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 interaction (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:
- o 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).
- o Repeat the word as best you can or show me the corresponding object.
- o The words may become softer and softer and may become difficult to hear, but try to guess if necessary.
- o 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.