few cases, went into greater depth, and got more details on the cases being examined (Neuman, 1997:331).

4.5.2 Description of the sample

Table 4.1 explains the description of the subjects. The backgrounds of the subjects are also discussed in detail in 5.5.1.

Table 4.1: Description of the sample

Number of subjects	8
Age	3-7 years
Stage of linguistic development	Transitional stage
School	Inclusive educational setting
Cultural background	Variable (1 Black, 2 Asian and 5 White)
First languages	English, Afrikaans, Sotho
Hearing status	Fitted with a cochlear implant and a contralateral hearing aid (bimodal amplification).
Type of hearing aids	Contralateral behind-the-ear digital hearing aids
Cochlear implant make	Nucleus Cochlear Implant
Onset of hearing impairment	Congenital
Causes of hearing impairment	Unknown causes Hereditary Complications during pregnancy/birth (prematurity) Wardenburg syndrome (Type 1) – only symptom is bilateral sensori-neural hearing loss
Age at implantation	2-years, 8-months to 5-years, 3-months
Duration of cochlear implant use	10-months to 3-years, 9-months
Additional handicaps	None
Hearing status of parents	Normal hearing for seven of the subjects Hearing impaired parents for one the subjects

4.6 APPARATUS AND MATERIAL

4.6.1 Apparatus for subject selection

- The **Profile of Actual Linguistic Skills (PALS) Individual Profile** checklist (refer to Appendix C) containing the characteristics of the different stages of linguistic development was provided to the teachers and therapists in order to determine who the possible candidates for the study were.

4.6.2 Apparatus for data collection and recording

- A **Heine-Minilux 2000 otoscope** was used to administer the otoscopic investigation.
- A **Grason-Stadler Tympstar (version 2) Middle Ear Analyser** (calibrated in February 2004) was used to conduct tympanometry in order to measure middle ear functioning. Appropriately sized probes were used for each subject.

- A **Grason-Stadler (GSI-61) audiometer** (calibrated in February 2004) was used to determine aided pure-tone thresholds, speech discrimination and Speech in Noise measurements.
- **Grason-Stadler speakers** in the soundproof room were used for administering pure tone and speech measurements.
- A **soundproof room** of the *Industrial Acoustic Corporation* was used to ensure a silent environment while testing.
- The communication assessment and parent-child interaction was recorded on VHS videotape.
- A VHS video recorder was used to record the communication assessment and parent-child interaction.

4.6.3 Material for data collection and recording

- A **questionnaire** and **cochlear implant form** (refer to Appendix C) was used to collect a case history about the subjects. Medical, developmental and otological history is included in the questionnaire.
- The **MAIS** (Meaningful Auditory Integration Scale) and **MUSS** (Meaningful Use of Speech) questionnaires (refer to Appendix C) were given to the parents and teachers of the subjects to complete.
- The **MICS** (Mother Infant Communication Screening), **Caregiver-Child Interaction**, **Rossetti Infant-Toddler Language Scale**, **DAS** (Developmental Assessment Schema) – **General Development**, **Reynell Developmental Language Scales III - Verbal Comprehension**, **PALS** (The Profile of Actual Linguistic Skills), **DAS** (Developmental Assessment Schema) - **Auditory Ability, SIR** (Speech Intelligibility Rating) and **VSA** (Voice Skills Assessment) was completed by the researcher while interacting with the subject, during teacher interviews and observation of the child, and after viewing the video recording of parent-child intercation (refer to Appendix C).
- The **Preschool Literacy Assessment** (refer to Appendix C) was completed after viewing the video recording of parent-child interaction and therapist-child interaction.
- **Paper towel** and **Milton** was used to sterilize the immittance probes before and after use.

- An **audiogram** (refer to Appendix C) compiled by the University of Pretoria: Communication Pathology Department was used to record the otoscopic, immittance, pure tone and speech measurement results.
- **Discrimination Word Lists for Children 3-5 Years** (Hirsh Davis, Silverman, Reynolds, Eldert & Benson, 1952) in English (refer to Appendix C) and "**Foneties Gebalanseerde Woordelyste vir Kinders 3 tot 5 jaar"** (Laubscher & Tesner, 1966) in Afrikaans (refer to Appendix C) (depending on the subject's language preference), was used to determine the speech discrimination and Speech in Noise abilities of the subjects. Common objects or pictures of common objects were used if the subject's speech was unintelligible, or if the subject experienced difficulties during the speech discrimination and Speech in Noise assessment.

4.7 DATA COLLECTION AND DATA RECORDING PROCEDURES

For the aim of this research study, the proposed assessment protocol was applied on the subjects on one occasion only.

4.7.1 Questionnaire and cochlear implant form

A background questionnaire including the medical, developmental and audiological history of each subject was completed by his or her parents (refer to Appendix C).

4.7.2 Parent and teacher feedback

The MAIS (Robbins, 1990:361-370) and MUSS scales (Robbins & Osberger, 1991) provide information about the child's use of auditory information in everyday situations as well as the use of meaningful speech, including voice control, production of speech-like sounds and communication strategy (refer to Appendix C). The MAIS and MUSS questionnaires were completed by the parents and teachers and scored by the researcher. The MAIS was scored by obtaining totals for the following three sections: (1) the reliance on using the speech processor, (2) alerting to sound and (3) attaching meaning to sound, and an overall score out of 40 was attained by adding the totals of the three sections. Similarly, the MUSS was scored by obtaining totals for the following three sections: (1) voice control, (2) speech sounds and (3) communication strategy, and an overall score out of 40, was attained by adding the totals of the three sections.

4.7.3 Communication assessment and parent-child interaction

A video recording was made while the child interacts with the parents and therapist in order to complete the following assessments:

- The Mother Infant Communication Screening (MICS) (Raack, 1989) and Caregiver-Child Interaction (Louw & Kritzinger, 2000) tests were used to determine the overall communication abilities of the subjects and quality of the parent-child interaction (refer to Appendix C). A ten-minute video recording was made while the child interacts with a parent during a book reading activity. The middle five minutes of the video was analysed by the researcher in order to complete the above parent-child interaction profiles. The MICS was scored by obtaining totals for the following sections: (1) Language and Synchrony, (2) Distress, (3) Feeding, (4) Play/Neutral State. These four sections were added up to obtain a total average score. The Caregiver-Child Interaction was totalled to obtain a score out of 40.
- The Rossetti-Infant Toddler Language Scale (refer to Appendix C) was used to assess the subject's communication abilities, including interaction attachment, pragmatics, gestures, play, language comprehension and expression (Rossetti, 1990:196). The scale was completed while observing the child in the classroom and during playtime. Information was also obtained during interviews with the teachers. The six sections mentioned above were documented on an age performance profile, in order to determine at which age level the child was functioning in each category.
- The DAS-General Development (refer to Appendix C) provides information about the child's general development, including personal social, perceptual-cognitive, self-help, gross- and fine motor skills as well as expressive and receptive speech-language skills (Anderson, Nelson & Fowler, 1978). The DAS (General Development) was completed while observing the child in the classroom and during playtime. Information was also

obtained during interviews with the teachers. The seven sections mentioned above were documented on an age performance profile, in order to determine at which age level the child was functioning in each category.

- The Reynell Developmental Language Scales III - Verbal Comprehension (Edwards, et.al, 1997) was used to assess the child's comprehensive language abilities (refer to Appendix C). The assessment was completed in the individual training rooms of the classroom, while the child interacts with the researcher. An FM-system was used during the evaluation to ensure that the researcher was audible at all times. Visual cues such as lip-reading were permitted. The assessment was applied according to the guidelines supplied in the Reynell Developmental Language Scales III resource manual, and no additional adaptations were made. The Verbal Comprehension A (more complicated) was used unless it was clear that the child is struggling severely and the Verbal Comprehension B (less complicated) was used. The raw score was obtained by adding up all the correct responses. The equivalent age and standard scores were determined from tables in the resource manual.
- The Preschool Literacy Assessment (Edmiaston, 1988:27-36) was completed in order to assess the child's pre-literacy skills (refer to Appendix C). While observing the subjects during classroom and play activities, the researcher completed the checklist. Information was also obtained during interviews with the teachers. No totals or scoring was required. The researcher interpreted the information and obtained a general overview in order to compare the subjects' pre-literacy abilities with their hearing peers in the classroom.
- The SIR (Dyar, 2003) was used to assess the subject's speech intelligibility (refer to Appendix C). The researcher completed the SIR during the interaction with the subjects (throughout the standardised assessment of verbal comprehension), as well as while observing the subjects during play and classroom activities. No scoring was required.
- The VSA (Dyar, 2003) was used to evaluate the subject's voice use and quality (refer to Appendix C). The researcher completed the VSA during the interaction with the subjects (throughout the standardised assessment of verbal comprehension), as well as

while observing the subjects during play and classroom activities. No scoring was required.

- The DAS - Auditory Ability (refer to Appendix C) was completed to assess the subject's listening abilities (Anderson, Nelson & Fowler, 1978). The DAS (Auditory Ability) was completed while observing the child in the classroom and during playtime. Information was also obtained during interviews with the teachers. The following eight categories were totalled: (1) Awareness of sound, (2) Sound has meaning, (3) Auditory feedback, (4) Discrimination skills, (5) Localisation skills, (6) Distance and directional listening, (7) Adding background noise and (8) Auditory memory and sequencing. A total score was obtained by adding up the totals from the eight categories.
- The PALS (Dyar, 2003) was administered to assess the effectiveness of the subject's spoken language capabilities at five levels: (1) everyday communication skills, (2) receptive skills, (3) expressive skills, (4) voice skills, and (5) speech skills. Although other checklists determine many of these skills, the PALS serves as a cross-reference to enhance the validity of the study (refer to Appendix C). The PALS was completed while observing the child in the classroom and during playtime. Information was also obtained during interviews with the teachers. No scoring was necessary. The five sections give an overall indication of the subjects' level of linguistic development (i.e. preverbal, transitional or functional).

4.7.4 Auditory ability

4.7.4.1 Inspection of the cochlear-implant and hearing aid

Inspection of the cochlear implant and hearing aid functioning was performed before administering the tests. The researcher ensured that the batteries were in working order and that all the subjects had undergone a mapping session within the last three to four weeks.

4.7.4.2 Otoscopic examination

The appearance and structure of the external auditory meatus and tympanic membrane was examined during the otoscopic investigation. The researcher noted all abnormal signs, such as the appearance of the external auditory meatus, excessive earwax, scratch marks or fluid in the meatus, blood or redness which are signs of *otitis externa*. The tympanic membrane was examined with reference to perforations, lesions, blisters, redness and grommets. The normal tympanic membrane appears pale grey and semi-transparent (Soer, 2001:5-10, 5-11). The necessary referrals were made if abnormalities were detected, and the subjects were assessed once the middle ear problems had been treated.

4.7.4.3 Immittance

Tympanometry was conducted to measure middle ear functioning. Appropriately sized probes were inserted into the subject's ears by pulling the pinna slightly up and back. Each ear was tested separately. The subject was instructed to sit as still as possible, without swallowing, coughing or talking during the test. Testing was started by selecting the "tymp" and "←" button. The results were automatically recorded. The "print" option was selected in order to print the results (Soer, 2001:10-24).

The tympanograms were classified as either normal or abnormal middle ear functioning (Martin & Clark, 2000:155). A Type A tympanogram indicates normal middle ear functioning. The Type A pattern is classified by a clear peak that occurs at -100 to +100 daPa. Like the Type A, the Type As pattern has a definable peak compliance at normal atmospheric pressure (i.e. 0 daPa). However, the base peak compliance is low (i.e. under 0.3 ml). This is indicative of an abnormally stiff mechanism and may result from a variety of pathological conditions, such as thickened tympanic membrane, otosclerosis and advanced *otitis media* ("glue ears").

In contrast to the shallow Type As pattern, the type AD is characterized by unusually high compliance (above 1.6 ml) in the –100 to +100 daPa area. This is indicative of a flaccid tympanic membrane, which is the result of widespread atrophic scaring on the membrane's surface, or it may signal ossicular discontinuity. The Type C is a clear sign that some kind of Eustachian tube malfunction is present, as the middle ear pressure is at least 100 daPa lower than ambient pressure. This pattern is characterized by a peak compliance that is found in the negative range relative to normal. This is indicative of Eustachian tube dysfunction. A Type B indicates little or no pressure change in the compliance of the tympanic membrane. No peak is present, and this is a sign of serious *otitis media*, impacted cerumen or foreign bodies (Bess & Humes, 1990:138; Martin & Clark, 2000:156–159; Soer, 2001:5-26–5-33). The necessary referrals were made if abnormalities were detected and the subjects were assessed once the middle-ear problems had been treated.

4.7.4.4 Aided pure-tone thresholds

Pure-tone audiometry was administered to determine the aided (cochlear implant and contralateral hearing aid) hearing thresholds of the subjects. A warble pure-tone stimulus was used. Frequency specific thresholds were obtained at 125, 250, 500, 1000, 2000, 3000, 4000, 6000 and 8000 Hz. The pure-tone threshold was determined at the level where the child responded 50% of the time. These thresholds indicate how much the child benefits from the bimodal amplification.

The subject and his/her caregiver were asked to sit in the soundproof room. A Perspex window separated the researcher from the subject, but they were able to see each other and were able to communicate via a microphone. The following instruction was given using a live voice: Press the button (or put a block in a bucket) every time you hear a "beep" sound, no matter how faint. Signals were presented at the above-mentioned frequencies. The signals were presented in a descending fashion starting at 70 dB and descending the stimulus in steps of 10 dB, until the subject's hearing threshold (softest level where the subject can hear the stimulus), were obtained. The threshold was confirmed by ensuring that the subject responded to that stimulus twice. If no response was obtained from the subject, the stimulus was increased in steps of 5 dB until the person responded 50% of the time at that same level (Martin & Clark, 2000:83-89; Soer, 2001: 5-14-5-19, 5-29, 5-30).

The responses were recorded on the audiogram (refer to Appendix C) with a [A] for free-field aided thresholds (Bess & Humes, 1990:75).

4.7.4.5 Speech measurements

Test results, which only contain pure-tone results does not give an indication of how a person functions in daily life. Hearing is mostly used to listen to speech, rather than to listen to other sounds (Scott, 2002:10-26). Speech audiometry has the advantages of versatility in its application to diagnostic or rehabilitative purposes. Speech audiometry is also relevant to the impact hearing-impairment has on one's daily functioning, and speech audiometry also affects one's sensitivity to central auditory dysfunction (Stach, 1998:229).

The following instructions were given via live voice to the subjects beforehand:

- You are going to hear some one-syllable words preceded by the phrase, "say the word" (if only words were used) or "show me the" (if objects and words were used).
- Repeat the word as best you can or show me the corresponding object.
- The words may become softer and softer and may become difficult to hear, but try to guess if necessary.
- Please do not look at my face while I am talking.

- **Speech discrimination testing**

The purpose of this test is to evaluate an individual's ability to recognize single-syllable words from a phonetically balanced word list. A list of 10 words using discrimination word lists for children were presented, with a value of one percent per word (Martin & Clark, 2000:131; Soer, 2001:10-14). The test was started at 20 dB above the speech reception threshold. This level is called the phonetically balanced hearing level (PBHL), and has been shown to be an appropriate level of presentation to achieve the maximum score for phonetically balanced words (PB-max). Common objects or pictures of common objects were used if the subjects had unintelligible speech or found it difficult to repeat the words. The subjects were expected to repeat the words or point to the correct object.

The words were presented one at a time with the carrier phrase "say the word" (if the child was able to repeat the word) or "show me the" (if the subject pointed to the appropriate object). The last word of the carrier phrase should always peak at "0" on the VU meter. A count was kept of the number of words the person repeated or identified correctly. The speech discrimination score was calculated by multiplying the number correct words by ten. The percentage was then recorded on the audiogram (refer to Appendix C) with a [A] (for aided free field threshold) at the appropriate area.

- **Speech in Noise Testing**

The Speech in Noise assessment was used to emulate a noisy classroom. Speech was presented at 60 dB and the speech noise at 55 dB through both speakers simultaneously. A list of 10 words using discrimination word lists for children were presented, with a value of one percent per word. Common objects or pictures of common objects were used if the subjects had unintelligible speech or found it difficult to repeat the words. The subjects were expected to repeat the words or point to the correct object. The words were presented one at a time with the carrier phrase "say the word" (if the child was able to repeat the word) or "show me the object" (if the subject pointed to the appropriate object). The last word of the carrier phrase should always peak at "0" on the VU meter. A count was kept of the number of words the person repeated or identified correctly. The Speech in Noise score was calculated by multiplying the number correct words by ten. The percentage was then recorded on the audiogram (refer to Appendix C) under the speech discrimination results.

The purpose of the Speech in Noise assessment is to determine what percentage word discrimination is reached, despite the noise. This information will assist in verifying the need for a FM system within the noisy classroom (DeConde Johnson, Benson & Seaton, 1997:58).

4.8 DATA ANALYSIS

The data obtained from the questionnaires, scales and tests performed on the subjects were analysed quantatively and qualitatively with the help of a statistician. Information was analysed and presented according to the sub-aims. Results are discussed, supported by graphs, figures and tables according to the nature of the sub-aims. Microsoft Office Excel (2003) was used for all the descriptive statistical analysis in order to calculate the mean (average) values from the assessment scores included in the proposed protocol. Patterns of similarities and differences across the subjects were examined to try and come to terms with their diversity. Method of agreement (where the researcher compares characteristics that are similar across cases that share a significant outcome) and method of difference (where the researcher compares characteristics among cases in which some cases share a significant outcome, but others do not, and the focus is placed on the differences) was applied (Neuman, 2006:473). Successive approximation was also used during data analysis. Successive approximation is “a method of qualitative data analysis in which the researcher repeatedly moves back and forth between the empirical data and the abstract concepts, theories or models, adjusting theory and refining data collection each time” (Neuman, 2006:469).

The proposed assessment protocol was administered on the subjects and the subsequent data analysis procedures (after scoring and totalling the assessment procedures) were used to realize the following sub-aims:

- *Sub-aim one: evaluation of the different assessment areas within the assessment protocol* - The information was organised in a table in order to compare similarities and differences between assessments to determine if over- or under-evaluation is occurring. Method of agreement, method of differences and successive approximation was used to analyse the data.
- *Sub-aim two: Evaluation of the type of information gained from the individual subjects and the assessment protocol* - The information was organised in a table in order to describe the type of information gained from the assessment protocol. Successive approximation was used to analyse the data.
- *Sub-aim three: Evaluating the duration for administering and interpreting the assessment protocol* – The mean values (for duration) were calculated for each subject and assessment procedure. The data was described and represented in graphs and tables. Method of agreement and method of differences was used to analyse the data.

- *Sub-aim four: Evaluating the cultural and language barriers affecting the administration and interpretation of the assessment protocol* – Mean values (from the assessment scores) were calculated for each subject and assessment procedure. The data was described and represented in graphs and tables. Method of agreement, method of differences and successive approximation was used to analyse the data.
- *Sub-aim five: The overall value of the assessment protocol* – The data obtained from the previous four sub-aims was critically discussed. Successive approximation was used to analyse the data.

4.9 SUMMARY

This chapter provides a thorough description of the procedures implemented in the research methodology to acquire the data according to the sub-aims, in order to address the main aim of the study. The need to determine the relevance of the assessment protocol designed by the Pretoria Cochlear Implant Programme, within their unique context, was the driving force behind this research. The research design was outlined followed by the selection criteria and description of the subjects used in the study. The apparatus and material used for the selection of subjects and the collection of data was subsequently discussed, followed by the procedures for data collection and recording. This chapter concludes with an overview of the data analysis procedures used during the realisation of the sub-aims.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 INTRODUCTION

Holistic assessments used to monitor the performance of the cochlear implant device itself, and the performance of the child with the device, provide important information for intervention and also highlights the importance of effective and efficient assessment protocols which are used within cochlear implant programmes.

The results are discussed whilst focusing on the main aim of the study, which is to determine the clinical relevance of the assessment protocol compiled by the Pretoria Cochlear Implant Programme. The results were addressed through the realisation of five sub-aims. The purpose of the first sub-aim was to establish what type of results are obtained from the different assessment areas within the protocol, to determine if over- or under-evaluation is occurring. The second sub-aim was to critically evaluate and describe the type of information gained from the proposed assessment protocol. The third sub-aim was to determine the duration for administering and interpreting the assessment protocol. The fourth sub-aim was to determine the cultural and language barriers affecting the administration and interpretation and the protocol, and the final sub-aim was to determine the overall value of the assessment protocol in an inclusive educational setting.

The purpose of this chapter is to present the results of this study according to the five sub-aims in order to address the main aim of the study. The results are presented and discussed by integrating the current body of knowledge, and extracting the significance of the results obtained. The results for each sub-aim will be presented, followed by an interpretation and discussion alongside current literature. In the final section of this chapter, recommended changes for the protocol and a summary of the results, as obtained from the administration of the assessment protocol in realisation of the main aim, will be supplied.

5.2 SUB-AIM ONE: EVALUATION OF THE DIFFERENT ASSESSMENT AREAS WITHIN THE ASSESSMENT PROTOCOL

The assessment results and various results obtained from the individual assessments included in the protocol were used to determine if over- or under evaluation is occurring.

Table 5.1 summarizes the areas assessed and individual assessments used.

Table 5.1 Areas assessed and individual assessments

Assessment Areas					
Auditory Abilities	**Language Abilities**	**Speech Abilities**	**General Development**	**Parent-Child Interaction**	**Questionnaires**
• Aided audiogram (125-8000Hz) • Speech discrimination • Speech in noise • Tympanometry • Checklist: Developmental Assessment Schema (DAS) (Auditory communication)	• Checklist: DAS (Expressive and receptive language) • Checklist: Rossetti Infant-Toddler Language Scale (receptive and expressive language) • Checklist: Profile of Actual Linguistic Skills (PALS) • Standardised test: Reynell Developmental Language Scales III Verbal comprehension	• Checklist: Speech Intelligibility Rating (SIR) • Checklist: Voice Skills Assessment (VSA) • Checklist: Profile of Actual Linguistic Skills (PALS)	• Checklist: DAS (gross and fine motor, personal-social, self help and perceptual-cognitive) • Checklist: Rossetti-Infant-Toddler Scale (gross and fine motor, play and gestures) • Checklist: Preschool literacy assessment	• Checklist: Mother Infant Communi-cation Screening (MICS) (video analysis) • Checklist: Caregiver-Child Interaction (video analysis)	• Background information (parents) • Meaningful Auditory Integration Scale (MAIS) (parents and teachers) • Meaningful Use of Speech (MUSS) (parents and teachers)

From the above table it is clear that all the vital areas of assessment are covered in the proposed assessment protocol, as discussed in detail in chapter 1. Literature regarding assessment in children with cochlear implants suggests that the following areas are essential and should be included in all assessment protocols: general development, parent-child interaction, general socialization, emerging literacy skills, auditory ability (including pure-tone audiometry, listening skills, auditory attention span and memory, phonological awareness, speech perception and speech discrimination), language skills (including receptive and expressive skills), speech production (including speech repertoire, intelligibility and voice use), and everyday communication skills (Mahshie, 2006:82; Dyar, 2003).

The Pretoria cochlear implant assessment protocol included the DAS (General Development) and Rossetti Infant-Toddler Language Scale in order to assess general development. These checklists were appropriate to obtain a general overview of subjects' development as personal-social, perceptual-cognitive, self-help, fine motor, gross motor, expressive language, receptive language, play and use of gesture development are included (Anderson, Nelson & Fowler, 1978; Rossetti, 1990). Literacy skills were assessed by completing the Preschool Literacy Assessment (Edmiaston, 1988).

Contextual factors play an important role in communication development and therefore should be considered in any assessment. Factors such as joint activity routines, communication of needs and opportunities for choice making and protesting should be considered. These factors are often predictable and repetitive activities requiring active involvement, reciprocal and exchangeable roles, a mutual focus of attention, turn-taking, and communicative exchange focused on a common theme or goal. Joint activity routines allow young children to participate and communicate actively, with the necessary situational and interactive support allowing for the greatest amount of participation. Children also have needs to communicate, as well as to reject, protest or make decisions in socially acceptable ways. It is from these experiences that children learn to communicate for a wide variety of communicative functions. Therefore, for successful communicative interactions and language growth, characteristics of parent-child interaction should be documented in all assessments to help determine whether any environmental adaptations should be made as part of the intervention programme (Prizant & Wetherby, 1995:163). Parent-child interaction was assessed by completing the Mother-Infant Communication Screening (MICS)

(Raack, 1989) and the Caregiver-Child Interaction (Louw & Kritzinger, 2000). Parent-child interaction is an important aspect, as optimal interaction between parents and their children is most favourable for aural habilitation and the continuation thereof at home (Venter, 2000:90). Information regarding everyday communication skills was also obtained by way of parent-child interaction video analysis, and while observing the subjects in the classroom. Children feel most comfortable in situations known to them and while they are among familiar people. Therefore, emphasis was placed on a naturalistic setting. Observation included sampling of various developmental behaviours, and recording of these behaviours (Zsilavecz & Naude, 2000:23).

Auditory ability was thoroughly assessed and is considered an important aspect in the proposed assessment protocol. It is crucial to evaluate the extent to which a child can receive auditory information from the environment. The auditory information will indicate what type of sounds or words the child is aware of and what sounds or words can be discriminated or identified. This information also provides an indication of the stage of auditory development, which is essential for intervention planning and auditory training (Mahshie, et.al, 2006:128). An aided audiogram, speech discrimination results, Speech in Noise Test and tympanometry was included in order to determine if optimal device functioning was present and to monitor listening development (Lutman et.al, 1996:39-42). The Developmental Assessment Schema (Auditory Communication) was completed to obtain an in-depth view of the subject's listening skills, once it was confirmed that the subjects have optimal hearing levels (Allum, 1996:39). It is believed that parents and teachers know the children best, and for this reason the Meaningful Auditory Integration Scale (MAIS) was included in the protocol in order to obtain information regarding the subjects' use and reliance on the implant in natural environments, such as their homes and schools. MAIS also allowed for the subjects' listening progress to be documented (Venter, 2000:90; Lutman et.al, 1996:48).

Language skills were assessed by completing the DAS (General Development) and Rossetti-Infant-Toddler Language Scale checklists as they contain expressive and receptive language sub-sections. The Reynell Developmental Language Scales III (Verbal Comprehension) was included as a standardised or formal measure to obtain a score for receptive language, whereby future re-assessments can easily be compared in order to monitor progress. The Profile of Actual Linguistic Skills (PALS) provided a broad description of language development given by the Classification of Linguistic Performance (Dyar, 2003). The PALS examined the linguistic competence of the subjects at five interrelated levels, namely communication, receptive language, expressive language, and voice and speech ratings. These five levels were combined to give an overall classification into one of three language categories: preverbal, transitional and functional language (Lutman et.al, 1996:41).

In both the Speech Intelligibility Rating (SIR) and Voice Skills Assessment (VSA) checklists are included to assess speech and voice skills and to document the intelligibility of emerging speech and voice skills (Lutman et.al, 1996:46). The Meaningful Use of Speech (MUSS) was completed by the parents and teachers to obtain an overview of the subjects' use of speech at home and at school (Venter, 2000:90).

Overlapping occurs with the DAS (General Development) and Rossetti-Infant Toddler Language Scale, as similar areas are assessed. Valuable information is obtained from the DAS and Rossetti Infant-Toddler Language Scale. The problem is that these tests are designed for children up to the age of 60 and 36 months respectively and the subjects in this study were all between four (48 months) and seven years (94 months). The result is that the age levels obtained are beyond 60 or 36 months in some developmental areas such as gross motor skills, self-help skills, personal-social skills, play and use of gesture development; rather than obtaining the exact age level at which the subjects are functioning.

During the assessment of parent-child interaction, overlapping occurs as the MICS and Caregiver Child Interaction was completed after the video analysis. The Caregiver Child Interaction was appropriate for the age group included in the study, but the MICS is designed for infants, and the subjects used in this study were above the age of four years. The areas assessed in the MICS are Language and Synchrony, Distress, Feeding, Play/Neutral State and Rest. These areas are important when assessing parent-infant interaction (Rossetti, 1990:46), but the MICS does contain many areas of assessment (e.g. rest and feeding) that may not be appropriate for toddlers.

Although the DAS (General Development) and Rossetti-Infant Toddler Language Scale include receptive and expressive language as areas of assessment, the Reynell is a standardised measure for verbal comprehension, and serves as a crosscheck for the informal measures (i.e. checklists) used. The PALS checklist had many purposes. It substantiated the findings from the speech and language assessments and recorded samples, serving as a crosscheck. In the context of the overall intervention programme, the PALS monitors' progress towards functional spoken language, which is expected in most cochlear implant recipients (Lutman, et.al, 1996:41).

The crosscheck implies that one test result confirms another test result. This principle clearly states that clinicians need verification with a battery of tests before the information obtained can be seen as accurate (Turner, 2003:269; Herzfeld, 2000:1). No further overlapping occurs as the other areas included in the protocol cover the previously mentioned vital areas of assessment. As a vast amount of informal measures such as observation and completion of checklists are included in the protocol, and part of the assessment occurs in a natural setting (i.e. school), ample opportunity is provided to enforce the crosscheck principle.

Therefore, although some overlapping occurs in the protocol, it should not always be seen as over-evaluation, but rather to ensure that accurate information is obtained from the assessment and that the crosscheck principle is being applied. As all the vital areas of assessment are covered in the protocol, under-evaluation is not a concern.

5.3 SUB-AIM TWO: EVALUATION OF THE TYPE OF INFORMATION GAINED FROM THE ASSESSMENT PROTOCOL

The assessment results obtained for each child on all the procedures included in the protocol were used to critically evaluate and describe the type of information gained from the proposed assessment protocol.

Table 5.2 summarizes the type of information gained from the assessment areas within the protocol.

Table 5.2 Type of information gained from the assessment areas within the protocol

	Background Information	**Audiograms**	**Developmental Assessment Schema (DAS) - Auditory Communication**	**Meaning Auditory Integration Scale (MAIS)**	**Meaningful Use of Speech Scale (MUSS)**	**Reynell Developmental Language Scale III**
Type of information gained	• First language • Culture group • Age hearing loss diagnosed • Cause of hearing loss • Age hearing aid fitting • Age cochlear Implant received • Cochlear implant experience	• Hearing thresholds (125 – 8000 Hz) • Speech discrimination • Speech in Noise Test • Otoscopy • Tympanometry	• Awareness of sound • Sound has meaning • Auditory feedback • Discrimination skills • Localization skills • Distance and directional listening • Adding background noise • Auditory memory and sequencing (long-term and short-term)	• Reliance on auditory input • Auditory input as alerting function • Auditory input adds meaning	• Voice control • Speech sounds • Communication strategy	• Standardised assessment of verbal comprehension
	Parent-Child Interaction	**Developmental Assessment Schema**	**Rossetti-Infant Toddler Language Scale**	**Preschool Literacy Assessment**	**Speech Intelligibility Rating (SIR)**	**Profile of Actual Linguistic Skills (PALS)**
Type of information gained	• Appropriate tactile stimulation • Pleasure during interaction • Responds to distress • Eye contact • Smiles contingently • Varies prosodic features • Encourages conversation • Responds contingently to behaviour • Modifies interaction • Uses communi-cation to teach language	• Personal-social development • Perceptual-cognitive development • Self-help development • Fine motor development • Gross motor development • Expressive speech • Receptive speech	• Interaction attachment • Pragmatics • Gesture • Play • Language comprehension • Language expression	• Situation-Dependant print • Book handling skills • Retelling of familiar stories • Productions of children's written language	• Speech intelligibility on a scale of 1 to 6 **Voice Skills Assessment (VSA)** • Voice attributes	• Communication • Language Expression • Language Reception • Voice • Speech

As previously mentioned, all the vital areas of assessment are included in the proposed protocol, compared to assessment areas used at other cochlear implant programmes across the world (Dyar, 2003; Lutman, et.al, 1996:38-49).

The background information questionnaire provided information regarding the subjects' first language, culture group, age at which their hearing loss was identified, cause of hearing loss, age at which hearing aids were fitted and age at which they received a cochlear implant and their cochlear implant experience. Information concerning the subject's family set-up, educational setting and communication mode was also obtained. All these factors contribute to the success of cochlear implantation, future rehabilitation and possible prognostic predictions regarding the child's intervention and long-term goals (Shapiro & Waltzman, 1998:58).

The audiograms provided valuable information regarding the subject's auditory abilities. Pure tone thresholds were obtained from 125 – 8000 Hz during aided (i.e. with cochlear implant and contralateral hearing aid) conditions. The subjects responded to the tones proving that they benefit from the cochlear implantation. These pure tone results indicate how much the subjects benefit from the implant, as well as if the implant is working as it should (Lutman et.al, 1996:39-42). Richter et.al, (2002:119) demonstrated that improvement in functional gain after approximately two years of cochlear implant experience was statistically significant, corroborating preceding literature (Snik, Vermeulen, Geelen, Brokx & Van den Broek, 1997:38; Van den Borne, Snik, Hoekstra, Vermeulen, Van den Broek & Brokx, 1998:460), that a functional gain of 40 dB in the 0.25-4 kHz range is obtained – which was significantly better compared to hearing aid benefit (especially high-frequency information) before implantation.

Results, which only contain pure tone information, do not provide an indication of how a person functions in daily life. Hearing is mostly used to listen to speech, rather than to other sounds (Scott, 2002:10-26). Therefore, speech discrimination testing was included in the protocol, even though the subjects have little spoken language abilities. The subjects were able to respond verbally or point to the corresponding toy, which clearly indicates and quantifies their benefit from the cochlear implantation. Assessment of speech perception in the paediatric population is therefore important to help determine whether a child is benefiting from a cochlear implant and secondly, follow-up assessments help track performance over time. Lastly, speech perception data in combination with speech and language outcomes are essential for establishing guidelines for habilitation. Research conducted at the Nottingham Cochlear Implant Programme indicated that the proportion of young children who can successfully complete the speech discrimination assessment ranges from 20% one year after implantation to 83% three years post-implantation. Furthermore, the thresholds achieved improved over a period of three years from approximately 60 to 55 dB on average, indicating an increasing ability to utilize speech cues. It was also demonstrated that speech discrimination can be performed earlier, and thresholds decrease further and faster in children who have an established spoken language base before implantation (Lutman et.al, 1996:43).

Similarly, a study conducted in Melbourne and Sydney used speech discrimination results from one hundred children and adolescents who were categorized based on the level of ability they demonstrated in formal assessments (Dowell & Cowan, 1997:208). Their results indicated that approximately 60% of the children in the group achieved significant open-set speech recognition, and approximately 30% of the group recognized over half of the phonemes in an open-set monosyllabic word test. For these children it was reasonable to conclude that they are capable of using audition alone for interactive communication (Dowell & Cowan, 1997:208). Various research regarding speech perception concludes that children with cochlear implants reach open-set speech perception after an average of two years of implant experience. Furthermore, O'Donoghue, et.al, (2000:467) report a positive influence of cochlear implantation on speech perception. Clear improvement and statistically significant differences were shown in pre- and post-operative comparisons (Richter et.al, 2002:119).

Mondain et.al, (2002:94) demonstrated how speech perception scores improve as cochlear implant experience increases. The mean scores for open-set speech perception were 21.4% before implantation, 21.3% one month post-implantation, and then steadily increased to 53.2% after three months of cochlear implant use, 57.9% after six months of cochlear implant use, 62.1% after nine months of cochlear implant use and 83.6% after twelve months of cochlear implant use. The entire test group obtained speech recognition scores greater than 60% after twelve months of cochlear implant use. Likewise, research by Calmels et.al, (2003:4) resulted in mean scores for open-set speech perception at 8.77% three months post-implant, 16.54% twelve months post-implant, 34.33% two years post-implant, 58.56% three years post-implant, 68.42%

four years post-implant and 76.3% five years after implantation. The improvement of the performances three months and one year post-implant was not significant, but there was a significant improvement in speech perception ability between one and five years after implantation. Closed-set speech perception improved significantly between three months and one year and between one year and five years post-implantation.

The Speech in Noise Test was included to emulate a noisy classroom situation in order to determine how the subjects function in the classroom setup or noisy situations at home (Eisenberg, et.al, 2005:1). The Speech in Noise Test results also provides the clinician with information regarding the recommended use of an F.M. system within the classroom. The subjects were able to respond verbally or point to the corresponding toy, which clearly indicates and quantifies their benefit from the cochlear implantation. A preliminary study conducted by Dowell & Cowan, (1997) evaluated the speech perception of open-set words in background noise for four children. The children were assessed over a six-month period using repeated assessments. During the six-month period, each child received weekly habilitation sessions, which included perceptual training in background noise. Results showed post-training scores on open-set words to be significantly higher than pre-training scores, when testing was completed in background noise. No significant increase was evident in quiet environments, despite the training received by each child (Clark et.al, 1997:214).

Tympanometry was included in order to measure middle ear function and possible otitis media. Otitis media can result in temporary threshold shifts, and should be treated as soon as possible. A decline in thresholds can be detrimental to a cochlear implant user for learning language, as hearing abilities are temporarily not optimal. Hearing levels usually return to the optimal levels once the infection has been treated (Martin & Clark, 2000:258). Children also often complain that they are having difficulty hearing or they exhibit odd behaviours, which may mean that their MAP's need to be re-adjusted (Mertes & Chinnici, 2005:8).

The DAS (Auditory Communication) completed by the researcher during observation at school, interviews with the teachers and during video analysis provided an indication of the subjects' listening abilities and progress in the home and school environment. The categories included in the checklist include: awareness of sound, sound has meaning, auditory feedback, discrimination skills, localization skills, distance and directional listening, adding background noise and auditory memory and sequencing (short-term and long-term). Although aided sound field audiometry provides a measure of sensitivity (the ability to detect an auditory signal through the implant), there is also a need to measure the child's developing ability to listen and interpret the signal. Following implantation, the child should be able to respond to auditory stimuli within the familiar, repetitive settings that are found to promote linguistic skills (Lutman et.al, 1996:44). Furthermore, video analysis in the early stages of auditory communication assessment is a sensitive measure, which can monitor changes over short time frames, months rather than years. Video analysis has proven to be repeatable and been found to predict to a significant extent the later developments of speech perception in children with limited verbal abilities (Nikolopoulos, Archbold & Gregory, 2004:4; Tait, Lutman & Nikolopoulos, 2001:8).

It is of the utmost importance to receive input from the teachers and parents during an assessment, as they know the children best, and are able to provide information regarding how the subjects behave in their natural environments at home and school. A better understanding of the child within his/her environment must be attained. These aspects emphasize that a child may react differently in a "test situation" as the child is under pressure, and there is always the underlying urge to get the test done in as short a period of time as possible. These influences will eventually affect the end product and final findings (Shipley & McAfee, 1998:191). Therefore the MAIS and MUSS questionnaires were included in order to determine the subjects' use of speech and audition in their natural environments. Research conducted at the Nottingham Cochlear Implant Programme on thirty-six children, using the MAIS, showed a difference between parents' and teachers' scores. Lower scores were given by teachers, which probably illustrates the greater length of time taken to attach meaning to sound in the noisier environment of the classroom than at home (Lutman et.al, 1996:48). Additionally, in the early days after implantation, the MAIS may provide evidence of the use of the device when other signs of device failure are few. Parents and teachers can be encouraged to consider the way in which the child is using the cochlear implant in everyday life, and to be observant of changing behaviours. Its use may provide parents and professionals with early signs of the child not adapting to the use of the system. Similarly, the use of the MAIS over the long-term may highlight a child who is becoming an intermittent user (Nikolopoulos, et.al, 2004:9). Moreover, the aim of the MAIS and MUSS assessments is to ensure that parents' and teachers' scores are similar and these questionnaires enhance the reliability of the assessments. It is often found that parents want their children to progress well and there observations are sometimes different to those of the teachers. This can provide valuable guidelines for parent guidance concerning realistic progress expectations for their children. Mondain et.al, (2002:94) documented improvement in MAIS and MUSS scores after nine months of cochlear implant use. Seven cochlear implant users aged between four and twelve years were included in the study. The average MAIS test score was 18.1/40 before implantation and 35.1/40 after implantation. The average MUSS test score was 24.4/40 before implantation and 34.1/40 after nine months of cochlear implant use. The improvement illustrates the children's increasing ability to utilize auditory information in everyday situations.

The Reynell Developmental Language Scales III (Verbal Comprehension) was included in the protocol as a standardised measure of verbal comprehension, although informal assessment methods have become more popular for the assessment of young children (Shipley & McAfee, 1998:184). The assessment follows the development of verbal comprehension from the earliest stage of selective recognition of certain word patterns on an affective level, through gradually increasing complexity of interpretation of different parts of speech, to the stage where verbal interpretation extends to situations beyond the here and now and language becomes a true vehicle of thought. After this point, verbal comprehension becomes linked to increasingly complex processes, and to increasing vocabulary knowledge, which in turn, merges into other intellectual processes to the extent that it can no longer be assessed as a relatively separate function. The Reynell scales attempt to follow this developmental process of verbal comprehension without too much complex vocabulary used, so that the Reynell Scales test word knowledge without excessively increasing the sentence length. Furthermore, the Reynell scales can be applied to children on a developmental age level of approximately two to seven years (Edwards, et.al, 1997; Reynell, 1977:15). Therefore, this test, although standardised seems to be an appropriate measure to include in the protocol in order to be able to measure progress over time. The Reynell Developmental Language Scales III (Verbal Comprehension) could be applied to the subjects in this research study. No additional adaptations were made during the administration of the assessment. The procedures for administration were followed according to the Reynell Developmental Language Scales III resource manual. However, if the subjects struggled severely, the Verbal Comprehension B section was used, as it is less complicated than the Verbal Comprehension A. Visual cues such as lip-reading were permitted and FM systems were used during the assessment. Richter, et.al, (2002:111) evaluated the expressive and receptive language skills of 106 children with at least 2-years cochlear implant experience using the Reynell Developmental Language Scales III. Results indicated that better speech development was present in the children who were implanted at a younger age, compared to children that were implanted at a later stage. Stallings, Gao & Svirsky (2000:232) found that studies of language development in paediatric cochlear implant users could be conducted successfully using the Reynell Developmental Language Scales III in combination with other language assessments. Previous research regarding the administration of the Reynell Developmental Language Scales III (Verbal Comprehension) demonstrated a significant effect of length of device use and a significant correlation between age of implantation and length of device use on the development of receptive language abilities. The rate of growth in the receptive language scores was significantly faster for the children implanted before the age of two years, than for the children implanted at a later age (Kirk, Miyamoto, Ying, Perdew & Zuganelis, 2000:140). This suggests that children implanted prior to the age of two years are closing the gap between the receptive language age and the chronological age at a faster rate than the children implanted after the age of two years. In fact, children implanted at the age of five years or after, show very small increase in their receptive language scores over time. This does not mean that their receptive language abilities were not improving longitudinally, but rather suggests that the gap between their language age and their chronological age remained constant over time (Kirk et. al, 2000:140). Similarly, Vermeulen, Hoekstra & Van den Broek, (1999:156) demonstrated after the administration of the Reynell Developmental Language Scales III (Verbal Comprehension), that although the rate of receptive language acquisition during implant use increased, the language retardation also increased, but not at the same rate as in the period before implantation.

The parent-child interaction checklist completed by the researcher during video analysis provided the following information: appropriate tactile stimulation, pleasure during interaction, response to distress, eye contact, varying prosodic features, encourages conversation, response to behaviour, modifies interaction and use of communication to teach language. This information is valuable as it can be used during parent guidance sessions in order to optimize parent-child interaction and consequently ensure ideal conditions for speech, language and auditory learning

(Venter, 2000:90). Video recorded samples allow for repeated viewing of the parent-child interaction for analysis and provide a more complete picture of the child's communication abilities (Dowell & Cowan, et.al, 1997:218).

It is important to look at a child holistically during an assessment, and assess all possible areas (Umansky & Hooper, 1998:341). Therefore, the DAS (General Development) and Rossetti Infant-Toddler Language Scale were completed by the researcher during observation of the child in classroom and play activities and during teacher interviews, to obtain an overview of the subjects' general development. The DAS (General Development) provided information regarding personal-social, perceptual cognitive, self-help, fine motor, gross motor, expressive speech and receptive speech development. The Rossetti Infant-Toddler Language Scale provided information about interaction attachment, pragmatics, and the use of gestures; play development, language comprehension and language expression. Using checklists such as these allows for easy administration as the checklists can be completed while observing the subjects in their natural environments (Shipley & McAfee, 1998:184; Gerald & Carson, 1990:61).

The Preschool Literacy Assessment provided information regarding the subjects' literacy abilities. Situation-dependant print, book handling skills, retelling of familiar stories and productions of children's written language are the areas included in the checklist (Edmiaston, 1988). This information was valuable, as the subjects' literacy skills could be compared to their hearing peers in the classroom while applying the principle of holistic assessment.

The SIR scale provided information regarding the subjects' speech intelligibility. Research conducted at the Nottingham Cochlear Implant Programme revealed that 91% of their test group had predominantly unintelligible speech to inexperienced listeners, when speech was not accompanied by gestures or contextual cues before implantation. Twelve months after implantation, 25% were at least intelligible to a listener who concentrates and lip reads. After two years of implant experience approximately 60% of the children had reached the level where they were using speech effectively as the primary means of everyday communication. The percentage had reached 91% by the three-year interval. Based on these results, it can be predicted that up to 90% of children implanted at the preschool stage will produce intelligible speech within five years of implantation (Lutman, et.al, 1996:47). Similarly, Calmels et.al, (2003:4) found that there was a significant improvement in speech intelligibility between three months and five years post-implant. After three years of cochlear implant use, more than half (71%) of the children had intelligible speech, and after five years of implant use, approximately 80% of the children achieved a maximum SIR score. The SIR has been found to be a practical clinical measure, which can be readily applied to cochlear implant users over time, irrespective of the child's age and speech abilities; and SIR has also been proven reliable between observers. Moreover, parents and non-professionals easily understand the overall pattern of development produced, and this in turn fosters realistic expectations (Nikolopoulos, et.al, 2004:10).

On the other hand, the VSA provided information regarding the subjects' voice use and voice skills (Lutman et.al, 1996:46), and looks at a range of prosodic or voice features as used by the implanted children in everyday settings, in order to highlight specific strengths and difficulties (Dyar, 1994:257). Perrin, Berger-Vachon, Topouzkhanian, Truy & Morgon, (1999:186) demonstrated that cochlear implantation tends to normalize voice aspects.

The PALS provided a broad description of language development and served as a crosscheck for the other speech and language assessments included in the protocol (Dyar, 1995). Assessment of communication, receptive language, expressive language, and voice and speech ratings provides professionals with an indication of the children's stage of linguistic development. The PALS was also used as a tool for subject selection in order to select subjects in the transitional stage of development (Lutman et.al, 1996:41). Research indicates that the PALS has been found to be a sensitive means of "profiling" changes in the spontaneous communication or linguistic skills of profoundly hearing-impaired children who have limited verbal abilities. The developmental approach of the PALS makes it an appropriate pre-cursor to norm-referenced language performance measures. It can provide global data on the linguistic status of children and identifies "gaps", which enables the clinician to plan immediate communication priorities and goals for the hearing impaired child (Nikolopoulos, et.al, 2004:6).

Therefore, it is clear that the assessment protocol can be successfully applied to children with cochlear implants in the transitional stage of linguistic development. The subjects were able to participate in all the areas of the protocol. Furthermore, the children's linguistic needs, as well as additional support needed, can be identified, and appropriate individualised intervention goals can be developed.

5.4 SUB-AIM THREE: EVALUATING THE DURATION FOR ADMINSTERING AND INTERPRETING THE ASSESSMENT PROTOCOL

The duration for administering and interpreting the assessment protocol was used to determine if the protocol is time-efficient in a clinical situation at the Pretoria Cochlear Implant Programme in particular.

Figure 5.1 describes the duration for the assessment areas included in the protocol.

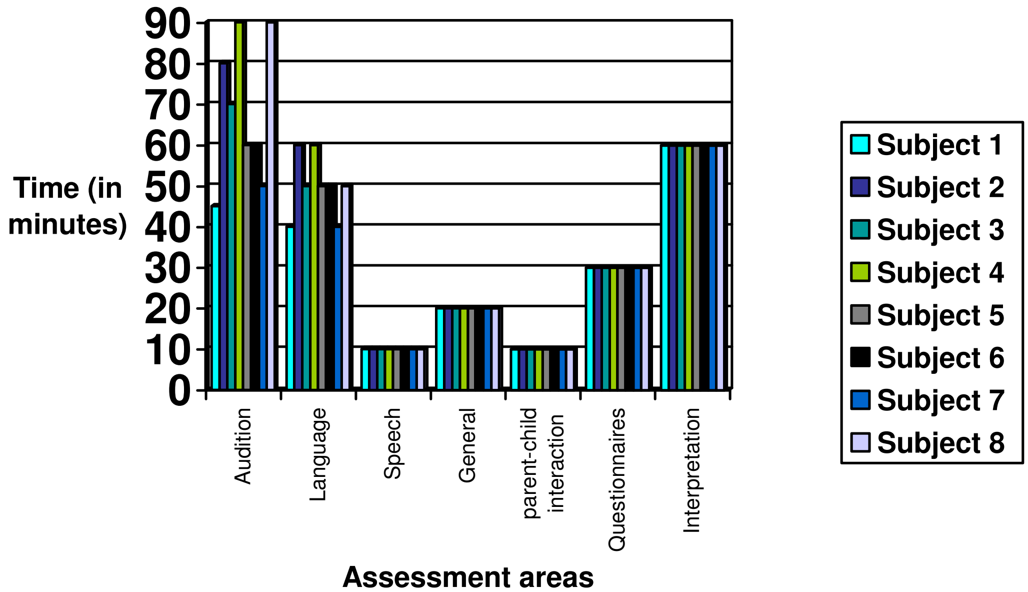

Figure 5.1 Duration (in minutes) for assessment

The duration (in minutes) for the auditory assessment took 45 minutes for subject 1, 80 minutes for subject 2, 70 minutes for subject 3, 90 minutes for subjects' 4 and 8, 60 minutes for subjects' 5 and 6, and 50 minutes for subject 7. The language assessment took 40 minutes for subject 1 and 7, 60 minutes for subjects 2 and 4, and 50 minutes for subjects' 3, 5, 6 and 8. The duration of the speech assessment took 10 minutes per subject for all eight subjects. The general development assessment took 20 minutes per subject for all eight subjects. The parent-child interaction video-analysis took 10 minutes per subject for all eight subjects. The questionnaires were completed while interviewing the teachers and parents, which took 30 minutes per subject for all eight subjects. The interpretation of the entire assessment protocol took 60 minutes per subject for all eight subjects.

From the above it is clear that the assessment of audition is the most time-consuming, followed by the interpretation of the protocol. The language assessment also takes a long time to administer, followed by the completion of questionnaires and assessment of general development. The speech assessment and parent-child interaction took the shortest time to administer.

For the administration of the entire protocol, subject 1 took 155 minutes (2.6 hours), subjects' 2 and 8 took 210 minutes (3.5 hours), subject 3 took 190 minutes (3.2 hours), subject 4 took 220 minutes (3.7 hours), subjects' 5 and 6 took 180 minutes (3 hours) and subject 7 took 160 minutes (2.7 hours).

Figure 5.2 describes the total duration taken for each subject.

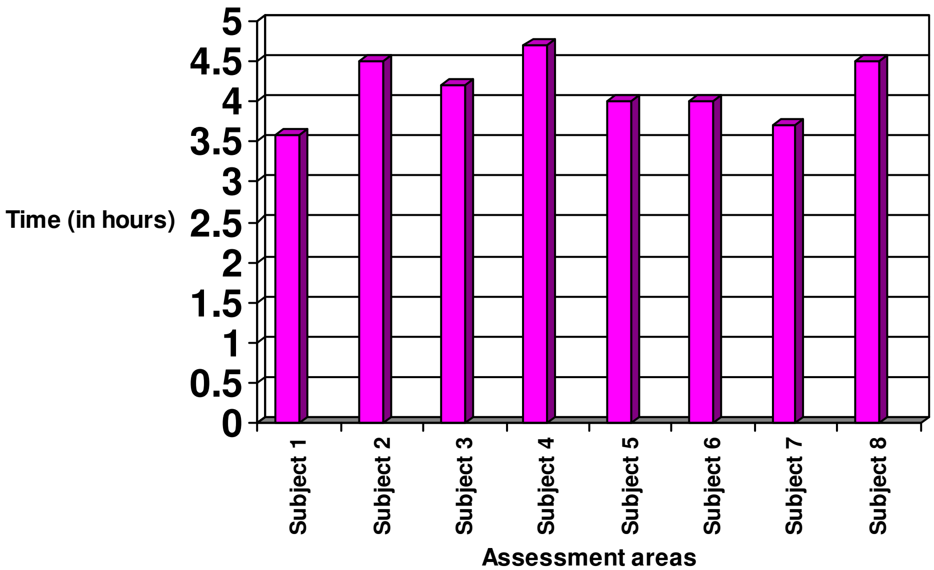

Figure 5.2 Total duration

Therefore, for the administration and interpretation of the assessment protocol, subject 1 took 215 minutes (3.58 hours), subject 2 and 8 took 270 minutes (4.5 hours), subject 3 took 250 minutes (4.2 hours), subject 4 for took 280 minutes (4.7 hours), subject 5 and 6 took 240 minutes (4 hours) and subject 7 took 220 minutes (3.7 hours).

Table 5.3 describes the average duration (in minutes) for each assessment area and for each subject.

Table 5.3 Total and average duration (in minutes) taken for each subject and assessment area

Subject Number	Audition	Language	Speech	General Development	Parent-child Interaction	Questionnaires	Interpretation	Total Duration
1	45	40	10	20	10	30	60	215
2	80	60	10	20	10	30	60	270
3	70	50	10	20	10	30	60	250
4	90	60	10	20	10	30	60	280
5	60	50	10	20	10	30	60	240
6	60	50	10	20	10	30	60	240
7	50	40	10	20	10	30	60	220
8	90	50	10	20	10	30	60	270
Average Duration	68	50	10	20	10	30	60	248 (4.1 hours)

The average duration for the assessment areas was: 68 minutes for audition, 50 minutes for language, and 10 minutes for speech, 20 minutes for general development, 10 minutes for parent-child interaction, and 30 minutes for the completion of questionnaires and 60 minutes for interpretation of the entire protocol. Therefore, the average duration for administering the protocol was 186 minutes (3.1 hours) per subject and for interpreting the results was 60 minutes (1 hour) per subject. The average total duration per subject was 248 minutes (4.1 hours).

Limited research exists regarding how long it should take for an audiological and speech and language assessment in the paediatric cochlear implant population. The duration for administering and interpreting an assessment protocol in young children with cochlear implants is individual to each programme, and depends on their patient load, staff structure and other responsibilities within the cochlear implant programme. It must be taken into account that this was the first time the protocol was administered on the subjects, and therefore it took approximately 3 hours per subject. It is expected that when the protocol is administered on a second or third occasion, the duration time will decrease as the children will feel more comfortable with the test situation and know what is expected of them. The teachers and parents will know what type of information is expected from them, making the assessment of the children and interviews with the parents and teachers an easier and quicker task. Certain areas e.g. motor development, self-help skills, play and use of gesture development, may not be necessary to include in the second or third assessment if the previous assessment indicated that their abilities are on an appropriate age level. This would also result in the duration for the administration of the assessment protocol to decrease significantly. Repeated interpretation of the same assessment protocol will also result in the clinicians being able to interpret the information in a faster and more efficient manner.

Therefore, the administration of this protocol seems time efficient and appropriate for the Pretoria Cochlear Implant Programme, as it is expected that the duration for the administration and interpretation of the protocol will decrease at each re-assessment session.

5.5 SUB-AIM FOUR: EVALUATING THE CULTURAL AND LANGUAGE BARRIERS AFFECTING THE ADMINISTRATION AND INTERPRETATION OF THE ASSESSMENT PROTOCOL

The results obtained from the assessments included in the proposed protocol was used in order to determine if there are any cultural or linguistic barriers affecting the administration and interpretation of the protocol.

5.5.1 Background Information Questionnaire

Table 5.4 describes the background information obtained from all the subjects.

Table 5.4 Background information

Subject Number	First Language	Culture group	Chronological age	Months Experience with Cochlear Implant
1	English	Asian	7 years, 4 months	31
2	Sotho	Black	5 years, 5 months	16
3	Afrikaans	White	5 years, 0 months	21
4	English	White	5 years, 5 months	10
5	Afrikaans	White	5 years, 7 months	33
6	Afrikaans	White	4 years, 3 months	4
7	English	Asian	7 years, 3 months	45
8	Afrikaans	White	7 years, 3 months	24

The background questionnaire indicated that there were 2 Asian subjects, 1 Black subject and 5 White subjects involved in the study. The Asian subject's first language was English, the Black subject's first language was Sotho, three of the White subject's first language was Afrikaans, and the other two White subject's first language was English. In the Asian group, the one subject had 31-months cochlear implant experience, and the second Asian subject had 45-months cochlear implant experience. The Black subject had 16-months of implant use, and out of the five White subjects, they had 21-, 10-, 33-, 4- and 24-months of cochlear implant experience at the time of the study.

5.5.2 Hearing assessment

Table 5.5, 5.6 and Figure 5.3 describes the pure tone thresholds and speech discrimination results obtained for each subject.

Table 5.5 Pure tone thresholds

Subject Number	125Hz	250Hz	500Hz	1000Hz	2000Hz	3000Hz	4000Hz	6000Hz	8000Hz	Average Pure tone Thresholds
1	35 dB	40 dB	45 dB	50 dB	50 dB	40 dB	45 dB	45 dB	55 dB	45.0 dB
2	40 dB	40 dB	40 dB	50 dB	55 dB	55 dB	55 dB	60 dB	60 dB	50.6 dB
3	35 dB	35 dB	35 dB	40 dB	40 dB	40 dB	40 dB	35 dB	45 dB	38.3 dB
4	45 dB	45 dB	45 dB	35 dB	45 dB	55 dB	55 dB	55 dB	60 dB	48.9 dB
5	30 dB	30 dB	40 dB	40 dB	45 dB	50 dB	50 dB	45 dB	45 dB	41.7 dB
6	45 dB	40 dB	45 dB	40 dB	40 dB	50 dB	55 dB	50 dB	65 dB	47.8 dB
7	40 dB	35 dB	40 dB	35 dB	45 dB	40 dB	40 dB	45 dB	40 dB	40.0 dB
8	35 dB	35 dB	45 dB	40 dB	40 dB	50 dB	45 dB	50 dB	55 dB	43.9 dB

Table 5.6 Speech discrimination results, where the subjects achieved 100%

Subject Number	100% Speech Discrimination Achievement
1	60 dB
2	65 dB
3	65 dB
4	65 dB
5	60 dB
6	65 dB
7	65 dB
8	65 dB

The information described in the above tables is proposed visually in the following figure.

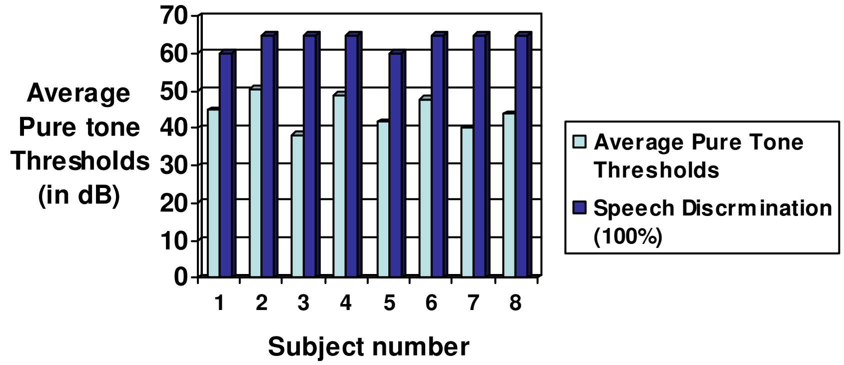

Figure 5.3 Pure tone thresholds and speech discrimination results

The audiograms indicated that the average pure tone thresholds (PTT) for subjects one, five, seven and eight were between 40-45 dB. From their background information, it is evident they have all been implanted for two years or longer. Additionally, the above-mentioned subject's first language is either English or Afrikaans, and the instructions for the hearing assessment were conducted in either one of their first languages. Furthermore, subjects one, seven and eight are all above the age of seven years and subject five is approximately five and a half years old. Therefore, these subjects are also functioning at a higher cognitive level compared to the younger subjects.

Subjects four and six achieved an average PTT between 45-50 dB. Their first language is also either English or Afrikaans, which meant that the hearing assessment was conducted in their preferred language. Their cochlear implant experience was 10- and 4-months respectively, which could contribute to their increased average PTT, as they are more than likely still adapting to their device. Their ages vary between four years three months and five years five months, indicating that they are also less cognitively mature compared to the older subjects.

Subject two had the highest average PTT, i.e. above 50 dB. From the background information questionnaire, it was evident that subject two's first language is Sotho, which meant that the hearing assessment was conducted in his/her second language rather than in his/her preferred language. The subject had only 16-months cochlear implant experience and was five and a half years old at the time of the study, which could also contribute to the increased thresholds obtained.

Subject three was the only subject with an average PTT below 40 dB. The subject was evaluated in his/her first language after 21-months of cochlear implant experience and he/she was five years old at the time of the study.

From the above-mentioned discussion, it is evident that the White and Asian subjects achieved the lowest average PTT. Possible reasons for this phenomenon could be because they were evaluated in their first language (either in English or Afrikaans) and their chronological ages were generally higher. The subject that achieved the highest average PTT was a disadvantaged Black subject in comparison to the Asian and White subjects; he/she had to be evaluated in his/her second language. Additionally, the Black subject had less implant experience compared to the Asian and some of the White subjects. For a child that may have several language influences in his/her life, it is important for the clinician to try and get an overview of what language the child knows, i.e. the child may be able to use a second language for conversational interaction; however, this does not mean that the child is able to understand or use speech well enough to participate in the classroom situation or learn new information in a timely manner (Mahshie, et.al, 2006:89). Differentiating between interpersonal and school language is an important aspect of assessing the child’s abilities and will probably be achieved through intensive intervention and ongoing evaluations. It can therefore be assumed that the language barrier (Zsilavecz & Naude, 2000:21; Umansky & Hooper, 1998:341), cochlear implant experience and chronological age are contributing factors that can affect the outcome of hearing thresholds obtained in young children with cochlear implants.

All the subjects obtained 100 % speech discrimination at 60-65 dB, which did not always correlate with the pure tone thresholds obtained. Although cochlear implant experience, chronological age and language barriers may influence the speech discrimination results, it was evident that in this present study, the subjects are used to listening through an FM system for most of the day, resulting in the subjects only listening when the speech is at a comfortably loud level rather than learning to listen at all levels, no matter how loud or soft the sounds are. It is also important to mention that a large amount of conditioning was needed before the subjects were able to perform the speech discrimination assessment successfully. Additionally, it is evident that speech discrimination is not often included in the audiological assessments when hearing thresholds are monitored. Research proves that speech discrimination results rather than pure tone thresholds give a better, more reliable indication of auditory abilities (Scott, 2002:10-26).

Type A tympanograms indicating normal middle ear functioning was elicited in the Asian, Black and White subjects (Martin & Clark, 2000:156). This demonstrates that language and cultural barriers does not affect the results obtained from tympanometry, as no behavioural responses were expected from the subjects.

Table 5.7 and Figure 5.4 lists the Speech in Noise Test results obtained for each subject at a speech to noise ratio of 60:55 dB.

Table 5.7 Speech in Noise Test results

Subject Number	Speech in Noise 60:55dB Ratio
1	100%
2	60%
3	10%
4	70%
5	70%
6	80%
7	60%
8	80%

The information described in the above table is proposed visually in the following figure.

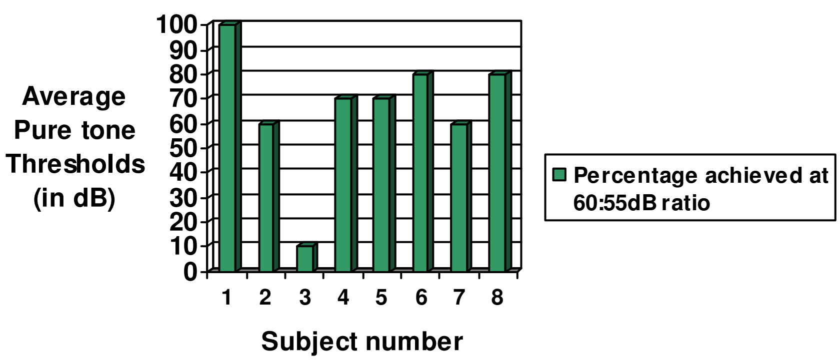

Figure 5.4 Speech in Noise Test results

Variable Speech in Noise Test results were obtained. No clear tendencies regarding culture group or language could be obtained. Five of the eight subjects obtained a Speech in Noise score of less than 80%. Only one subject achieved a score of 100%. These results emphasize that the subjects are used to listening through an FM system for most of their day, making it more difficult for them to discriminate speech in the presence of background noise. Additionally, this was the final assessment included in the hearing evaluation, and the subjects were tired and fidgety by that time.

Overall, no cultural barriers seemed to affect the audiological results, however, linguistic barriers together with individual factors such as cochlear implant experience, and chronological age, mood and energy levels could impact the final outcome of the audiological results.

5.5.3 Developmental Assessment Schema (Auditory Communication)

Table 5.8 and Figure 5.5 lists the Developmental Assessment Schema (Auditory Communication) results for each subject.

Table 5.8 Developmental Assessment Schema (Auditory Communication)

Developmental Assessment Schema (Auditory Communication)	Subject Number							
	1	2	3	4	5	6	7	8
Awareness of sound	8/8	7/8	7/8	7/8	6/8	8/8	7/8	8/8
Sound has meaning	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5
Auditory feedback	17/17	15/17	14/17	16/17	15/17	16/17	17/17	16/17
Discrimination skills	28/31	16/31	21/31	25/31	28/31	23/31	22/31	25/31
Localization skills	5/5	0/5	0/5	4/5	0/5	5/5	5/5	5/5
Distance & directional listening	7/7	5/7	5/7	7/7	7/7	7/7	7/7	7/7
Adding background noise	6/6	4/6	5/6	2/6	6/6	6/6	6/6	6/6
Auditory memory & sequencing - short-term	9/11	3/11	3/11	6/11	11/11	10/11	8/11	11/11
Auditory memory & sequencing - long-term	12/17	3/17	3/17	1/17	13/17	5/17	11/17	5/17

The information described in the above table is proposed visually in the following figure.

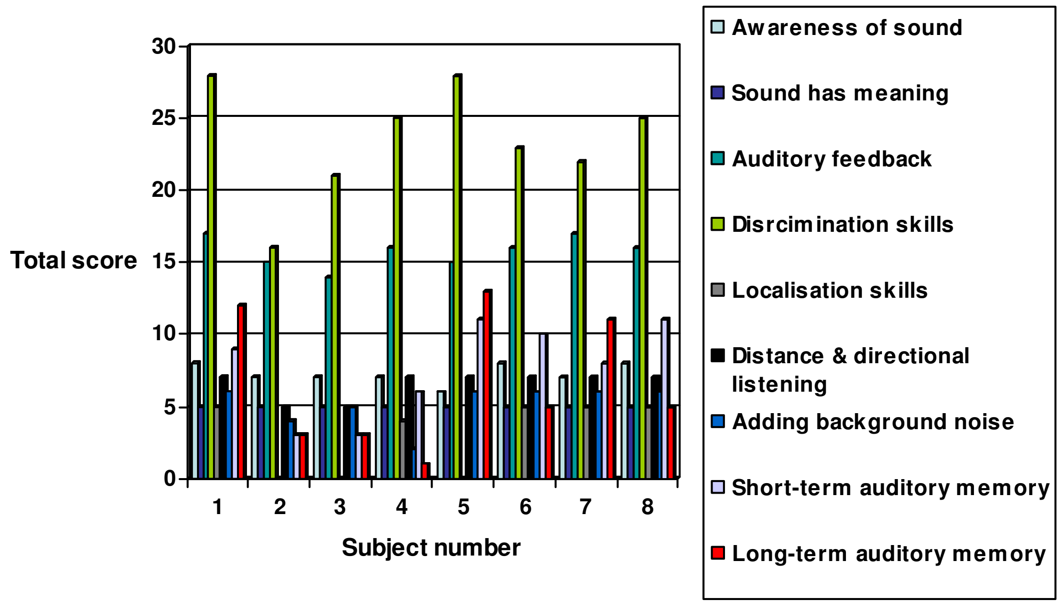

Figure 5.5 Developmental Assessment Schema (Auditory Communication)

The DAS (Auditory Communication) includes nine sub-sections. In the awareness of sound, sound has meaning, auditory feedback and distance and directional listening categories, no significant differences in the subject's scores were found. In the discrimination skills category, subject two obtained the lowest score, while the other subjects received scores above 20. Possible reasons for this phenomenon could be that subject two only had 16-months' cochlear implant experience at the time of the study and he/she was expected to process the auditory information in his/her second language, which is more difficult than processing information in his/her first language (Owens, 1999:107).

In the localization skills category, subject two, three and five achieved scores of zero. No tendency between these subjects is evident as cochlear implant experience varies between 16 and 33 months. The heterogeneity amongst the hearing impaired population is highlighted, and it is obvious that children do not function in a uniform fashion (Estabrooks, 1998:79). Subject four scored the poorest in the background noise category, partly due to the fact that he/she only had 10-months' cochlear implant experience at the time of the study.

In the auditory short-term memory and sequencing category, subject two and three had the poorest scores. Cochlear implant experience of less than two years could be a contributing factor for the lower scores as well as second language barriers for subject two, as he/she is expected to process the auditory information in his/her second language. Similarly, in the auditory long-term memory and sequencing category, subjects two, three, four and six achieved the poorest scores. Cochlear implant experience of less than one or two years may have influenced these results.

Overall, in the DAS (Auditory Communication) scale, culture or language did not affect the administration of the scale, as the scale was completed while observing the subjects in their natural environments at school and during teacher interviews. However, language barriers may influence the results obtained, as second language learners may have more difficulties processing auditory information in their second language as apposed to their first language (Owens, 1999:107). Therefore, the clinicians administering and interpreting the scale need to be aware of and sensitive to second language learners, to ensure that no biased assessments occur. In this study, the largest contributing factor to discrepancies in scores amongst the subjects was cochlear implant experience.

5.5.4 Meaning Auditory Integration Scale (MAIS)

Table 5.9 and Figure 5.6 list the MAIS results obtained from each subject.

Table 5.9 Meaningful Auditory Integration Scale (MAIS)

Subject Number	Parent Response	Teacher Response
1	39/40	28/40
2	36/40	27/40
3	31/40	32/40
4	14/40	22/40
5	35/40	32/40
6	26/40	31/40
7	37/40	28/40
8	34/40	30/40

The information described in the above table is proposed visually in the following figure.

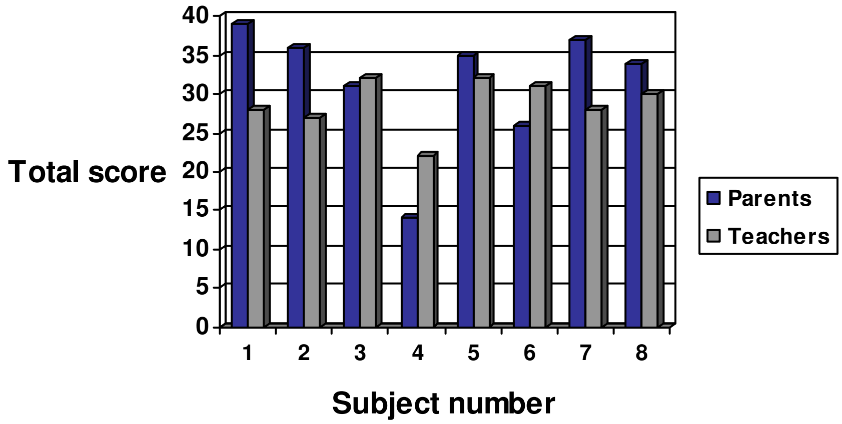

Figure 5.6 Meaningful Auditory Integration Scale

The MAIS (parent response) indicated that higher scores were given for five of the subjects compared to the responses from teachers. Research demonstrates that teachers usually give lower scores. The reason for this may be that a greater length of time is required to attach meaning to sound in the noisier classroom situation (Lutman, et.al, 1996:48). In this study, however, the subjects function in an ideal listening environment where they are exposed to FM systems for most of the day. Therefore, the poorer scores reported by the teachers are most likely not due to the noisier classroom situation, but rather due to the more realistic scores given by teachers as apposed to parents, as parents want their children to succeed and are more "lenient" when scoring.

Subjects one, five and seven, who have more than 35-months of cochlear implant experience obtained the highest scores (above 35) from the parent response. However, subject 2 who had only been implanted for 16-months at the time of the study also obtained a score of 36 from the parent response. Subjects three and eight who had 21-24 months of implant experience, received scores from 31-34. Subjects four and six who have the shortest implant experience (less than ten months) received the lowest scores from the parent response.

From the teacher response, subjects three, five, six and eight received the highest scores between 30 and 32. Subjects three, five and eight had between 21- and 33-months cochlear implant experience, however, subject six had only 4-months implant experience at the time of the study.

Subjects one, two and seven received scores between 27 and 28 and had 16-45 months of cochlear implant experience.

No significant tendencies can be obtained from the parent and teacher responses, as variable scores were obtained, and cochlear implant experience does not seem to cause significant differences between the scores. The heterogeneity of the subjects is highlighted once again (Estabrooks, 1998:79).

Cultural barriers did not seem to have an effect on the administration and interpretation of the MAIS. Language may possibly affect the outcome of the scale, as the MAIS is currently only available in English. Parents and teachers with Afrikaans, Sotho or Sign Language as their first language were therefore expected to complete an English questionnaire. The clinician should be sensitive to language differences and ensure that the parents and teachers have a complete understanding of the questions included in the MAIS.

5.5.5 Meaning Use of Speech (MUSS)

Table 5.10 and Figure 5.7 list the MUSS results obtained from each subject.

Table 5.10 Meaningful Use of Speech (MUSS)

Subject Number	Parent Response	Teacher Response
1	31/40	24/40
2	28/40	22/40
3	34/40	25/40
4	8/40	23/40
5	32/40	30/40
6	32/40	27/40
7	27/40	23/40
8	24/40	22/40

The information described in the above table is proposed visually in the following figure.

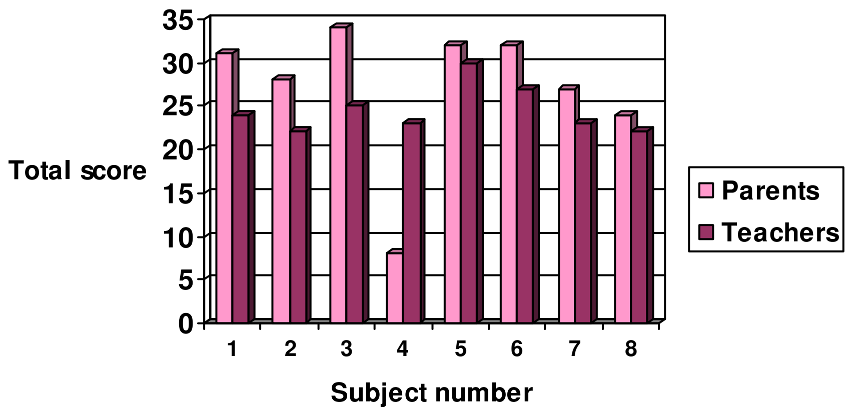

Figure 5.7 Meaningful Use of Speech Scale

For seven of the subjects, the MUSS (parent response) scores were poorer than the teacher response scores. This may demonstrate that it is more difficult for teachers to adapt too many hearing-impaired children's use of language, while it is easier for parents to understand their own child's use of language.

In the parent response questionnaire, subject one, three, five and six obtained the highest scores (above 30). Their implant experience varied from 4-33 months. Subject two, seven and eight received scores from 24-28 after 16-45 months of cochlear implant experience. Subject four received the lowest parent response score after only 10-months of implant experience at the time of the study.

From the teacher response questionnaire, subject five received the highest score (30) after 33-months of cochlear implant experience. The remaining seven subjects received scores between 22-27 and they had variable cochlear implant experience that ranged between 4-45 months.

As with the MAIS, no clear tendencies could be obtained between the subjects' scores due to the discrepancies between the variable scores obtained and the months of cochlear implant experience. It is evident that hearing-impaired children do not function in a uniform manner (Estabrooks, 1998:79). Furthermore, cultural barriers did not affect the administration and interpretation of the MUSS. However, as with the MAIS, language barriers may influence the outcome of the questionnaire, as parents and teachers are often expected to complete the MUSS in their second language, as the MUSS is currently only available in English. The clinician needs to take note of this aspect and ensure that the parents and teachers fully understand the contents of the MUSS.

5.5.6 Rossetti Infant-Toddler Language Scale

Table 5.11 and Figure 5.8 lists the Rossetti Infant-Toddler Language Scale results obtained for each subject.

Table 5.11 Rossetti Infant-Toddler Language Scale

Subject Number	Gesture (In months)	Play (In months)	Language Comprehension (In months)	Language Expression (In months)
1	>24-27 months	>33-36 months	>33-36 months	>33-36 months
2	>24-27 months	>33-36 months	33-36 months	30-33 months
3	>24-27 months	>33-36 months	30-33 months	27-30 months
4	>24-27 months	>33-36 months	33-36 months	24-27 months
5	>24-27 months	>33-36 months	>33-36 months	>33-36 months
6	>24-27 months	>33-36 months	33-36 months	30-33 months
7	>24-27 months	>33-36 months	>33-36 months	30-33 months
8	>24-27 months	>33-36 months	>33-36 months	30-33 months

The information described in the above table is proposed visually in the following figure.

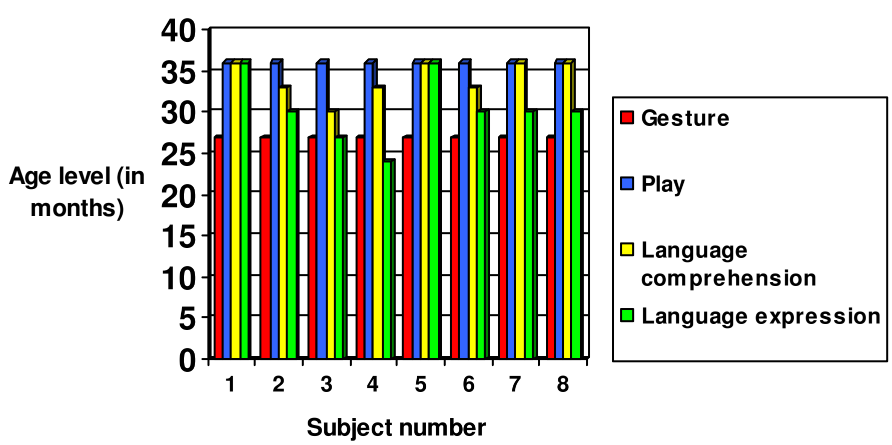

Figure 5.8 Rossetti Infant-Toddler Language Scale

The Rossetti Infant-Toddler Language Scale consists of the following categories: Interaction attachment, pragmatics, use of gestures, play development, language comprehension and language expression. However, the age levels of the subjects in this study were above the age level for the interaction attachment and pragmatics assessment. In the gesture and play category, all the subjects functioned above a 24-27 month and 33-36 month level respectively. For the language comprehension category, subjects one, four, seven and eight function above a 33-36 month level. These subjects have 24-45 months of cochlear implant experience and their chronological ages are above seven years, except for subject five who was approximately five-and-a-half years old at the time of the study.

Subjects two, four and six's receptive language was on a 33-36 month age level. They had the shortest cochlear implant experience (i.e. 4-16 months), and their chronological ages varied between four and five-and-a-half years of age. Subject three's receptive language was on the lowest level (30-33 months) after 21-months of cochlear implant experience. Subject three was five years old at the time of the study.

For the language expression category, subject one and five function above a 33-36 month age level after 31-33 months of implant experience and their chronological ages varied between five-and-a-half and seven years of age. Subjects two, six, seven and eight's expressive language was on a 30-33 month age level. Their implant experience varied between 4 and 45 months, and their chronological ages were between four and seven years of age. Subject three's expressive language was at a 27-30 month age level; although he/she had 21 months implant experience and this subject was five years old at the time of the study. On the other hand, subject four's expressive language was at a 24-27 month age level, even though he/she was only implanted for 10-months at the time of the study and was approximately five-and-a-half years old.

Research illustrates that implanted children's receptive language is usually at a higher level than their expressive language (Kirk et.al, 2003:140). From this study it was evident that the children with longer cochlear implant experience seemed to have better expressive and receptive language abilities, compared to children with shorter implant experience. Some exceptions to this generalization were present, e.g. subject three, which again highlights the heterogeneity of the hearing impaired population (Estabrooks, 1998:79). Furthermore, it is expected for the "gap" between the receptive language, expressive language and chronological age to close at a faster rate for children implanted before the age of two years, and this rate decreases when children are implanted between the ages of two and four years. For children implanted after the age of five, the "gap" would remain constant over time as language abilities improve (Kirk et.al, 2003:140).

Cultural barriers did not affect the administration and interpretation of the Rossetti Infant-Toddler Language Scale, as the scale was completed during observation of the subjects in their natural environments at school and during interviews with the teachers. However, it must be kept in mind that cultural barriers may affect the interaction attachment category, as different cultures have various views regarding communicating with their children, e.g. certain African cultures follow the principle that 'children must be seen and not heard', which may influence the results obtained from the scale. The clinician should be sensitive to all cultural differences, and keep them in mind when interpreting the information obtained and especially when providing guidelines for communication development. Although language barriers did not directly affect the administration of the scale, the clinician needs to keep the second language learners in mind and make the necessary adaptations when administering and interpreting the scale. It is also important for the clinician to distinguish between specific language disorders or early stages of second language acquisition (Owens, 1999:107).

5.5.7 Developmental Assessment Schema (General Development)

Table 5.12 and Figure 5.9 lists the general developmental age of the subjects as determined by the DAS (General Development)

Table 5.12 Developmental Assessment Schema (General Development)

DAS (General Development) (In months)	Subject Number							
	1	2	3	4	5	6	7	8
Personal-social	>60	60	57-60	60	60	60	>60	57-60
Perceptual cognitive	60	51	42-45	51-54	57-60	45-48	54-57	54-57
Self-help	>60	60	60	60	60	60	>60	>60
Gross motor	>60	60	60	60	60	51	>60	>60
Fine motor	>60	60	48-51	60	60	57-60	>60	>60
Expressive speech	60	30-33	30-33	27-30	36-39	30-33	45-48	30-33
Receptive speech	57-60	48-51	51-54	57-60	57-60	45-48	51-54	51-54

The information described in the above table is proposed visually in the following figure.

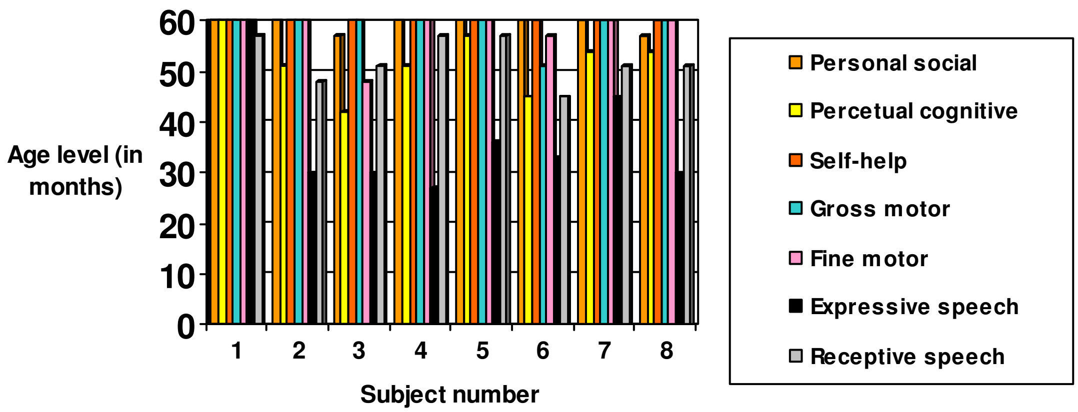

Figure 5.9 Developmental Assessment Schema (General Development)

The DAS (general development) assesses the following five developmental categories: personal-social, perceptual-cognitive, self-help, gross motor, fine motor, expressive speech and receptive speech.

In the personal-social category, subject one and seven functioned above a 60-month age level, which is appropriate for their chronological age. Similarly, subject two, four, five and six functioned at a 60-month age level, which is also appropriate for their age. Subject three and eight functioned at a 57-60 month age level, which is below the average for their chronological age. Cochlear implant experience should not directly influence personal-social skills, but could be a contributing factor.

In the perceptual-cognitive category, subject one functioned at a 60-month age level and subject five at a 57-60 month age level. Subject seven and eight functioned at a 54-57 month age level and subject two and four functioned at a 51-54 month age level. Subject six who had the shortest cochlear implant experience functioned at a 45-48 month age level. The heterogeneity of the hearing impaired population is evident in subject three who functioned at a 42-45 month age level, although he/she had 21-months cochlear implant experience at the time of the study. It is evident that the older subjects with longer cochlear implant experience function at a higher cognitive level, compared to the younger subjects with shorter implant experience. However, the individuality of the subjects is clear (Estabrooks, 1998:79).

In the self-help, gross-motor and fine motor categories, all the subjects functioned at levels appropriate for their chronological age, except for subject three who had a moderate delay in his/her fine motor skills. This information provides the clinician with a holistic overview of the subjects' general development, whereby appropriate referrals can be made if necessary.

As in the Rossetti Infant-Toddler Language Scale, it is evident that the receptive language age levels are higher than the expressive language age levels. Subject one, whose chronological age was seven years and four months, had a receptive language level of 60-months, and his/her expressive language was at a 57-60 month age level, this after 31-months implant experience. Subject two's receptive language was at a 48-51 month age level and his/her expressive language was at a 30-33 month age level, after 16-months of implant experience. The child's chronological age was five years and five months. Subject three was five years old and his/her receptive language was at a 51-54 month age level and the expressive language was at a 30-33 month age level, after 21-months implant experience. Subject four's receptive language was at a 57-60 month age level and his/her expressive language was at a 27-30 month age level, after 10-months of cochlear implant use; the child's chronological age was five years and five months. Subject five was five years and seven months old and this subject's receptive language was at a 57-60 month age level and his/her expressive language was at a 36-39 month age level, after 33-months of cochlear implant experience. Subject six's receptive language was at a 45-48 month age level, whilst his/her chronological age was four years and three months; his/her expressive language was at a 30-33 month age level, after only 4-months of cochlear implant use. Subject seven's receptive language was at a 51-54 month age level and his/her expressive language was at a 45-48 month age level, after 45-months of implant experience and the child's chronological age was seven years and three months. Subject eight's receptive language was at a 51-54 month age level and his/her expressive language was at a 30-33 month age level, after 24-months of implant use and his/her chronological age was seven years and three months.

Comparison of the Rossetti Infant-Toddler Language Scale and DAS (General Development) is not always possible as the Rossetti Infant-Toddler Language Scale measures development up to

36-months, while the DAS (General Development) measures development up to 60-months. Additionally, the scales include different categories, as well as variable aspects within the categories. It may be possible to compare expressive and receptive language if the children function at, or below, a 36-month age level. According to the current study, some subjects function on a higher language level according to the DAS (General Development), and a lower language level according to the Rossetti Infant-Toddler Language Scale. This could be due to the differing aspects included in the receptive and expressive language categories, making direct comparisons difficult. The clinician should therefore focus on the information obtained from both the DAS (General Development) and Rossetti Infant-Toddler Language Scale, in order to provide appropriate intervention and make the necessary referrals, rather than directly comparing the two scales.

No significant tendencies between the subjects' chronological age, cochlear implant experience and general development could be identified. However, it is expected that the cochlear implant users with longer experience have a smaller "gap" between their chronological age and language abilities (Kirk et al, 2003:140). This phenomenon was evident in subject one and seven, but there were definite exceptions to the rule which is to be expected when working with a heterogeneous population.

Cultural barriers did not seem to affect the administration and interpretation of the DAS (General Development), but, on the other hand, language barriers can affect the administration and outcome of the results, especially within the expressive and receptive language categories. The DAS (General Development) was completed during observation of the subjects at school, during interaction with the subjects, and during interviews with the teachers. The clinician must therefore make the necessary adaptations during the application of the DAS (General Development) on second language learners to ensure that the language barriers are overcome.

5.5.8 Reynell Developmental Language Scales III (Verbal Comprehension)

Table 5.13 and Figure 5.10 list the results obtained from the Reynell Developmental Language Scales III (Verbal Comprehension).

Table 5.13 Reynell Developmental Language Scales III (Verbal Comprehension)

Reynell Developmental Language Scales III (Verbal Comprehension)	Subject Number							
	1	2	3	4	5	6	7	8
Chronological age (in years & months)	7.04	5.05	5.00	5.05	5.07	4.03	7.03	7.03
Age equivalent (in years & months)	6.07-7.00	2.02	2.08	2.00	4.03	3.02	3.06	2.11

The information described in the above table is proposed visually in the following figure.

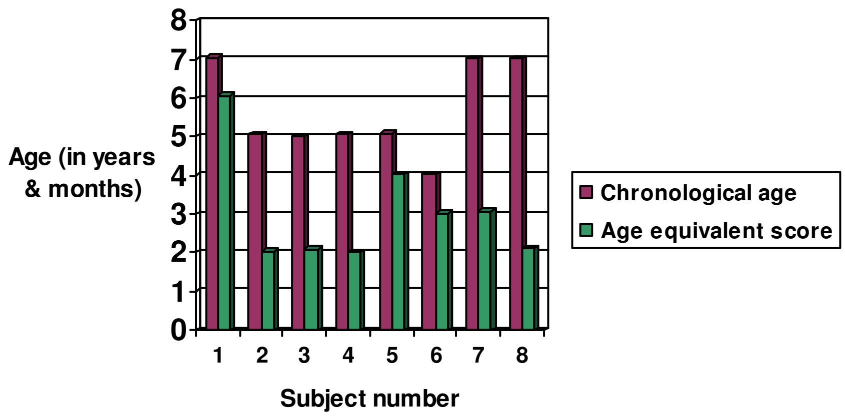

Figure 5.10 Reynell Developmental Language Scales III (Verbal Comprehension)

Subject one's chronological age was 7.04 years and his/her verbal comprehension was at a 6.07-7.00 year age level after 31-months of cochlear implant experience. Subject two's chronological age was 5.05 years and his/her verbal comprehension was at a 2.02-year- age level after 16-months implant experience. Subject three's chronological age was 5 and his/her verbal comprehension was at a 2.08-year age level after 21-months cochlear implant use. Subject four's chronological age was 5.05 years and his/her verbal comprehension was at a 2 year age level after 10 months of cochlear implant experience. Subject five's chronological was 5.07 years and his/her verbal comprehension was at a 4.03 years age level after 33-months of implant experience. Subject six's chronological age was 4.03 years and his/her verbal comprehension was at a 3.02 years age level after only 4-months of cochlear implant use. Subject seven's chronological age was 7.03 years and his/her verbal comprehension was at 3.06 years age level after 45-months of cochlear implant experience. Subject eight's chronological age was 7.03 and his/her verbal comprehension was at a 2.11 year age level after 24-months of implant experience.

Research demonstrates that in children implanted before the age of five years, the “gap” between their receptive language and chronological age will close over time with increased cochlear implant experience. In children implanted after the age of five years, the”gap” remains constant over time. (Kirk et.al, 2003:140; Vermeulen et.al, 1999:4). This phenomenon was evident in subject eight who had been implanted after the age of five years, as a large “gap” remains even though his/her language abilities are improving. It is therefore expected that the “gaps” for subjects one to seven will close over time, however, the rate at which they will close will depend on the age at implantation, i.e. the younger the age at implantation, the faster the rate of “gap” closure between the receptive language and chronological age (Kirk et.al, 2003:140; Vermeulen et.al, 1999:4).

No cultural barriers seemed to affect the administration and interpretation of the Reynell Developmental Language Scales III (Verbal Comprehension). Language barriers can definitely affect the end-result of this assessment, as standardised assessments always run the risk of being biased to second language learners. In general, second language acquisition is more difficult than first language acquisition, which for most children is fairly effortless. A language assessment must distinguish between those errors that reflect this difficulty and those that represent a language impairment (Owens, 1999:107). Therefore, the clinician needs to make the necessary adaptations when administering and interpreting the Reynell Developmental Language Scales III (Verbal Comprehension), to ensure that second language learners are accommodated.

5.5.9 Parent-Child Interaction

Table 5.14 and Figure 5.11 list the scores of the parent-child interaction analysis.

Table 5.14 Parent-child interaction

Parent-Child Interaction	Subject Number							
	1	2	3	4	5	6	7	8
Tactile stimulation	4/4	4/4	4/4	4/4	4/4	4/4	4/4	4/4
Pleasure during interaction	4/4	4/4	4/4	4/4	4/4	4/4	3/4	3/4
Responds to distress	4/4	4/4	4/4	4/4	4/4	4/4	4/4	4/4
Eye to eye contact	4/4	4/4	4/4	4/4	4/4	4/4	4/4	4/4
Smiles contingently	4/4	4/4	4/4	4/4	4/4	4/4	4/4	4/4
Varies prosodic features	4/4	4/4	4/4	4/4	4/4	4/4	4/4	4/4
Encourages conversation	4/4	4/4	4/4	4/4	4/4	4/4	4/4	4/4
Responds to behaviour	4/4	4/4	4/4	4/4	4/4	4/4	4/4	4/4
Modifies interaction	4/4	3/4	4/4	4/4	4/4	4/4	4/4	4/4
Uses communication to teach language	4/4	4/4	4/4	4/4	4/4	4/4	4/4	4/4

The information described in the above table is proposed visually in the following figure.

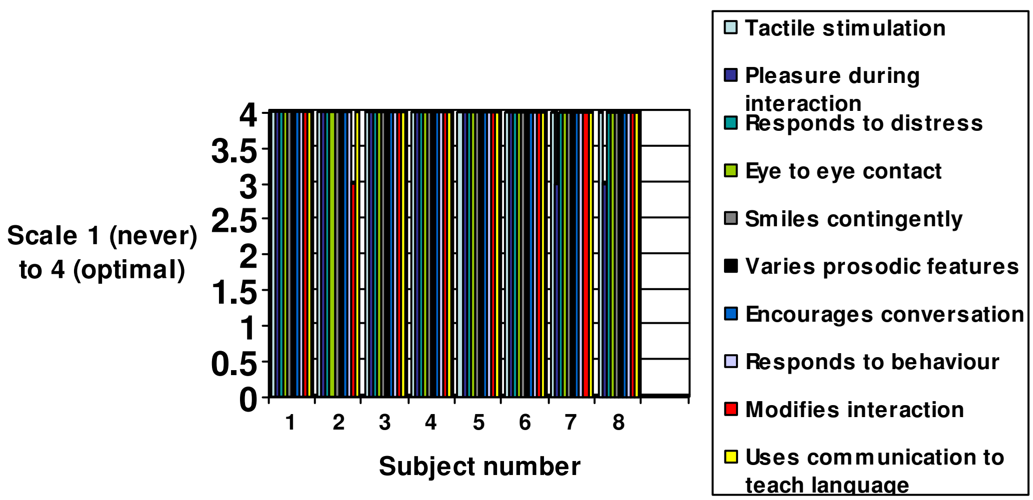

Figure 5.11 Parent-Child Interaction

The parent-child interaction assessment evaluated the following ten aspects regarding the interaction between the parents and the subjects: tactile stimulation, pleasure during interaction, response to distress, eye-to-eye contact, smiles contingently, varies prosodic features, encourages conversation, responds to behaviour, modifies interaction and uses communication to teach language.

All the subjects scored a 4 (optimum) in all the categories, except for subject seven and eight that scored a 3 for the 'pleasure during interaction' category, and subject two who scored a three for the 'modifies interaction' category. Linguistic or cultural barriers did not seem to affect the administration and interpretation of the parent-child interaction as all the subjects received similar scores. The parents at the school also receive compulsory parent training, contributing to the fact that the subjects received similar and mostly optimum scores for the parent-child interaction checklist.

5.5.10 Speech Intelligibility Rating (SIR)

Table 5.15 and Figure 5.12 list the SIR scores achieved by each subject.

Table 5.15 Speech Intelligibility Rating (SIR)

Speech Intelligibility Rating	Subject Number							
	1	2	3	4	5	6	7	8
Scale 1 (unintelligible) to 6 (intelligible)	4	3	3	3	3	3	4	3

The information described in the table above, is proposed visually in the following figure.

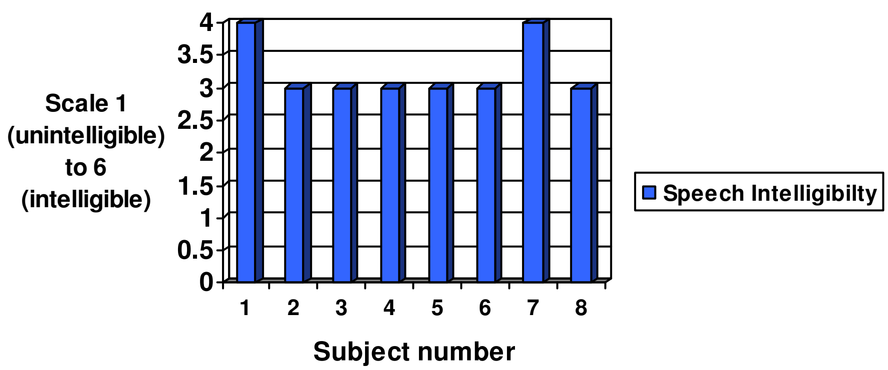

Figure 5.12 Speech Intelligibility Rating

Subjects one and seven scored a four, which indicates that their speech is intelligible to a listener who concentrates and lip-reads. The other subjects scored a three, which indicates that their speech is unintelligible, but experienced listeners can follow a known topic. Subjects one and seven had 31-45 months of cochlear implant experience, which validates their score. The other subjects had mostly shorter cochlear implant experience, and therefore scored a three. Speech abilities before implantation also contribute to the scores obtained. Linguistic barriers do not affect the outcome of this scale; however, cultural barriers may, as the Asian and Black subjects have an accent that causes their speech to be more unintelligible to a person that may not be used to the accent, regardless of the speech delay (Owens, 1999:106).

5.5.11 Voice Skills Assessment (VSA)

Table 5.16 describes the voice quality of the subjects.

Table 5.16 Voice Skills Assessment (VSA)

Voice Skills Assessment	Subject Number							
	1	2	3	4	5	6	7	8
Normal vs. abnormal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal

The Voice Skills Assessment (VSA) Scale indicated normal voice qualities in all the subjects. Research illustrates that cochlear implantation tends to normalize voice qualities (Perrin et.al, 1999:7). Cultural or linguistic barriers do not seem to have an effect on the administration and interpretation of the VSA scale.

5.5.12 Preschool Literacy Assessment

Table 5.17 describes the preschool literacy skills of the subjects.

Table 5.17 Preschool Literacy Assessment

Subject Number	Level of Preschool Literacy Skills
1	Same level as hearing peers
2	Same level as hearing peers
3	Same level as hearing peers
4	Same level as hearing peers
5	Same level as hearing peers
6	Same level as hearing peers
7	Same level as hearing peers
8	Same level as hearing peers

All the subjects' preschool literacy skills were at the same level as their hearing peers in the classroom. Cultural or linguistic barriers do not seem to have an effect on the administration and interpretation of the Preschool Literacy Assessment, as the cochlear-implanted children are receiving similar preschool literacy training as their hearing peers. They also receive additional individual sessions, which reinforce and ensure understanding of the aspects covered in the lessons.

5.5.13 Profile of Actual Linguistic Skills (PALS)

Table 5.18 describes the linguistic levels of the subjects according to the PALS.

Table 5.18 PALS

Subject Number	Stage of Linguistic Development
1	Transitional language stage
2	Transitional language stage
3	Transitional language stage
4	Transitional language stage
5	Transitional language stage
6	Transitional language stage
7	Transitional language stage
8	Transitional language stage

All the subjects were within the transitional stage of linguistic development, which was a pre-requisite for subject selection for the current study. The PALS considers communication, receptive language, and expressive language, voice and speech ratings in order to "profile" the subjects. Cultural or language barriers did not have a direct influence on the administration and interpretation of the PALS, although the clinician involved should be sensitive to language barriers and should make the necessary adaptations for second language learners.

5.6 SUB-AIM FIVE: THE OVERALL VALUE OF THE ASSESSMENT PROTOCOL

The question posed in sub-aim five was whether the assessment protocol would be valuable in an inclusive educational setting. The question may be answered by critically evaluating the results of the previous four sub-aims.

The protocol includes the different assessment areas considered vital in the paediatric cochlear implant population (Mahshie, 2006:82; Dyar, 2003), and the protocol ensures that the children are looked at holistically during the assessment (Umansky & Hooper, 1998:341).

The auditory assessment determines if the device is functioning and monitors listening skills and development. The DAS (General Development) and Rossetti Infant-Toddler Language Scale evaluate general development, and they provide a general overview of development in the paediatric population.

The MICS and Caregiver Child Interaction Scale were completed during the video analysis. Valuable information regarding the interaction between the parents and subjects was obtained, and the results can be used during parent guidance sessions in order to ensure that an optimal environment for speech, language and auditory development is created at home.

Informal and formal measures were used to evaluate expressive and receptive language. A clear indication of the age level at which the subjects function was obtained. The SIR and VSA document the intelligibility of emerging speech and voice skills. The Preschool Literacy Assessment gives an overview of literacy skills.

Questionnaires (MAIS and MUSS) completed by the parents and teachers were also included in the protocol as it is important to receive information from the people who know the child best, before any conclusions can be made about a child's development (Venter, 2000:90; Lutman et.al, 1996:48).

It can be concluded that the protocol can be successfully administered on young children with cochlear implants, in the transitional stage of spoken language development. The protocol also ensures that the crosscheck principle is being applied, as some overlapping occurs in the assessments included in the protocol.

All the results obtained from administering the protocol are valuable for future habilitation; long- and short-term goal setting, as well as to monitor progress in the paediatric cochlear implant population.

The duration for the administration and interpretation of the protocol has proven to be realistic within a clinical setting. Although some linguistic barriers that may affect the outcome of the results when assessing receptive and expressive language are identified, these can be overcome by being especially sensitive when assessing a child in his/her second language, and possibly by making use of an interpreter when assessing, in order to clarify difficult concepts (Owens, 1999:109). Cultural barriers did not seem to have an affect on the administration and interpretation of the protocol; however, clinicians need to be culturally sensitive in all assessments in order to ensure the validity of the results obtained.

The protocol makes use of many informal measures as well as one standardised measure for verbal comprehension, although informal measures are more popular in the paediatric population (Shipley & McAfee, 1998:184). Informal measures are easily applied in a natural setting; therefore the child can be evaluated in a setting where he/she is most comfortable (Shipley & McAfee, 1998:191). The informal and formal assessments allow easy monitoring of progress on an annual basis, and give clear guidelines for further intervention. Therefore, the use of the proposed assessment protocol in an inclusive educational setting seems feasible and valuable for use by the Pretoria Cochlear Implant Programme.

The results of this study indicate that the proposed assessment protocol is clinically appropriate for use within the Pretoria Cochlear Implant Programme. The type of areas assessed and the results obtained, are appropriate for young cochlear implant users in the transitional stage of language development. Furthermore, the duration for the administration and interpretation of the assessment protocol seems feasible and can be used within a clinical setting. Although linguistic barriers were identified, these barriers can be overcome if the clinicians involved are sensitive to language and cultural issues that may arise during assessments. From the above-mentioned aspects, it is clear that the proposed assessment protocol is relevant and valuable; and could be used efficiently within an inclusive educational setting.

5.7 RECOMMENDED CHANGES FOR THE ASSESSMENT PROTOCOL

From the results of sub-aim one, two, three, four and five, the following recommendations are made to change the assessment protocol.

Firstly, the MICS is not appropriate for children that are older than 36-months. Secondly, the DAS (General Development) is not appropriate for children older than 60-months. It is recommended that another scale should be used for describing the general development of children older than 60-months. Alternatively, the similar developmental areas should be used, but described qualitatively during assessments. Thirdly, the Rossetti Infant-Toddler Language Scale can only be used for infants up to the age of 36-months, and therefore aspects included in the scale are inappropriate for older children. Fourthly, the background questionnaire, MAIS and MUSS assessments are currently only available in English. In order to prevent misinterpretations of the content, and to accommodate parents and teachers whose first language is not English, it is recommended that these questionnaires be translated into Afrikaans and the commonly used African languages, to ensure that all the questionnaires that are used, are linguistically appropriate.

Furthermore, as a large amount of conditioning was necessary during the hearing assessments, an assistant audiologist should be used when assessing the hearing and speech perception abilities of young cochlear implant users. It is suggested that the same assistant audiologist be used during all assessments to enhance the reliability of the study. Using an assistant audiologist would also result in shorter test durations, making the hearing assessments more time efficient. Moreover, it is suggested that the Listening Progress (LiP) developed by the Nottingham Cochlear Implant Programme be used instead of the DAS (Auditory Communication). The DAS (Auditory Communication) is lengthy and takes a long time to complete and the LiP was specifically designed for children with cochlear implants (Archbold, 1994:200). Therefore, it would be more time efficient and valid for children with cochlear implants. Lastly, the assessment protocol did not include a specific assessment for pragmatics, although pragmatics can be easily assessed during observation of a child in his/her natural environment. As children mature, they gain increasingly more complex categorisation or word-associational strategies and increasingly more complex organisational word and structure systems. The most appropriate and effective way of expressing oneself depends on a number of variables that are stylistic, socio-emotional, personal and contextual. In other words, linguistic variation is the result of skills in pragmatics or language use (Owens, 1998:286). It is recommended that the Pragmatic Aspects of Language (Prutting & Kirchner, 1987:105-119) be included in the protocol, to provide a guideline for the assessment of pragmatics.

Table 5.19 summarises the new recommended assessment areas and individual assessments according to the results of this study.

Table 5.19 Recommended assessment protocol

Assessment areas					
Auditory Abilities ***Make use of an assistant audiologist***	**Language Abilities**	**Speech Abilities**	**General Development**	**Parent-Child Interaction**	**Questionnaires** **Available in English, Afrikaans and African languages*
• Aided audiogram (125-8000Hz) • Speech discrimination • Speech in Noise Test • Tympanometry • Checklist: Listening Profile (LiP)	• Checklist: DAS (Expressive and receptive language) • Checklist: Rossetti Infant-Toddler Language Scale (receptive and expressive language) • Checklist: Profile of Actual Linguistic Skills (PALS) • Checklist: Pragmatic Aspects of Language • Standardised test: Reynell Developmental Language Scales III - Verbal Comprehension	• Checklist: Speech Intelligibility Rating (SIR) • Checklist: Voice Skills Assessment (VSA) • Checklist: Profile of Actual Linguistic Skills (PALS)	• Checklist: DAS (gross and fine motor, personal-social, self help and perceptual-cognitive) **For children under the age of 60-months* • Checklist: Rossetti-Infant-Toddler Scale (gross and fine motor, play and gestures) **For children under the age of 36-months* • Qualitative assessment of general development (gross and fine motor, personal-social, self-help and perceptual-cognitive) **For children over the age of 60-months* • Checklist: Preschool literacy assessment	• Checklist: Mother Infant Communication Screening (MICS) (video analysis) **For children under the age of 36-months* • Checklist: Caregiver-Child Interaction (video analysis) **For children over the age of 36-months*	• Background information (parents) • Meaningful Auditory Integration Scale (MAIS) (parents and teachers) • Meaningful Use of Speech (MUSS) (parents and teachers)

5.8 RECOMMENDATIONS FOR THE EDUCATIONAL SETTING

Subsequent to the administration and interpretation of the assessment protocol, certain issues were highlighted. The positive aspects of the inclusive educational setting were clear. First of all, the hearing-impaired children were able to function in an inclusive setting as they share classrooms and activities with their hearing peers, and simultaneously receive the additional support services that they need. Furthermore, compulsory parent guidance offered at the school is undoubtedly beneficial to the subjects and their parents. During the parent-child interaction assessment, optimal scores were mostly obtained. Lastly, the subjects' preschool literacy skills were all at the same level as their hearing peers. This is indicative that a large amount of time is spent on book reading and literacy activities.

The concerns that emerged from this study was firstly that the subjects are used to listening in ideal circumstances only, and they experience difficulties when the circumstances change, or when the FM systems are not used. This was evident in the poor 'Speech in Noise Test' results that were obtained. Providing individual sessions or therapy while introducing background noise may assist the individuals to function better in noisy situations, as well as to listen even if the auditory signal is soft or not optimal (Clark et.al, 1997:214). In addition, it was apparent that the subjects are not used to speech discrimination assessments, even though it is strongly recommended in the literature (Scott, 2002:10-26). It is therefore suggested that the educational setting ensures that speech discrimination testing is always included as part of the hearing assessment. Furthermore, poor receptive language scores were evident in all the subjects. It is expected that the "gap" between the chronological age and language scores will close for children implanted before the age of five years (Kirk et.al, 2000:140). Hence, in order to improve the children's language abilities, it is suggested that individual sessions should focus on auditory highlighting of certain sounds or concepts that are below average for their age to enhance their general language abilities and to increase the rate at which their receptive and expressive language develop.

5.9 SUMMARY

In this chapter the results obtained in the current study were discussed according to the five specified sub-aims. These sub-aims were selected in an attempt to answer the main aim of the study. Each sub-aim provided results that were discussed and integrated with current literature to ascertain the validity thereof. A summary of the results was compiled from the findings in each sub-aim, and supplied at the end of the chapter. Recommendations for adaptations to the current protocol followed. The results provided the current study with some clinical implications for further research and applications in the clinical setting.

CHAPTER 6

CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

The main aim of the current study was to determine the relevance of an assessment protocol, which was designed by the Pretoria Cochlear Implant Programme. The protocol was administered on children with cochlear implants in the transitional stage of language development, in an inclusive educational setting. Conclusions drawn from each sub-aim, including the implications of the results obtained will de discussed. This will be followed by the shortcomings and advantages of the current research. In the final section of this chapter, recommendations for further research will be discussed.

6.2 CONCLUSIONS AND IMPLICATIONS FOR CLINICAL PRACTISE

6.2.1 The type of information obtained from the protocol to determine if over- or under-evaluation is occurring

The literature regarding the vital areas of assessment in the paediatric cochlear implant population was critically examined, to ensure that all the essential areas for monitoring of progress in children with cochlear implants, is included in the proposed protocol. Auditory abilities, language skills, speech, voice, general development and parent-child interaction are the areas included in the protocol. Furthermore, research highlights the importance of including the parents and teachers in the assessment process. This was accomplished by requesting the parents and teachers to complete questionnaires pertaining to their children's use of audition and speech. Therefore, as all the vital areas of assessment are covered in the protocol, under-evaluation is not a concern. Some overlapping occurs with the MICS and Caregiver-Child Interaction, as well as with the Rossetti Infant-Toddler Language Scale, DAS (General Development) and Reynell Developmental Language Scale III. However, these assessments ensure that the crosscheck principle is being applied, and should not be seen as overlapping, but rather to ensure that accurate information is being obtained from the assessment. Additionally, the DAS (General Development), Rossetti Infant-Toddler Language Scale and MICS were not age-appropriate for all the subjects, and therefore should only be used for younger children that are age-appropriate. The PALS gave an overview of the children's language developmental level and was used to select the subjects for this study. The other assessments included in the protocol are used to perform an in-depth assessment of the child's abilities on an annual basis to monitor progress. It is recommended that in-depth assessments occur on an annual basis only after to years of cochlear implant experience, to ensure that progress is closely monitored and to note developmental patterns of change. Intervention goals should also be changed accordingly (Tye-Murray, 2004: 751).

6.2.2 The type of information gained from the assessment protocol

The assessment results obtained for each child on all the procedures included in the protocol were used to critically evaluate and describe the type of information gained from the proposed assessment protocol.

After the administration and interpretation of the assessment protocol, it was clear that the protocol could be successfully administered on young children with cochlear implants, in the transitional stage of linguistic development. The information gained can be used effectively for future intervention planning and adaptations can be made where necessary. The background information questionnaire provided important information regarding the subject's family set-up, implant experience, previous hearing-aid use, culture group and languages spoken. This information is essential for intervention planning and possible prognostic predictions.

The audiograms provided essential information to (a) ensure that the device is functioning properly, and (b) that the subject's speech perception abilities in quiet and noisy conditions are tested. One of the ultimate goals of cochlear implantation is that the person should learn to listen and comprehend speech. The DAS (Auditory Communication) provided an indication of the subjects' listening abilities within their natural environments. For a young child who is implanted with a cochlear device, it takes time to achieve the level of listening for the comprehension of speech. The language input he/she receives and the age of implantation plays a decisive role. The DAS (Auditory Communication) checklist provides information regarding the exact stage of auditory development of the child. In the current study, all the children were past the awareness of sound stage, and their scores indicated that they functioned on the discrimination skills stage where they were starting to comprehend speech. That was the motivation for using the children who functioned on the transitional stage of language development according to the PALS for this study. These results can provide information regarding the correlation with the PALS language level and possibly with the Reynell Developmental Language Scale III (Verbal Comprehension) results.

The teachers and parents contributed to the assessment by completing the MAIS and MUSS questionnaires, as they know the children best and are able to provide information regarding the children's use of audition and speech in the educational and home environments. Assessment of parent-child interaction allows for parent guidance to ensure that the child has an optimal environment in which speech, language and auditory acquisition can occur. Their language abilities and general development were assessed using the DAS (General Development), Rossetti Infant-Toddler Language Scale, PALS and Reynell Developmental Language Scale III (Verbal Comprehension). The SIR and VSA provided information regarding the subjects' speech and voice abilities. The Preschool Literacy Assessment compared the subjects' literacy skills to their hearing peers. The proposed protocol ensured that holistic assessments that can be repeated at specified intervals, or at least annually, are included.

Moreover, the protocol included subjective assessments that can be administered in natural settings, as well as objective measurements that can be used for progress monitoring over time. Video analysis allows for repeated viewing and comparisons of the child's progress can be made during future assessments.

6.2.3 The duration for administering and interpreting the assessment protocol

Subsequent to the administration and interpretation of the proposed protocol, it was found that it took approximately four hours per subject. It is expected that this time duration will decrease as the subjects become more comfortable with the "test situation" and the parents and teachers will know what type of information is expected from them during an assessment. Furthermore, after repeated interpretation of the same assessment protocol, the duration for interpretation will decrease. Therefore, it can be concluded that the administration of this protocol is time efficient and can be used effectively within the clinical setting of the Pretoria Cochlear Implant Programme.

6.2.4 Language and cultural barriers affecting the administration and interpretation of the assessment protocol

Following the administration and interpretation of the proposed protocol, it was evident that during the auditory ability assessment, no cultural barriers affected the results, however, linguistic barriers together with individual factors such as length of cochlear implantation experience, chronological age, mood and energy levels would have an understandable impact on the final outcome of the audiological results. The DAS (Auditory Communication), DAS (General Development), Rossetti Infant-Toddler Language Scale, PALS, VSA, SIR and Preschool Literacy Assessment were not directly affected by cultural or linguistic barriers, as the checklists were completed during observation of the subjects in their natural contexts at school and during teacher interviews. When rating the SIR, it is essential to take cultural aspects such as accents into account to ensure that accurate, unbiased scores are given.

During the administration of the Reynell Developmental Language Scale III, linguistic barriers can definitely affect the outcome of the results, which is typical when using standardised assessments on second language learners. Cultural and linguistic barriers did not affect the parent-child interaction assessment, as the checklist was completed during video analysis. Similarly, the MAIS and MUSS was not directly influenced by linguistic or cultural barriers, however, linguistic barriers can affect the end-result as teachers and parents are often expected to complete the questionnaires in their second language and currently the MAIS and MUSS are only available in English. It is therefore the clinician's responsibility to ensure that the parents and teachers fully understand the contents of the questionnaires, or to make use of translated questionnaires, to ensure that any linguistic barriers are eliminated.

From the above discussion, it can be concluded that overall, cultural barriers did not affect the administration and interpretation of the proposed assessment protocol. On the other hand, linguistic barriers can have a larger impact on the outcome of the results obtained, as second language learners are expected to receive instructions, respond and process auditory information in their second language, which is more difficult than processing information in their first language. The clinician should therefore be aware of, and sensitive to, the cultural and linguistic barriers, and should make the necessary adaptations during the administration and interpretation of the protocol, ensuring that unbiased assessments do not occur.

6.2.5 The overall value of the assessment protocol

The proposed assessment protocol offers a framework with which to assess audition, language and communication in real-life situations. It is innovative in design and offers a structured approach to the behaviour of young children with a hearing loss. Although designed for use within a cochlear implant programme, it can be used with a range of children with a hearing loss, where information is required about their development in audition and speech production as well as aspects of communication and language development. The protocol also provides a means of monitoring development both in the short-term, looking in detail at small changes in behaviour; and in the long-term, looking at significant changes over time. This is an essential requirement when working with young cochlear implant users, as the long-term goals can only be accomplished once the short-term goals have been achieved. When difficulties or problems are identified, adjustments are made to the short-term goals in order to reach the long-term goal of functional spoken language and intelligible speech. The protocol is time-efficient and can be incorporated into standard practice and procedures. The assessment protocol includes observation in natural contexts and reports involving parents and teachers. This means it does not only depend on elicited behaviours, which can be very unreliable in young children. The Reynell Developmental Language Scales III (Verbal Comprehension) was included as a standardised measure in order to monitor progress in the long-term, and prepare the young cochlear implant users for more structured assessments. This is essential especially if the child is referred to a mainstream educational setting. Additionally, the clinicians needed to keep the cultural and linguistic barriers in mind and were required to make the necessary adaptations when assessing second language learners.

The protocol is useful because it focuses on a child's strengths as well as weaknesses, thereby providing a comprehensive assessment as a basis for management. In addition to monitoring the child's development, it allows for the identification of additional problems and areas of difficulty as well as specific abilities and skills. This enables the clinician to determine appropriate intervention strategies, and to monitor them according to the observed progress. It also provides indications for other assessments or referrals necessary to explore developmental difficulties.

Clear information about cochlear implant users' progress is needed for a number of purposes. Information is provided to parents on which to base the decisions they make about the educational management of their child. The information obtained from the assessments included in the protocol provides clear, objective and accessible information on an individual child's development. As a more general resource, it provides both parents and professionals with information on large groups of children in terms of expected rate of progress as a basis for intervention planning for an individual child. This information may also help highlight areas in which progress does not meet expectations and which may need in-depth assessments or referrals to other professionals (e.g. ENT surgeons, Paediatricians and Occupational Therapists). For local professionals working with hearing impaired children, it is helpful to have a means to measure change. A strength of the protocol is the fact that its measures can be used in a variety of settings. Moreover, most of the measures are easily understood by non-professionals and can be translated into other languages. The data obtained from the protocol also contributes to the more general information required concerning the children's progress for audit and predictive purposes.

Some of the factors such as age, other disabilities and lack of available support services may not be amendable to change. Nevertheless, a systematic identification and documentation procedure, such as the proposed assessment protocol, may highlight the need for counselling and assist implant programme professionals to prioritize or target the intervention accordingly in order to reduce the sequel of such problems. Finally, the results obtained from the protocol may contribute to the funding process of cochlear implants. Medical aids and insurance companies need evidence-based and up to date information for both current users and prospective users, as well as for future planning and allocation of resources. The protocol can be a neutral, yet sensitive way of promoting positive interdisciplinary collaboration and peer support with team discussions. “An important element of the rehabilitation programme is the monitoring of progress over a period of at least five years after implantation. This ensures adequate device performance, identifies problems and sets suitable expectations for parents and professionals local to the child. A wide range of tests is needed because the ages of children implanted are often low, and their linguistic status varies from preverbal through transitional to having functional language” (Lutman, et.al, 1996:49).

In summary, the assessment protocol has been shown to be innovative, time effective, user-friendly, informative and relevant for the assessment of young cochlear implant users in the transitional stage of language development in an inclusive educational setting.

6.3 SHORTCOMINGS OF THE CURRENT STUDY

As is the case with most research, shortcomings are commonly identified. The shortcomings of this current research are as follows:

Firstly, only eight subjects were used for this study; however, detailed and in-depth assessments resulted in large amounts of data for each subject. Secondly, the duration for the administration of the protocol was lengthy, especially the duration for the assessment of auditory abilities. The duration of the hearing assessments could have been considerably reduced if the researcher made use of the same assistant audiologist throughout the study, rather than asking the parents to assist with the conditioning of the children. Thirdly, the protocol was administered in absolutely ideal conditions with FM systems. These circumstances are not commonly found at other educational settings. Nevertheless, difficulties experienced by cochlear implant users in absolutely ideal settings were highlighted. Lastly, the background questionnaire, MAIS and MUSS assessments were only available in English at the time of the study. Some of the parents’ and teachers’ first languages were Afrikaans, Sotho and Sign Language. Consequently, the questionnaires were completed in the parents' and teachers' second language, which could have affected the validity and reliability of the results, as the risk for misinterpretations increased. However, the researcher did assist the parents and teachers that did not fully understand the content of the questionnaires by explaining the content in their first language or by using simpler English language.

6.4 ADVANTAGES OF THE CURRENT STUDY

This study is the first of its kind for the Pretoria Cochlear Implant Programme. By determining the relevance of the assessment protocol, the Pretoria Cochlear Implant Programme can start to collect outcome measures of all the children implanted within their programme and can develop a database using the same assessment protocol. Furthermore, the subjects included in this study received a complete auditory, speech and language assessment, whereby adaptations to their intervention programme can be made. These results were also made available to the Pretoria Cochlear Implant Programme, so that a database of outcome measures can be established. The outcome measures can be used for prognostic predictions for future cochlear implant candidates and for funding purposes. Moreover, the researcher selected a school representative of an inclusive educational setting with approximately twenty to twenty-five learners in a classroom. Ideal circumstances for auditory learning are provided at the school. The results of this study provided information regarding the advantages and disadvantages of the inclusive educational setting, as well as recommendations for possible solutions. Additionally, the protocol used ensured that different assessments were included to verify the results obtained. Finally, the heterogeneity of the cochlear implant population was continuously highlighted throughout the study. Therefore, direct comparisons between the subjects were impossible although certain outcome measures can be described qualitatively. The results of this study illustrated the importance of reporting individual scores, as reporting average scores across individuals does not specify the most critical information. The most important focus is the absolute level of performance for each child in order to monitor progress. The proposed protocol provides individual data that can be reported in scattergrams or bar graphs. After the administration and interpretation of the protocol, the results obtained can be used for reporting possible reasons for device failures. Professionals can also investigate and share information on the potential reasons for poor performance in those children who appear to be "under-functioning", as well as providing information on star implant users.

6.5 RECOMMENDATIONS FOR FUTURE RESEARCH

As in the case with all research, the methodology and findings lead to recommendations for further research in this field. The following specific recommendations apply to future research.

- Although the proposed assessment protocol appears to be a relevant method for assessing effective cochlear implantation, intervention strategies and for monitoring progress over time, more research is necessary to determine the current protocol's sensitivity to longitudinal change.
- The background questionnaire, MAIS and MUSS are currently only available in English. This could result in misinterpretation for parents and teachers whose first language is not English. The translation of these questionnaires into Afrikaans and commonly used African languages would prevent any misinterpretation on the content included in the questionnaires.
- The assessment protocol used in this study was specifically designed for cochlear implant users in the transitional stage of language development. Assessment protocols for children in the pre-verbal and functional language stage need to be piloted in various educational settings in order to determine their relevance for use within the Pretoria Cochlear Implant Programme.
- In this study, the assessment protocol was administered on children in an inclusive educational setting. The current protocol can be applied to children in other educational settings, e.g. special schools for the hearing-impaired or within mainstream schools.
- Although all the assessments included in the protocol were proven to be relevant for use within an educational and clinical setting, further research could be done to possibly substitute certain assessments included in the current protocol, e.g. the value of using the LiP (Listening Progress) devised by the Nottingham Cochlear Implant Programme instead of using the DAS (Auditory Communication).

- Further research is needed to determine the value of using the proposed assessment protocol as part of the cochlear implant candidate selection procedure for the Pretoria Cochlear Implant Programme.
- Research regarding the effects of linguistic barriers can be investigated by providing questionnaires to parents firstly in English, and then in their first language to determine the effects of the linguistic barriers on the answers received from the questionnaires.

6.6 FINAL COMMENTS

In spite of the difficulties in designing appropriate assessments, with reported wide variation in individual outcomes following implantation, it is vital that paediatric implant programmes develop a sensitive and appropriate assessment battery for children of all ages in their care. The principle aim of implantation is to give auditory access to speech that was not possible with conventional hearing aids. The progress of each child must be monitored in the use of audition from the very earliest stages following implantation to assess benefit, monitor tuning and functioning of the device and to evaluate the effectiveness of the intervention programme. In addition to monitoring individual progress for clinical purposes, outcome measures are needed to respond to many questions being asked about cochlear implantation regarding selection criteria for candidates and the most effective forms of intervention. The controversy, which continues to surround paediatric cochlear implantation, can best be resolved by careful and objective documentation of progress and difficulties. **"In times of increasing financial accountability and scrutiny in health care services throughout the world, benefits arising from paediatric implantation must be quantified by consistent collection of outcome data on every implanted child" (**O' Donnoghue, 1992:655).

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APPENDICES

- Appendix A: Consent letters
- Appendix B: Proposed assessment protocol
- Appendix C: Recommended assessment protocol

APPENDIX A

CONSENT LETTERS

Universiteit van Pretoria
Pretoria 0002 Republiek van Suid-Afrika Tel 012-420-2357 / 012-420-2816 Faks 012-420-3517 http://www.up.ac.za

Departement Kommunkasiepatologie
Spraak- Stem- en Gehoorkliniek

Hoof: ONK
H/v Prinsloo & Skinnerstraat
Pretoria
0001
Julie 2004

Geagte Prof. J. Swart

KOMMUNIKASIEASSESSERING VAN KINDERS MET KOGLEêRE INPLANTINGS VIR NAVORSINGSPROJEK

Ek is tans ‘n nagraadse spraakterapie en oudiologie student by die Departement van Kommunikasiepatologie, Universiteit van Pretoria. Die doel van my studie is om vas te stel of ‘n assesseringsprotokol wat deur die Pretoria Kogleêre Inplantingspan opgestel is, relevant is.

Die studie sluit die uitvoering van die assesseringsprotokol op kinders met kogleêre inplantings wat in die vroeë stadiums van taalontwikkeling is, in. Die kinders moet binne ‘n spesifieke skoolomgewing wees. Die assessering-sessies sal op ‘n video- en kassetband opgeneem word sodat die navorser die kommunikasievaardighede na die sessie kan evalueer, om te verseker dat geen belangrike inligting verlore gaan nie. Die inligting wat ingesamel word sal gebruik word om die areas in die assesseringsprotokol, sowel as die protokol as ‘n geheel, se relevantheid te bepaal en te beskryf. Daar is geen ongemak verbonde aan die navorsing vir die kinders wat aan die navorsingsprojek deelneem nie. Al die inligting wat ingesamel word sal gebruik word deur die Pretoria Kogleêre Inplantingspan om die vordering van die kinders te meet; en om verdere intervensie meer effektief te beplan. Die inligting sal gepubliseer word as ‘n artikel en deel vorm van my verhandeling.

Deelname is vrywillig. Al die inligting wat ingesamel word sal as vetroulik hanteer word, en alle name sal anoniem bly. Videomateriaal wat die kinders se identiteit beskerm sal gebruik word vir opleiding. U sal gevra word om ‘n toestemmingsbrief te teken, waarvan u ook ‘n kopiè sal ontvang. Vir enige verdere navrae, kontak my asseblief by (012) 664-2325 (h), (012) 354-2720 (w) of 0834920204.

Ek vertrou dat u my versoek gunstig sal oorweeg.

Vriendelike groete

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Katerina Yiallitsis	Mev. N. Venter	Prof. B. Louw
Navorser	Studieleier	Departementshoof

Toestemming: ----------------------
Prof. J. Swart

University of Pretoria

Pretoria 0002 Republic of South Africa Tel 012-420-2357 / 012-420-2816 Fax 012-420-3517 http://www.up.ac.za

Department of Communication Pathology
Speech, Voice and Hearing Clinic

July 2004

Dear Sir/Madam

COMMUNICATION ASSESSMENT OF CHILDREN WITH COCHLEAR IMPLANTS FOR RESEARCH PROJECT

I am currently a postgraduate student at the Department of Communication Pathology, at the University of Pretoria. The purpose of the study is to determine the relevance of an assessment protocol designed by the Pretoria Cochlear Implant Team.

The study involves the administration of the assessment protocol on children with cochlear implants, who are at the initial stages of language development and within a specific school environment. The assessment sessions will be recorded on videotape and cassette, with the intention that the researcher is able to closely evaluate communication skills after the session, as too much important information may be overlooked. The information obtained will be analysed to establish the relevance of the different assessment areas included in the assessment protocol, as well as of the assessment protocol as a whole. There is no risk or discomfort for the children who participate in this research. All the information obtained from the assessment will be used by the Cochlear Implant Team Members to measure the progress made by the children, and to effectively plan the course of further intervention. The information will also form part of a master's thesis.

Participation is voluntarily, and you are free to withdraw your consent for your child to participate in this research at any time without prejudice to your child's subsequent care. All the records of this study will be kept confidential and all participants will remain confidential. Video material that protects your child's identity may be used for training purposes. You will be requested to sign a consent letter of which you will receive a copy. For any further enquiries, feel free to contact me at (012) 664-2325 (H), (012) 354-2720 (W) or 0834920204.

I trust that my request will be favourably considered.

Yours sincerely

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Katerina Yiallitsis Researcher	Mrs. N. Venter Supervisor	Prof. B. Louw Head of Department

INFORMED CONSENT

I, -- have read all the above information, and willingly agree to let my child participate in this study which has been explained to me.

PARENT

NAME: **--**

SIGNATURE: **--** DATE: **---**

RESEARCHER

NAME: **--**

SIGNATURE:**---** DATE: **---**

Universiteit van Pretoria

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Departement Kommunikasiepatologie
Spraak- Stem- en Gehoorkliniek

Julie 2004

Geagte Meneer/Mevrou

KOMMUNIKASIE-ASSESSERING VAN KINDERS MET KOGLEêRE INPLANTINGS VIR NAVORSINGSPROJEK

Ek is tans 'n nagraadse spraakterapie en oudiologie student by die Departement van Kommunikasiepatologie, Universiteit van Pretoria. Die doel van my studie is om vas te stel of 'n assesseringsprotokol wat deur die Pretoria Kogleêre Inplantingspan opgestel is, relevant is.

Die studie sluit die uitvoering van die assesseringsprotokol op kinders met kogleêre inplantings wat in die vroeë stadiums van taalontwikkeling is, in. Die kinders moet binne 'n spesifieke skoolomgewing wees. Die assessering-sessies sal op 'n video- en kassetband opgeneem word sodat die navorser die kommunikasievaardighede na die sessie kan evalueer, om te verseker dat geen belangrike inligting verlore gaan nie. Die inligting wat ingesamel word sal gebruik word om die areas in die assesseringsprotokol, sowel as die protokol as 'n geheel, se relevantheid te bepaal en te beskryf. Daar is geen ongemak verbonde aan die navorsing vir die kinders wat aan die navorsingsprojek deelneem nie. Al die inligting wat ingesamel word sal gebruik word deur die Pretoria Kogleêre Inplantingspan om die vordering van die kinders te meet; en om verdere intervensie meer effektief te beplan. Die inligting sal gepubliseer word as 'n artikel en deel vorm van my verhandeling.

Deelname is vrywillig, en u is welkom om u kind enige tyd van die navorsing te onttrek. Onttrekking van u kind van die navorsing sal hom/haar op geen manier benadeel nie. Al die inligting wat ingesamel word sal as vetroulik hanteer word, en alle name sal anoniem bly. Videomateriaal wat u kind se indentiteit beskerm sal gebruik word vir opleiding. U sal gevra word om 'n toestemmingsbrief te teken, waarvan u ook 'n kopie sal ontvang. Vir enige verdere navrae, kontak my asseblief by (012) 664-2325 (h), (012) 354-2720 (w) of 0834920204.

Ek vertrou dat u my versoek gunstig sal oorweeg.

Vriendelike groete

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Katerina Yiallitsis	Mev. N. Venter	Prof. B. Louw
Navorser	Studieleier	Departementshoof

BRIEF VIR INGELIGTE TOESTEMMING

Ek, --- het al die bogenoemde inligting gelees, en ek stem in dat my kind aan hierdie studie mag deelneem.

OUER

NAAM: ---

HANDTEKENING: -------------------------------- DATUM: --------------------------------

NAVORSER

NAAM: ---

HANDTEKENING: -------------------------------- DATUM: --------------------------------

Universiteit van Pretoria

Pretoria 0002 Republiek van Suid-Afrika Tel 012-420-2357 / 012-420-2816 Faks 012-420-3517 http://www.up.ac.za

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Queenswood
0121
Julie 2004

Geagte Mev. B. Roodt

KOMMUNIKASIEASSESSERING VAN KINDERS MET KOGLEêRE INPLANTINGS VIR NAVORSINGSPROJEK

Ek is tans ‘n nagraadse spraakterapie en oudiologie student by die Departement van Kommunikasiepatologie, Universiteit van Pretoria. Die doel van my studie is om vas te stel of ‘n assesseringsprotokol wat deur die Pretoria Kogleêre Inplantingspan opgestel is, relevant is.

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Ek vertrou dat u my versoek gunstig sal oorweeg.

Vriendelike groete

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Katerina Yiallitsis	Mev. N. Venter	Prof. B. Louw
Navorser	Studieleier	Departementshoof

APPENDIX B

PROPOSED ASSESSMENT PROTOCOL

PROPOSED ASSESSMENT PROTOCOL FOR CHILDREN WITH COCHLEAR IMPLANTS

Transitional Stage of linguistic development

1. Questionnaires:
   - Questionnaire and cochlear implant form **completed by parents*
   - Meaning Auditory Integration Scale (MAIS) **completed by parents and teachers*
   - Meaningful Use of Speech Scale (MUSS) **completed by parents and teachers*

2. Assessments completed during observation and interaction with the child, video analysis and teacher interviews:
   - Parent-Child Interaction
   - Rossetti Infant-Toddler Scale
   - Developmental Assessment Schema (DAS)
   - Reynell Developmental Language Scale (Verbal Comprehension)
   - Preschool Literacy Assessment
   - Speech Intelligibility Rating (SIR)
   - Voice Skills Assessment (VSA)
   - Profile of Actual Linguistic Skills (PALS)

3. Auditory ability:
   - Developmental Assessment Schema (DAS) – Auditory Ability **completed during observation of the child and teacher interviews*
   - Otoscopic assessment
   - Immittance
   - Aided pure tone threshold (cochlear implant or cochlear implant and hearing aid)
   - Speech in Noise assessment
   - Speech discrimination threshold

APPENDIX C

RECOMMENDED ASSESSMENT PROTOCOL