Educational audiology in Ghana – developing screening tools for hearing in infants and children

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Yaw Nyadu Offei
aus Winneba (Ghana)

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Foreword

The inclusion of all children in mainstream education has been a subject for debate in recent times. The right of every child to equal educational opportunities has been defined clearly in legislative instruments and policy statements such as the United Nations Convention on the Rights of Persons with Disabilities (CRPD). This convention mandates governments to provide a rights framework and equal opportunities for their citizens living with disabilities by integrating all children who have special education needs (SEN) in mainstream schools and to enrol all hard-to-reach and out of school children by 2015.

Ghana has ratified this convention and has the challenge to develop strategies to implement this policy. Any attempt to include the disabled in education must have as its basis the early identification and intervention of children with educationally significant disabling conditions such as hearing impairment.

Early identification and appropriate early intervention have a significant effect on the quality of life of the children with disabilities as well as their families. However, in Ghana many children do not have any prospect of getting their auditory abilities tested and monitored early in life. Even, in the event of children being identified there is minimal or no early intervention available. Without appropriate intervention the idea of early identification lacks impact.

One of the factors militating against early identification in Ghana is the lack of appropriate tools for testing and monitoring the auditory development of children when they are very young. Therefore, in this thesis, an attempt is made to develop simple, cost effective, language appropriate and effective test tools for young Ghanaian children.

This thesis is set out in eight chapters. In Chapter One a brief history and challenges of educational audiology are discussed. Also, population statistics on the state of hearing impairment in Africa south of the Sahara and in Ghana are discussed. Implications of early onset hearing loss, methods of testing hearing impairment and some tools that are commonly used to test the auditory function of children are also discussed.

Chapter Two focuses on procedures used in developing screening tools for Ghana. The tools include the LittlEARS® Auditory Questionnaire, the Multiple Frequency Animal Sound Test (mFAST) and the Adaptive Auditory Speech Test (AAST).

In Chapter Three the objectives of the dissertation and the research questions are discussed. Chapter Four contains a description of methods used in collecting and analyzing the data. In Chapter Five the results are stated and, discussed in Chapter Six.

Chapter Seven is dedicated to conclusions based on the results. It is anticipated that with the introduction of the LittlEARS® Auditory Questionnaire, mFAST and AAST, in Ghana, about 90% of the population of Ghanaian infants and children will be screened early and monitored. Data generated from screening tests would serve as basis for informing and educating parents, the students themselves, the public and other relevant individuals and corporate bodies on issues related to early identification and intervention for Ghanaian children. The chapter ends with recommendations and questions for future research.

Chapter Eight briefly summarizes ways in which the tests developed in this thesis are being implemented in Ghana. It is hoped that this modest attempt to develop screening tools for Ghanaian children will stimulate further research and discussion on the way forward for early identification and intervention for children with educationally significant disabilities living in Ghana.

Abstract

The following objectives were set for this thesis:

1. To investigate the appropriateness of the LittlEARS® Auditory Questionnaire as a screening tool for hearing loss and other related educationally significant disorders in Ghanaian children aged 4 - 36 months.

2. To adapt and evaluate the multiple Frequency Animal Sound Test (mFAST) as an alternative to pure tone audiometry in screening children.

3: To construct, norm and validate four (4) language versions (Asante, Akuapem, Fante and Ghanaian English) of the Adaptive Auditory Speech Test (AAST) in quiet and in noise.

In order to attain the set objectives, six (6) research questions were raised.

Design:

A cross- sectional design was used to select a total of 1820 participants for the study. This sample included parents, younger and older children as well as adults. For validation of LittlEARS® Auditory Questionnaire, norm data were collected for N=448 children. The effect of 'administration mode' was investigated by collecting data from N=152 parents (respondents) and the feasibility of using LittlEARS® Auditory Questionnaire as a screening tool between 24-36 months was investigated by collecting data from N=513 respondents. Validation data for mFAST were collected from N=45 students aged between 20 and 30 years with normal hearing. In order to determine the Akan AAST norm, data were collected from (N=581) children who spoke Asante, Akuapem and Fanti as their native language. Finally, in order to determine learning effects data were collected from (N= 81) children.

Results:

Results show that the Ghanaian and German norm curves are comparable and it does not make any difference whether LittlEARS® Auditory Questionnaire is administered via self administration or by interview. The data also supports the use of the LittlEARS® Auditory Questionnaire to screen for hearing loss in Ghanaian infants and children from 4 months old up to the age of 3 years.

Overall the results support the proposition that the LittlEARS® Auditory Questionnaire, the multiple Frequency Animal Sound Test (mFAST) and the Adaptive Auditory Speech Test (AAST) are appropriate tools for the early identification of Ghanaian children with hearing loss.

Zusammenfassung

Die Arbeit verfolgt die folgenden Ziele:

1. Es soll untersucht werden, ob der LittlEARS® Fragebogen für das Screening von Hörstörungen und anderen, bildungsrelevanten Störungen bei ghanaischen Kindern im Alter zwischen 0 und 36 Monaten geeignet ist.

2. Der „Multi-frequency animal sound test“ (mFAST) soll als Alternative zum Hörscreening mit Reintonaudiometrie bei Kindern adaptiert und evaluiert werden.

3. Für den Adaptiven Auditiven Sprachtest (AAST) in Ruhe und mit Störgeräusch sollen vier ghanaische Sprachversionen (Asante, Akuapem, Fante und ghanaisches Englisch) entwickelt, normiert und evaluiert werden.

Aus dieser Zielsetzung ergaben sich sechs Forschungsfragen.

Design:

In einem Querschnittsdesign wurden insgesamt 1820 Studienteilnehmer ausgesucht. Die Stichprobe setzte sich aus Eltern, jüngeren und älteren Kindern, sowie Erwachsenen zusammen. Zur Validierung des LittlEARS® Fragebogen wurden Normdaten von 448 Kindern erhoben. Der Effekt des „Durchführungsmodus“ wurde anhand der Daten von 152 befragten Eltern untersucht. Die Tauglichkeit des LittlEARS® Fragebogen als Screeninginstrument für Kinder im Alter zwischen 24 und 36 Monaten wurde anhand der Daten von 513 Befragten ermittelt. Validierungsdaten für mFAST wurden von 45 normalhörenden Studenten im Alter von 20 bis 30 Jahren erhoben. Um die Norm für den Akan-AAST zu ermitteln, wurden Daten von 581 Kindern erhoben, deren Muttersprache Asante, Akuapem oder Fanti war.

Schließlich wurden zur Ermittlung möglicher Lerneffekte die Daten von 81 Kindern erhoben.

Ergebnisse:

Die Ergebnisse legen nahe, dass die ghanaischen und deutschen Normkurven für den LittlEars® Fragebogen vergleichbar sind. Zudem zeigte sich kein Unterschied zwischen den Arten der Befragung mit dem LittlEARS® Fragebogen (Durchführungsmodus: eigenständig oder Interview). Die Daten sprechen außerdem für den Einsatz des LittlEARS® Fragebogen für das Hörscreening bei ghanaischen Säuglingen und Kindern von der Geburt bis zum Alter von 3 Jahren. Insgesamt stützen die Daten die Aussage, dass LittlEARS®, mFAST und AAST) geeignete Werkzeuge zur Früherkennung ghanaischer Kinder mit Hörverlust sind.

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Abbreviations

AAST: Adaptive Auditory Speech Test

ABR: Auditory Brainstem Response Audiometry

dB: Decibels

Hz: Hertz

kHz: Kilo Hertz

mFAST: multi Frequency Animal Sound Test

OAE: Otoacoustic Emissions

PTA: Pure Tone Audiometry

RQx: Research Question number x

SDEV: Standard Deviation

VRA: Visual Reinforcement Audiometry:

1.0 Chapter One

INTRODUCTION

1.1 Educational Audiology - Historical perspectives

Educational audiology is the practice of audiology in educational or school settings. This field of audiology has developed as a specialty to provide specific services that are required for a particular population such as infants and children of school going age. Services provided by educational audiology include coordinating hearing screening programs, providing community awareness about hearing, conducting comprehensive hearing evaluations and providing management for hearing aids and other assistive devices (Johnson, Benson & Seaton, 1997).

Educational audiology is about having a clear understanding of how children develop and what role audition plays in a child's communicative ability, academic success and psychosocial well-being. Educational audiology is about how to communicate audiological test findings and recommendations to parents, the child, teachers and all other related professionals. It is about the audiologist being part of a team of professionals that focuses on educating and empowering the child.

Educational audiologists are interested in testing how developing young children perceive speech in realistic conditions. Therefore factors such as noise levels and the distance between the child and a source of sound are of much concern to the educational audiologist. Testing the auditory perception of children in realistic environments is needed even after neonatal screening because tests such as otoacoustic emissions (OAE) and the Brainstem Electric Response Audiometry (BERA) which are often used in routine audiometric screening, are limited to specific sound perception, rather than to functional sound perception.

Indeed, pure tone audiometry and speech audiometry (in quiet) are not very good predictors of the ability to understand speech in noise, and yet this appears to be the greatest handicap associated with hearing impairment (Smits, Kapteyn, & Houtgast, 2004). Hearing assessment must therefore additionally focus on skills at the detection level as well as at the discrimination levels.

Tests such as the Adaptive Auditory Speech Test (AAST) have therefore been developed (Coninx, 2005) and validated for use in Ghana as part of this dissertation. These will improve the quality and practice of educational audiology in Ghana by giving an additional push to attempts toward early identification of educationally significant hearing loss and other associated disabling conditions in Ghana. Educational audiology may therefore best be described as “audiology in action” within educational settings.

The provision of audiological services for education purposes dates back over several decades. Davis, Mencher and Moorjani (2004) noted that hearing screening was implemented as far back as the 1930s even though no standardized procedures were used then. Ewing (1957) recommended that all children in the United Kingdom (UK) must be screened at school entry using a pure-tone ‘sweep test’. This practice is still ongoing in the UK and has been considered very useful in identifying those children who may not have already been identified.

Periodic screening of hearing at school provides a means by which the hearing acuity of students can be assessed, and those who may have problems identified for timely intervention. In the United States of America (USA) audiology for educational services has been in use since the 1960s. Since then educational audiology has developed rapidly, mainly due to federal legislation which mandates specific services for children with disabilities. Advocacy groups

have also played a major role in interpreting and monitoring legislative actions (Johnson et al., 1997).

Section 504 of the Rehabilitation Act (1973) specifically has impact for children whose disabilities, even though mild and still significant, may not meet the eligibility requirements of special education in the USA - for example, those with milder hearing impairment and children who have Auditory Processing Disorders (APD). (Central) Auditory Processing Disorders [(C)APD], are defined as "difficulties in the perceptual processing of information in the central auditory nervous system (CANS) and the neurobiological activity that underlies that processing and gives rise to the electrophysiological auditory potentials." (Shinn, 2012, para.1). According to Shinn, available evidence shows that cases of (C)APD have been reported both in children as well as in adults. (C)APD may either “exist alone or with other disorders such as Attention Deficit Hyperactivity Disorder (ADHD) and language impairments” (para1).

For both of these groups acoustic accessibility is a ‘hidden’ barrier to their hearing and understanding of auditory information. It appears that many people, including educators, overlook this need unless and until knowledgeable professionals such as audiologists and specialized teachers highlight the needs of these children in their regular classrooms.

The right of every child to education has been specified in a number of legislative instruments and policy statements. For example, in Ghana, the Education Act of 1961 emphasized the need for the education of all Ghanaians, presumably including persons with disabilities (Koray, 1998). Article 25(1) of the 1992 Constitution of Ghana provides that all persons shall have the right to equal educational opportunities (Republican Constitution of Ghana, 1992).
Ghana has ratified the UN Convention on the Rights of Persons with Disabilities (CRPD) which makes it mandatory for Governments to provide a rights framework for all of their citizens who are living with disabilities. One major

objective of the CRPD is to provide equal “educational opportunities by integrating all children who have special education needs (SEN) in mainstream schools and to enrol all hard-to-reach and out of school children by 2015” (Gyimah & Vanderpuye, 2009, p 4).

In order to attain the United Nations Millennium Development Goal (MDG) of CRPD, Ghana has initiated some concrete plans. For example, the government of Ghana has passed the Persons with Disability Act, 2006 (Act 715) (Persons with Disability Act, 2006) which makes provision for the education and well-being of children with special education needs (SEN). For instance Article 17 of the Act states “The Minister of Education shall by Legislative Instrument designate schools or institutions in each region which shall provide the necessary facilities and equipment that will enable persons with disability to fully benefit from the school or institution” (p 6). What this implies is that centres must be established, equipped and made operational in designated schools or institutions in all the 10 regions of Ghana to resource individuals with special education needs.

Already, there is a National Assessment and Resources Centre for Children with SEN and Disabilities at Achimota in Accra. In addition, there is a Centre for Hearing and Speech Services at the University of Education, Winneba which provides a variety of services to children with hearing and speech problems, their parents as well as teachers and other professionals who support learners with hearing difficulties. There are also units established in major hospitals in Ghana for example, the Korle-Bu Teaching Hospital in Accra and the Komfo Anokye Teaching Hospital at Kumasi where the assessment of hearing and vision takes place. (Gyimah & Vanderpuye, 2009, p 4-5).

Further, Article 20(1) of the Disability Act (Act 715) states “A person responsible for admission into a school or other institution of learning shall not refuse to give

admission to a person with disability on account of the disability unless the person with disability has been assessed by the Ministry responsible for Education in collaboration with the ministries responsible for Health and Social Welfare to be a person who clearly requires to be in a special school for children or persons with disability" (Persons with Disability Act, 2006, p.6).

What (Act 715) of the Disability Act seeks to do is to make it obligatory for all schools in Ghana to admit children with disabilities unless otherwise advised by designated authorities (Persons with Disability Act, 2006). The implication of the article is that it is possible for some persons to be excluded from receiving their education in regular classes based on the assessment report or recommendation of some authority. Even though Article 20(1) conveys some good intentions about the educational and general well-being of children with disability, the article nevertheless bears traces of segregation of some children. Obviously, this is at variance with the principle governing full educational inclusion. Full inclusion implies that all children are educated in the mainstream without recourse to any condition.

Article 20(1) proposes inter ministerial and departmental collaboration (between health and education. By implication, effective inclusion of SEN children requires cooperation, collaboration and networking among professionals. This is obviously a good provision for a country (Ghana) that seeks full educational inclusion for all her citizens and, this is a position that educational audiology supports. Educational audiology is about networking, sharing of knowledge and resources with other relevant practitioners and being an active member of a team of professionals who aim to empower every child, to attain their full educational potential.

The concept of 'Inclusive Education' has been captured in the Education Act 2008 (Act 778) of Ghana. Article 5 prescribes that the design and infrastructure

of all educational institutions have to allow for easy accessibility by persons living with disabilities. Inclusive Education is defined in Act 778 within the context of a value system which grants all persons who attend an educational facility should have equal access to learning.

This undoubtedly goes beyond the idea of physical location to promote friendship participation and interaction which is very good. However, there appears to be emphasis on 'physical structure' at the expense of learning support which is needed for the achievement of equity is the accessibility to learning. Furthermore, even though Act 778 makes provision for all children to be screened on admission to school, it does not specify what children are to be screened for.

In an attempt to realise the vision of inclusive education (IE) in Ghana, the Special Education Division (SpED) of the Ministry of Education of Ghana, has since 2003 targeted and piloted inclusive education programmes in 35 districts located within the Greater-Accra, Central and Eastern Regions of Ghana (Gyimah & Vanderpuye, 2009, p 4-5). It is expected that this pilot initiative would be extended to other regions in Ghana.

Since the CRPD is a legal document it is more extensive and comprehensive than the Persons with Disability Act (Act 715) of Ghana. For instance a significant difference is that the CRPD includes "intellectual impairment" in its definition of disability. Act 715 also defines 'disability' in a general way to cover physical, mental or sensory impairment and specifies visual, hearing and speech disability. This definition clearly, does not include persons with specific learning disabilities. Further, although Act 715 provides for free education for all children with disabilities, it does so within the framework of designated schools in the regions of Ghana that provides the necessary facilities for persons with

disabilities (PWD). Undoubtedly, this is segregation and therefore, is at variance with the spirit and letter of the CRPD which emphasizes full inclusion.

Act 715 states that government should set up special schools for individuals whose disability makes it impossible for them to receive their education in the mainstream. What this means is that when a child is assessed and found to be in need of special schooling such a child may be refused admission into the mainstream. Again, this provision is against the principles of CRPD which makes it obligatory for institutions of learning to make the regular classroom a most enabling learning environment for all categories of children including those with disability.

Further, in the policy document on the Free Compulsory Basic Education (FCUBE), the government of Ghana affirms its commitment to making schooling from Basic Stage 1 through 9 free and compulsory for all school age children by the year 2005. Within this document, the government has stated in clear terms its commitment, not only to achieve universal access to basic education in 10 years, but also to improve the quality of educational services provided (Koray, 1998). Again, this presumably includes the disabled, who form a vulnerable and disadvantaged group within society. It is therefore quite clear that education for all children is seen as the best tool for development and consequently the solution to the myriad challenges posed by a fast changing world.

The quality of the civilization of the people is determined by the way in which they treat the most vulnerable and disadvantaged in their midst. It is for this reason that governments should illustrate commitment to persons with disabilities by enacting laws which protect the interests of the disabled and also ensure the provision of appropriate Special Education services for them.

However, this does not exclusively refer to the provision of special schools for the children with SEN because this would lead to segregation and removal of these children from the mainstream of society. On the contrary, the Salamanca Statement and Framework for Action on Special Needs Education (1994) called for inclusion in mainstream education to be the norm so that all children have the opportunity to learn together (Peters, 2004).

The focus of Inclusive Education therefore, is to get children living with disability into and through school by developing schools that will respond to the specific, diverse educational needs of children and communities. Inclusive education is about achieving both access and quality as highlighted in the Education for All (1990) and MDG action frameworks (Hooker, 2007, p.3). Educational audiology supports 'Inclusive Education' within such a broad sense.

1.2 Challenges of Educational Audiology

Educational audiology is rewarding but, it also has its challenges. The challenge lies in reconciling many children and their diverse needs with very minimal support, equipment, money and staff to address those needs. On the other hand, the rewarding aspect is that educational audiology creates an opportunity to make a significant difference in a child's everyday life. Johnson et al. (1997) listed potential challenges in educational audiology which include large in-school and out-of school populations, shortages of audiologists, working with professionals with limited knowledge in hearing needs, limited financial resources, limited time to conduct audiological services and adapting the medical model of audiology into an educational model.

1.2.1 Large in-school and out-of school population

Large in-school population poses a huge challenge both in developed countries such as in the USA, which has current data on such populations and, developing countries. Similarly, there is a challenge regarding large out-of-school population (Johnson et al., 1997). Children with hearing losses from these populations must be identified, and appropriately managed. The challenges are more profound and widespread in developing countries such as Ghana where funding and research in disability issues are inadequate, and negative public attitudes towards individuals with disabilities are commonplace.

1.2.2 Children served by special education

A constantly growing percentage of children and youth served by special education and related services also poses a huge challenge to educational audiology. For example, the USA Department of Education, (1994b) reported a rise from 4.5% in 1976-77 to 6.4% in 1992-93 (Johnson et al., 1997). Unfortunately, research information on the percentage of children being served by special education in Ghana is very scanty.

1.2.3 Shortage of audiologists

An alarming shortage of audiologists to provide audiological services to children is a challenge in both developed and developing countries. In Ghana, there are less than 10 audiologists serving a population in excess of 24 million. There are audiologists in three out of the ten regions of Ghana namely, the Greater Accra, Ashanti and Central Regions. The ratio of audiologists to hearing impaired in Ghana is about 1:180,000 and the ratio of audiologists to the entire population of Ghana is about 1:3,100,000. Almost all of these audiologists work in hospitals, with very few working in educational settings. This has implications for audiological service provision to children with auditory disorders who are included in mainstream education in Ghana in the future.

1.2.4 Hearing services in Ghana

Currently, there are about 15 hearing assessment centres in Ghana. Four of these are located in Special Schools for the Deaf and staffed by teachers of the Deaf who have received basic training in early intervention with hearing impaired children at the University of Education in Winneba, Ghana. Three of the centres are hospital based, and three others privately owned. This means that currently in Ghana audiological services are not restricted to the hospitals. Those located in the Schools for the Deaf also provide resource services to regular school teachers within their localities. The greatest concentration of centres however is in the capital city of Accra. This makes accessibility to audiological services difficult for people living in remote and rural locations in Ghana. This has implications for the future of audiological service delivery in Ghana.

1.2.5 Working with other professionals

Working with regular teachers and special education administrators who often have limited, if any, knowledge about audiological and hearing needs of children, is also a potential challenge. Ghana has committed itself to include all children in education, but there are several regular school teachers who know little or nothing about how to manage children with disabilities. In Ghana the University of Education in Winneba has the mandate to train teachers for all categories of learners. The Department of Special Education is running programmes at various levels for teachers and other professionals working with persons with disabilities.

1.2.6 Limited financial resources

Limited financial resources are needed to provide the necessary amplification equipment and services for each child. In Ghana, for example, parents are expected to purchase hearing aids and accessories for their hearing impaired children, which are very expensive and not yet catered for by the National Health Insurance.

1.2.7 Adapting the medical model into an educational model

A potential challenge is the adaptation of a traditionally medical model of audiology into an educational model and the development of a service that is functional, meaningful, and responsive within the educational context.

1.3 Population Statistics and the burden of hearing loss in Ghana

The World Health Organization (WHO) estimates show that about 278 million people worldwide suffer from a disabling hearing impairment (moderate to profound hearing loss greater than 40dB hearing level). Out of this figure, 70% live in developing countries and 25% develop their hearing during their childhood (Czechowicz, Messner, Alarcon-Matutti, Alarcon, Quinones-Calderon, Montano, & Zunt, 2010). Sub-Saharan Africa comprises 46 countries and has a population of 748.9 million Annually in sub-Saharan Africa close to 180,000 babies are either born with, or acquire, permanent hearing loss (>40dBHL) during the first weeks of life. These estimates, however, exclude other categories of hearing loss such as mild and unilateral losses (Olusanya, 2008).

Although sub-Saharan Africa accounts for a substantial percentage of the global burden of permanent congenital and early-onset hearing loss (PCEHL), there appears to be very little or no systematic attempt to address the diverse communication, psychosocial, economical and educational challenges which early childhood hearing loss presents (Olusanya, 2008).

The prevalence of hearing impairment varies between countries in the developing world. In Africa and most developing countries, the prevalence rate is between 7-10% (Essel, 1999; Amedofu, Opoku-Buabeng, Osei-Bagyina & Antwi, 2003; Amedofu, Ocansey, Antwi, 2006). In Ghana it is estimated that, of about 2.4 million people who live with disabilities, about 60% are hearing impaired (Kwawu, 1998). These estimates show that the prevalence of hearing loss in Ghana is quite high, so ongoing screening is urgently required.

In the present context, Ghana is considered a middle income country and the second most urbanized country in sub-Saharan Africa, with an annual live birth of 700,000 (Olusanya, 2008) and a population of about 24 million (Ghana Statistical Service, 2011). Ghana is a multi lingual society and home to more than 100 different ethnic groups which includes the Akan.

Akan is a language which is spoken by about 40-44%% of Ghana's population as a first language (L1), and spoken as a second language (L2) by several ethnic groups in west, south-east and south-west of Ghana. The dialects of Akan grouped in to two main categories namely, 'Fante' and 'Twi' which comprises all the non-Fante dialects such as 'Asante', 'Akuapem', 'Akyem' etc. (Dolphyne, 2006; Osam, 2004).

In terms of usage, Akan covers an extensive range of socio cultural domains. For example, in all the areas of Ghana where Akan is the L1, it is used as a medium of instruction in schools and in addition, it is taught as a school subject at the basic and secondary levels of education (Osam, 2004). Akan is offered as a course at all levels in at least, two public universities in Ghana (Winneba and Cape Coast). Akan is as well used for business purposes and in many churches in locations where it is the L1 as well as in areas which have a high immigrant population of Akan speakers (Osam, 2004, p.3). Akan is therefore growing in influence as a potential national language since it is used widely as a lingua

franca. This is in spite of the fact that English is still recognized as the official language of Ghana (Obuapong, 2011, p.10; Osam, 2004).

1.4 Hearing during early childhood

Hearing is a critical part of an infant's development, particularly in the first few years of life. The first years of a child's life constitute an important period during which the child's brain development is most susceptible to physiological and experiential influences. During the period from birth to age 5 years the foundation for later developmental achievements in children, including overall well-being, is determined for many domains, such as social, emotional, and cognitive, but for sensory development intervention may be necessary during the first year of life (Olusanya, 2008). Even a mild or partial hearing loss at this stage can affect a child's ability to learn how to speak and understand language.

According to Yoshinaga-Itano (2003a) the first six months of life are so important for language development that even children with significant hearing loss but who have access to language during this period are able to develop language skills which are comparable to those of average normally-hearing peers. Early intervention can therefore, completely resolve or at least minimize the effect of hearing loss so that children can participate maximally in the learning process. Unfortunately, for a significant number of children, particularly those in developing countries such as Ghana, there is very little possibility for them to have their hearing tested and any hearing loss detected at this crucial early stage.

1.5 Implications of hearing loss

The effect of hearing loss on an individual can be extensive. In addition to creating difficulties associated with basic receptive communication, a hearing

impairment often produces difficulties in other significant areas such as expressive communication, educational challenges, psychosocial adjustment, mental development, and economic problems (Schow & Nerbournne, 1989). Of all the obstacles that confront persons with hearing loss, communication difficulties are among the most prominent (Lane, Hoffmeister, & Bahan, 1996; LaSasso & Metzger, 1998; Marschark, 1997; Ogden, 1997; Eleweke & Rodda 2000).

Vostanis, Hayes and Du Feu (1997,) have reported a relationship between communication deviance and psychosocial impairment. They mention that "behavioural problems in deaf preschoolers have been found to be affected by family factors such as strain on the parent-child relationship, family stresses and sources of family support, and parenting in relationship to the child's impairment" (p.240).

The hearing mechanism is the channel by which one acquires receptive and spoken language to the extent that even newborns with functional auditory systems perceive auditory stimuli. This is the start of language acquisition. Absence of good auditory function therefore has effects upon language perception and production. It is on the basis of this finding that hearing assessment is considered crucial. Clinical records in Ghana have shown that the greater the degree of hearing loss the more the effect upon language acquisition and production (Essel, 1999).

Since language development occurs in a sequence of receptive and expressive skills, the mastery of each skill is contingent upon acquiring each preceding skill. Consequently, the hearing impaired pre-lingual child is hindered since the auditory reception of language is either distorted or non-existent. Hearing impairment interferes with spoken language, which is the medium of instruction particularly in regular schools where hearing impaired children are integrated.

Therefore, a child with little defect in the ear happens to be at a disadvantage at the expense of instruction (Eleweke & Rodda, 2000).

Hearing loss presents educational consequences because schools are largely auditory environments. Children with hearing loss often perform poorly academically, are less likely to complete their secondary level education and are more likely to be unemployed (Czechowicz, 2010). At school age, permanent childhood early hearing loss (PCEHL) significantly affects educational development, with significant substantial lifetime costs to the society (Olusanya, 2008). Therefore for most developing countries such as Ghana, where no systematic hearing screening of infants and children has yet been implemented, early identification and intervention of children with hearing loss is an important educational issue.

In Ghana one major challenge facing education of persons with hearing loss is the nature of assessment. Gyimah (2000) identified some deficiencies and inadequacies in the assessment procedures for persons with disabilities in Ghana. First, there are very limited standardised tests available to determine the hearing acuity, intelligence and academic proficiency levels of the hearing impaired. And even where standardized tests existed, they had not been adapted to suit indigenous needs.

In addition to this, there are no experts with the requisite training to administer standardized tests in Ghana. Thus the assessment practices upon which decisions on school placements in Ghana are made are not comprehensive enough to address the needs of individuals who receive special education and other related services. In this dissertation an attempt is made to develop, adapt and validate simple tests (such as the LittlEARS® Auditory Questionnaire, Adaptive Auditory Speech Test (AAST) and Multiple Frequency Animal Speech

Test (mFAST) which are standardized, suitable to the Ghanaian context, relatively cheap, easy to perform and quick to complete.

Regarding the economic implications of hearing loss, a World Health Organization (WHO, 2001) report has documented that auditory related disabilities such as communication disorders (an outcome of hearing loss) costs the USA close to 3% of gross national product through rehabilitation, special education and loss of employment. The figure could be much higher in developing countries.

Hearing loss is therefore a benign disability, but failure to intervene early after onset threatens “essential quality of life indicators” (Swanepoel, Louw, & Hugo, 2007, p. 321). Yoshinaga-Itano (2003b) reported that the social-emotional aspects of the family and child who are identified early are better than those identified with hearing loss after they are 6 months old.

1.6 Early identification (0-36months)

The advent of universal newborn hearing screening programmes has made it possible for hearing loss in infants to be identified earlier than ever before. The implementation of such programmes, together with earlier intervention using cochlear implants has resulted in much improved methods of assessing younger children (Coninx et al., 2009). Consequently early identification of hearing loss has significantly increased the need for early audiological care, particularly for infants and children.

Olusanya, Luxton, and Wirz, (2004) stated that newborn hearing screening (NHS) is the best method for producing comparable educational and social outcomes for children with permanent childhood early onset hearing loss (PCEHL). Children who are identified very early do not, as yet, have language

developmental delays so families of such children have better opportunities for accessing information and counselling support over a long period of time, in order to prevent the occurrence of any significant language delay (Yoshinaga-Itano, 2003b).

Studies have shown that in the USA, with the implementation of universal newborn hearing screening (UNHS), the mean age of identification of hearing impairment has reduced from 12- 24 months pre-UNHS to 3-6 months post UNHS (Canale, Favero, Lacilla, Recchia, Schindler, Roggero, & Albera, 2006).

Early detection of hearing loss, if followed immediately by appropriate early intervention services, could result in “optimal speech and language outcomes” (Olusanya et al., 2004, p.295; Yoshinaga-Itano, 2003a). Children born in hospitals with UNHS programs who were identified with hearing loss in the first few months of life “had no secondary disabilities and had an 80% probability of having language development within the normal range from birth through five years of age” (Yoshinaga-Itano, 2003a p. 199).

However, early identification in the first months of life must be followed immediately by the initiation of appropriate intervention services, not least because a screening pass has no lifelong validity. Children who have late-onset progressive and acquired hearing gloss will be missed unless there is additional screening after newborn hearing screening (NHS) (Coninx, 2011, p.34). Additional screening procedures are needed between neonatal screen and the age of 6. Significant concerns have been raised in the hearing literature about the efficiency and suitability of the UNHS in countries where it is implemented, but particularly within the context of developing countries. This is particularly the case because “existing NHS protocols would miss cases of progressive, late onset and acquired hearing impairment” (Olusanya et al., 2004 p. 295).

For a developing country such as Ghana this is particularly critical because a significant percentage of PCHLs are acquired after birth (post natal) through etiologies such as measles, mumps, meningitis and the effects of ototoxic medications. What makes this situation even more precarious is that their onset occurs within a wide time span and single screening protocols that can be used to detect this category of hearing loss early enough are currently scarce in Ghana. An ongoing infant hearing surveillance or screening is required in situations where babies either are not enrolled on NHS or get lost to follow-up and yet need timely detection and compensation (Neumann, Coninx, Schäfer, & Offei, 2012; Olusanya et al., 2004).

On-going monitoring-screening is also required in Ghana because of the high prevalence of acquired conductive hearing loss caused mainly by suppurative middle ear diseases (Amedofu et al., 2003; Essel, 1997; Davidson et al., 1989) frequently associated with either an intratemporal or intracranial complication (Davidson et al., 1989).

Dunmade et al., (2006) stated that in developing countries, preventable causes of hearing loss include infections and obstetric mishaps, but noise-induced hearing loss is also an important cause. Although the effect of noise in classrooms in Ghana is not yet documented, physical evidence shows that most kindergarten and nurseries in Ghana currently operate under very noisy conditions. Excessive exposure to noise has significant educational implications for the growing school child. Apart from the poor listening conditions that intolerably excessive classroom noise levels create for children, it is also possible for children with conditions such as auditory processing disorders (APD) to be wrongly diagnosed and mislabeled as having learning disabilities (LD). This could be potentially dangerous for the educational future of the child.

Mild or unilateral hearing losses are often very difficult to detect but they can result in significant communication difficulties, especially in noisy classrooms, (Czechowicz, 2010) so ongoing screening is required. A mild acquired childhood hearing impairment or a less severe conductive hearing loss which develops later during childhood could significantly delay the linguistic and educational progress of the child, thereby resulting in social and psychological consequences for the affected child and their families (Amedofu et al., 2003).

Early identification of hearing loss is beset with several challenges particularly in developing countries. Major challenges include non-availability or limitations in material and human resources (e.g. lack of qualified and relevant professionals). Formal full-time training for audiology and speech therapy are lacking in most tertiary institutions in the developing world. For instance, in Ghana, the full-time training of audiologists started only very recently, in 2011. There are no training programmes for speech pathology in Ghana, and in Nigeria, which has a population of over 100,000,000, there are no training programmes for audiology and speech pathology (Olusanya, 2008).

There are situations where parents are told by health-care providers that their children are too young to be tested for hearing, or that as they grow the impairment will clear away. This unduly prolongs diagnosis and intervention. In addition, often, hearing impairment is presented as a developmental delay rather than as a life-long developmental impairment. However, “delay” portrays the impression that eventually the child will hear normally once the disorder gradually disappears (Olusanya, 2008).

Furthermore, some parents are not aware of facilities available to them where they could go for hearing tests. Even if they were aware, extreme poverty could prevent parents from sending their children for hearing tests. Linked to poverty is the distance between home and audiology where tests could take place.

Hearing screening programmes are very scanty but even when they are available distance could pose a potential challenge. A way of addressing this challenge is to combine hearing screening to routine vaccination clinics which are widespread in several communities in Ghana, and which are highly patronized by parents.

In countries where UNHS is implemented, a mandatory practice of a second screen after initial failure is added because there could be as much as a 52% reduction of screening failure upon re-screening (Amedofu et al., 2003). However, the practice of a second screen may not be practicable in some developing countries, due to lack of resources .Olusanya (2008) stated that resource constraints and the standard of health-care practices in many countries in Africa south of the Sahara make some of the goals of early hearing detection and intervention unattainable, thus creating the need to set priorities for addressing this health condition.

Amedofu et al. (2003) therefore recommend a cheaper option which includes a school screen, where failures are referred to a resident or local medical (or educational) personnel for follow-up assessment and intervention. Olusanya et al. (2004) recommends that priorities must be set among complementary screening options because any screening protocol that seeks to detect postnatal hearing losses can rarely serve as an alternative to NHS which is designed solely for the early detection of PCEHL. Ongoing screening requires screening tests to be developed which are age and context specific, relatively cheap and easy to use.

Assessing infants and young children for their auditory functioning is challenging, even for trained professionals. One major challenge is that there are few reliable diagnostic tools available for assessing the auditory potential and capabilities of infants and children (May-Mederake, Kuehn, Vogel,

Keilmann, Bohnert,& Mueller et al., 2010) probably, because of developmental limitations inherent in the infant population (Tharpe and Flynn, 2005). For a developing country such as Ghana this poses some challenges. The implications are that audiological screening tests must be developed which are contextually relevant and age specific.

1.6.1 Objective methods of hearing testing – OAE, BERA etc

Any child of any age can be tested with the appropriate hearing test. However, the type of test to be used depends on the child's chronological age, level of development or maturation, or both factors. While some hearing tests require no behavioral response from the child, others use games to excite a child's interest and thereby stimulate a response. The most important issue is to figure out which test method would be most suited for each child.

Currently, with the improvement in technology, the measurements of otoacoustic emissions (OAEs) and automated auditory brainstem response (ABR) are used routinely as part of test batteries in several universal newborn hearing screening (UNHS) programmes to provide complementary information about the status of the auditory system of many children (Canale, et al., 2006; Olusanya, 2008; & Davis, et al., 2004). Both of these test tools can detect hearing loss in infants of 30 to 40 decibels (dB) or more in the regions of 500-4000 Hertz (Hz), which are most important for speech recognition.

The results from an ABR and an OAE evaluation can predict the child's hearing, determine if there is a loss, determine the type of hearing loss, and help with decisions regarding intervention. These screening procedures are not painful and can be done while the child is resting quietly. Younger children or infants with ages ranging from 5 months to 2 and a half years who cooperate and are alert are frequently tested using a method called visual reinforcement

audiometry (VRA). Children aged 3-5 years of age who can engage more complex tasks are often tested using a technique called play audiometry, in which sounds are paired with a specific response or task. For older children and adults the most commonly used method of screening for hearing loss is a pure-tone test.

Most newborn hearing screening programmes therefore use OAEs and ABR as the main test batteries. Canale et al. (2006) has reported that in North-West Italy, where UNHS has been operating since January 2009, their programme includes a 4-step routine for healthy babies, three of which are based on transient evoked otoacoustic emissions (TEOAEs). The first test is done just before discharge from the maternity hospital and the second and third are done after 15-30 days and 30-60 days respectively. A fourth step, involving ABR is carried out on babies who are referred by any of the previous three tests.

In Ghana the Hearing Assessment Centre of the Korle-Bu Teaching Hospital has very recently rolled out the nation's first Universal Neonatal Hearing Screening programme. Korle-Bu Teaching Hospital is currently the only medical facility undertaking a Universal Neonatal Hearing Screening. The programme was started on 12th November 2012, and is conducted five days a week (Monday to Friday) at the maternity block of the hospital. By the beginning of February 2013 a total of 1560 children have being screened using the Otoacoustic Emission (OAE) screener for a simple Pass or Refer.

This data includes all babies delivered in the maternity block of the hospital. About 146 (9.4%) of the 1560 children screened so far were referred (test "fail") based on the initial testing, and are scheduled for a review appointment in six weeks for a follow-up second screen. Data from the first follow-up/ review appointment is not readily available at the time of compiling this dissertation. It is clear, however, that parental involvement has been very high, with every parent

(mother) eager to know the auditory status of their new baby.

1.6.2 Use of Parent Questionnaires

The advantages of using parent questionnaires in order to identify infants and children with hearing disorders and other disabilities have been highlighted in the hearing literature. These questionnaires document parents' observations of the auditory behavioural responses at various stages of the infant's or child's development.

The need for families (and in particular, parents and caregivers) to participate in the assessment and management of infants' and children's hearing is underscored in the literature. In Ghana, the importance of parental involvement in screening, diagnosis, assessment, placement and school life of their children with disabilities and the need for multi-disciplinary participation in order to meet modern standards and practices in assessment was identified some years ago (Final Communique, First National Delegates' Conference of Special Needs Education, Winneba, Ghana, 1998). The conclusion is that family friendly collaborative services are critical to successful assessment outcomes (Mencher & DeVoe, 2001).

A multidisciplinary approach to the evaluation of children's development has become standard in clinical practice, although few reliable diagnostic instruments are available. The inadequacy of reliable tools for screening infants and young children led to the creation of functional auditory measures such as the LittleEARS auditory questionnare (May-Mederake et al., 2010).

Functional auditory measures (FAM) have been developed to meet the need of infant assessment and to expand test batteries for children. Its goal is to provide, not only information about what a child can hear, but also how the child

uses what he/she hears in everyday situations. In addition, FAM provides information about how listening behaviors might change in different situations and conditions, or with different speakers. According to Thorpe and Flynn (2005), FAMs evaluate listening behaviour in real world settings, i.e. outside the confines of the soundproof room where many formal audiological tests take place.

Information gathered from FAMs can be used to inform management plans for infants and children who have hearing loss. This information can be accessed via self-assessment or parent/teacher questionnaires. Obrycka, Garcia, Pankowska, Lorens, & Skarzynski, (2009) stated that asking parents or other caregivers about their child's behavior using a structured questionnaire is a useful way to identify hearing losses among pre-verbal children. Parental questionnaires may also be used to complement professional assessments that are carried out before and after cochlear implantation in formal clinic contexts (Obrycka, Pankowska, Lorens, & Skarzynski, (2010).

Functional assessment can be part of the comprehensive audiological test battery used to determine individual needs (i.e. use of frequency modulated (FM) or other technologies), to indicate if any environmental modifications are needed and to demonstrate potential benefit from amplification. Tharpe and Flynn (2005) suggested that some functional assessments do not have the validation needed for widespread use. A good measure of auditory skill development needs to be validated if it is meant to inform evidence-based rehabilitation practice (Coninx et al., 2009).

The following are examples of some of the commonly used functional assessment tools for infants and children:

- Auditory Behaviour in Everyday Life (ABEL)
- Early Listening Function (ELF)

- Infant Toddler Meaningful Auditory Integration Scale (IT-MAIS)
- Meaningful Auditory Integration Scale (MAIS)
- Parents' Evaluation of Aural/oral performance of Children (PEACH)
- Preschool Screening Instrument For Targeting Educational Risk (Preschool SIFTER)
- Screening Instrument For Targeting Educational Risk (SIFTER)
- Teachers' Evaluation of Aural/oral performance of Children (TEACH):

1.6.3 Auditory Behaviour in Everyday Life (ABEL)

The Auditory Behaviour in Everyday Life (Purdy**,** Farrington, Moran, Chard, & Hodgson, 2002) is a twenty-four (24) item questionnaire. It has an excellent overall reliability of 0.95) using three subscales namely, Aural-Oral, Auditory Awareness and, Social/Conversational skills. ABEL was designed to evaluate auditory behavior in everyday lives of children with ages ranging from 2-12 years. The auditory behavior of children can be assessed using either an overall rating or separately for all three factors. The application time for this questionnaire is approximately 20 minutes (Souza, Osborn, Gil & Iorio, 2011). In comparison, the LittlEARS® Auditory Questionnaire has 35 items and takes a relatively shorter completion time (5 to 10 minutes). This makes the LittlEARS® auditory questionnaire the most preferred choice for the screening children in Ghana.

1.6.4 Early Listening Function (ELF)

ELF (Anderson, 2000) consists of twelve listening situations in which parents and audiologists are required to observe the child and to document the distance at which the child responds appropriately to the auditory stimuli. It was designed for infants and children aged 5 months - 3 years. In a search of the hearing

literature no age dependent norm data was found for the ELF. This is a limitation because norm data constitute important criteria for screening and assessment tools. Besides the 12 items (situations) do not cover a broad range of auditory behaviours as the LittlEARS® Auditory Questionnaire does with 35 items. Also, results of the test depend on the skills and precision of parents in the test process. It is just like doing a test therefore parents' ability to make an exact decision on what constitutes an appropriate response is critical.

1.6.5 Meaningful Auditory Integration Scale (MAIS)

MAIS (Robbins, Renshaw, & Berry, 1991) is a parental interview with ten questions, designed to assess how children aged 3 to 4 years and above bond "to the listening device, alerts to sounds and assembles sounds meaningfully with a hearing instrument of implant before and after implantation" (Sahli & Belgin, 2011, p. 386). At least 2 (20%) out of the 10 items in MAIS (questions 1 and 2) are based on the child's confidence in using his/her hearing device. What this means is that test items 1 and 2 cannot be used for norm groups and children who do not use hearing devices. The remaining 8 questions document awareness to sound (Questions 3 – 6) and understanding of sounds (questions 7-10) (Sahli & Belgin, 2011).

1.6.6 Infant Toddler Meaningful Auditory Integration Scale (IT-MAIS)

IT-MAIS (Zimmerman-Phillips, Robbins, & Osberger, 2001) is a modified version of the Meaningful Auditory Integration Scale (MAIS) (Robbins et al., 1991). IT-MAIS is a 10-item structured parental interview "designed to assess the child's spontaneous responses to sound in his/her everyday environment" (Sahli & Belgin, 2011, p.386). In other words IT-MAIS aims at evaluating the meaningful use of sound in daily situations such as vocal behaviour, attachment with hearing instrument, ability to alert to sound and ability to attach meaning to

sound. It was designed for infants and children aged 0 to 3 years. When compared to the LittlEARS® Auditory Questionnaire, the MAIS and IT-MAIS are both limited in terms of variety and number of auditory behaviours measurable in children. The LittlEARS® Auditory Questionnaire was therefore chosen to be used in Ghana because the 35 items cover a wider domain of auditory behaviours in children.

1.6.7 Parents' Evaluation of Aural/oral performance of Children (PEACH)

PEACH (Ching, Hill, & Psarros, 2000) is a 15-item parental interview which targets the child's everyday environment. It includes scoring for 5 subscales (Use, Quiet, Noise, Telephone, and Environment) and is designed for children ranging in age from preschool to 7 years.

1.6.8 Children's Home Inventory for Listening Difficulties (CHILD)

CHILD (Anderson & Smaldino, 2000) is designed for children aged 3-12 years. It is also recommended for children aged –12 years old. CHILD is a child/parent questionnaire comprising 15 situations that rates how well the child understands speech (Tharpe & Flynn, 2005). In comparison the LittlEARS® Auditory Questionnaire appears to cover a wider range of childrens' auditory behaviours than the CHILD.

1.6.9 Functional Auditory Performance Indicators (FAPI)

The Functional Auditory Performance Indicators (FAPI) assessment protocol (Stredler-Brown & Johnson, 2001) is an American test that evaluates the child's functional auditory skills in an integrated and hierarchical order with seven hierarchical categories that include "sound awareness, meaningful sound, auditory feedback, sound source localization, auditory discrimination, short term

auditory memory, and linguistic auditory processing" (Ferriera, Moret, Bevilacqua & Jacob Rde, 2011, Abstract).

The FAPI (Stredler-Brown & Johnson, 2001) "provides a procedure to establish a profile of a child's auditory skill development, to quantify the level of competency a child acquires with each skill, and to provide accountability" (Stredler-Brown, 2010, p. 307). FAPI also examines the child's skill in a variety of various listening conditions. Most of the measurements assess the acquisition or attainment of skills which are either as "present" or "absent". The FAPI provides a scoring rubric that makes it possible to make a quantitative documentation of the child's skills. This is a unique characteristic of FAPI (Stredler-Brown, 2010 p. 307).

1.6.10 LittlEARS® Auditory Questionnaire

The trend toward cochlear implantation at an early age of about 12 months, or even earlier, necessitated the development of the LittlEARS® Auditory Questionnaire (Coninx 2004; Weichbold et al., 2005; Coninx et al., 2009). The LittlEARS® Auditory Questionnaire is designed with an easy "YES" – "NO" format. It is scored in a straightforward manner (Bagatto, Brown, Moodie, & Scollie, 2011) and requires between 5 and 10 minutes to complete.

The psychometric properties of the LittlEARS® Auditory Questionnaire, such as norm data, support its use as a tool for evaluating auditory behaviour in all children and in more than 15 languages (Coninx et al., 2009) (Figure1). Initial field studies on using the LittlEARS® Auditory Questionnaire as a screening tool have been carried out (Coninx & Schäfer, 2012), and the sensitivity for hearing loss, as assessed so far, is about 0.99 (Neumann, et al., 2012).

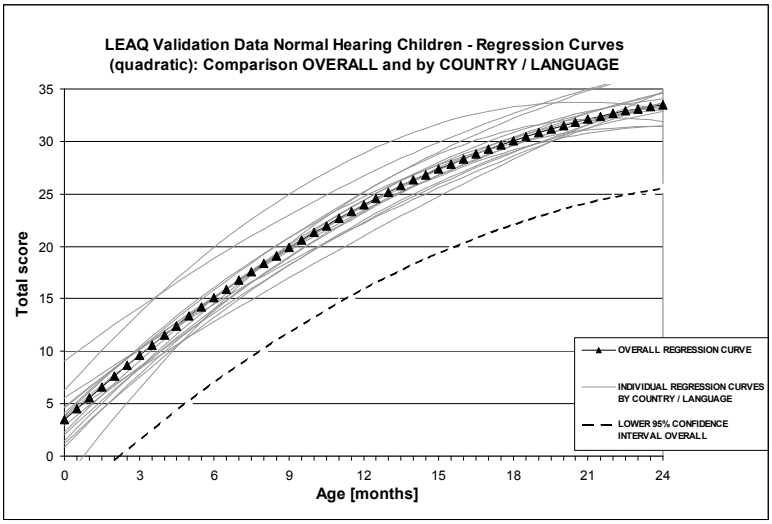

Figure 1: LittlEARS® Auditory Questionnaire validation data (Coninx et al., 2009).

The impact of the LittlEARS® Auditory Questionnaire as an evaluation tool has been reported in the literature. Bagatto et al. (2011) graded 12 auditory-related subjective paediatric outcome evaluation tools on conceptual clarity, norms, measurement model, item/instrument bias, respondent and administrative burden, reliability, different types of validity, responsiveness, alternate/accessible forms and language adaptations scales.

Bagatto et al. (2011) found that the LittlEARS® Auditory Questionnaire received an “A” grade on the conceptual clarity domain and performed well on the scale of “lack of respondent and administrative burden”. The evaluation tools which were investigated used either a rating scale or yes/no response format similar to that of the LittlEARS® Auditory Questionnaire for example, the ABEL, CHILD, ELF, FAPI, and PEACH.

Several applications of the LittlEARS® Auditory Questionnaire have been documented in the literature. For example, May-Mederake et al. (2010) found that LittlEARS® Auditory Questionnaire was a quick and effective tool for assessing the auditory skills of children aged between 6 and 24 months with

hearing loss and additional disabilities. Schäfer (2013) also reported results of an investigation of N=5320 German children who underwent a Second Hearing Screening (SHS). The study identified 6 children with permanent hearing loss as well as infants with frequent otitis media, speech or other developmental dysfunctions like autism and cognitive deficits.

The conclusion is that the LittlEARS® Auditory Questionnaire is sensitive to hearing disorders, language delay, autism spectrum disorders and other cognitive deficits. Therefore LittlEARS® Auditory Questionnaire is useful for a Second Hearing Screening (SHS) for children particularly those whose ages range between 10 and 12 months. In addition however, the LittlEARS® Auditory Questionnaire could also be useful in screening children aged between six and thirty-six months. This is an important topic that has been addressed in this thesis.

Obrycka, (2010) has observed that using a structured questionnaire to obtain parents' or other caregivers' view about their child's behavior is a useful way to identify hearing losses among pre-verbal children. In addition, parental questionnaires could complement professional assessments that are carried out before and after cochlear implantation. In this way parents' reports have been shown to be a reliable way of assessing child development (May-Mederake et al., 2010).

Bagatto et al. (2011) support the use of parents' questionnaires to evaluate the auditory ability of their children. In their view, subjective measures focus on the child's responses to various sounds in real-life situations, as these are reported by the caregiver. Furthermore, questionnaires provide important information which supports the objective tests performed by clinicians.

However, Johnson and Danhauer (2002) have warned about possible administrative barriers that could emerge with caregiver reports. For example, questionnaires are more appropriately administered in the native language of the family, and there may be challenges for caregivers who have literacy issues. This situation is particularly applicable in Ghana, a middle income country with over 100 ethnic groups and immense multi-cultural diversity (Dolphyne, 2006; Osam, 2004). In Ghana, about 30% of the adult population has never been to school and about 17% have been to school but do not have any qualification (Ghana Living Standards Survey, 2008).

These challenges could be overcome when questionnaires are administered in various languages or the tool is administered as a person-to-person interview rather than in a written format. This has been an issue for research in Ghana and raises important questions that are addressed in this thesis.

1.7 Early identification (3 years and older)

Testing of older children, for whom speech perception testing is the most common method, is used to determine their auditory capacity or their use of their functional hearing, and is not usually as difficult as testing infants and very young children. For older children, diagnosis of auditory problems should include physiological, behavioural, and functional auditory measurements both in the clinic and in the child's own natural environment (Tharpe & Flynn, 2005).

1.7.1 Pure Tone Audiometry (PTA)

Pure-tone audiometry is the most commonly used procedure for measuring hearing loses. The purpose of pure-tone audiometry is to measure the hearing threshold in order to be able to describe the degree and type of hearing loss (Wood, 2004). Hearing threshold is defined in various ways in the hearing

literature. For example, Gelfand (2004) defined normal hearing threshold as the quietest sound that a young person with no history of damaged hearing can detect at 1000Hz. The definition of auditory threshold has been described as arbitrary (Wood, 2004 p.158). According to Wood, threshold lies in between “an intensity above which an individual responds on all presentation and a lower intensity below which the individual will fail to respond on all presentations” (p. 158).

Durrant & Lovrinic (1984) and Gelfand (2004) defined the absolute threshold as the sound that can just be perceived by the organism. According to the authors, the absolute threshold of hearing (ATH), also known as the auditory threshold, is the minimum sound level of a pure tone that an average ear with normal hearing can perceive when no other sound is present. They contend further that absolute threshold is not a discrete point, but rather a point at which a response is elicited a certain percentage of the time.

The exact value of a threshold may be affected by patient variables such as, attention, motivation and concentration (Wood, 2004 p.158). In addition, regular equipment calibration, background noise and other procedural variables such as the instructions given to the patient, the procedure of threshold measurement, attenuator step size and the criterion adopted for threshold are also important variables that may affect a hearing threshold (Wood, 2004 p.158).

The process of using pure tones to determine hearing threshold is as follows: In this method of testing, the child being tested listens to a series of pure-tones generated by the test leader from the audiometer and the softest dB level that he/she is able to respond to at least 50% of the time at each frequency is recorded. “Ideally, the patient’s response should be silent and indicate the during of the test tone by, for example, pressing a button (or raising a finger)

when the tone appears and releasing the button (lowering the finger) when the tone is no longer heard" (Wood, 2004).

1.7.2 Testing children using pure tones

Normally, children aged 3 years and above (sometimes children as young as 2,6 years) are able to be tested with pure tone audiometry. For example, audiometric tests that use toy materials could be used to assess the hearing thresholds of children provided the tester has expert skills in testing. Such tests are normally conducted in a sound treated room and children are accompanied by their parents or caregivers (Wood, 2004). In Ghana pure tone audiometry is often used in testing the hearing of children (Amedofu et al., 2003; Essel, 1992). The child's ability to hear is often tested on the following frequencies; 500Hz, 1000Hz, 2000Hz, and 4000Hz.Depending on what kind of information that is needed sometimes hearing thresholds are determined on frequencies such as 1500Hz and 3000Hz.

1.7.3 mFAST as a possible alternative

For several years the use of pure tones as stimuli for frequency-specific (detection) hearing threshold tests has been considered the golden standard for audiological screening and diagnosis. This is because pure tones are language and culture independent. What this means is that pure tones are the same and are well calibrated all over the world. PTA is therefore a well established technique and has proven its value. There are several advantages of pure tone audiometry. First, the norm values and results from PTAs are internationally comparable. Secondly, PTA is frequency specific and is very useful for diagnosis and hearing aid fitting.

However, there are disadvantages to the PTA approach of testing. For instance, PTA reflects only the auditory sensitivity at the detection level. It does not therefore provide any information concerning the suprathreshold processing of acoustic signals (sound and speech discrimination and identification). As a consequence of this PTA does not reflect real-life hearing skills (Coninx & Offei, 2012).

Secondly, as described above, pure tones do not only have advantages. Pure tones are acoustic signals that are not often used in real life situations. It appears therefore that PTA is not really a very interesting test for children. Even though there is no research evidence available, it is common knowledge that children tend not to pay attention to a task if they are not interested. This could result in inaccurate test results.

Thirdly, PTA is sensitive to the skills and experience of the tester. Since measurements and reinforcement are crucial for running successful tests, this may cause problems, especially in screening of children. Fourthly, pure tones cause uncontrolled acoustic resonances in the out ear. Together with hearing threshold fine structure, inaccuracies of 5-10 dB may occur, particularly in the frequency region 2-8 kHz.

Further, pure-tone audiograms in the standardized layout (ISO 8253-1, 1989) show that the threshold in quiet is flat between the audiometric frequencies (Heise, Verhey, & Mauermann, 2008). However, when detection thresholds are measured with small frequency steps, consistent variations in thresholds across frequencies of up to 15-20dB are seen (Lee & Long, 2012). This phenomenon is referred to in the literature as ‘microstructure’ (Long & Tubis, 1988) or ‘fine structure’ (Kapadia & Lutman, 1999; Mauermann et al., 2004; Lee & Long, 2012).

Lee and Long (2012) observed that in most research settings, tests used to evaluate hearing status are usually obtained with discrete frequency pure tones such as octaves, half or third octaves. Although the tested frequencies remain the same for all individuals, the threshold fine structure is unique to the individual ear. Therefore, there is the possibility that for some individuals one or more of the audiometric frequencies tested might give an artificially low threshold estimate because other nearby frequencies would have higher thresholds. Consequently the obtained threshold may not be representative of thresholds in that frequency region.

Horst & de Kleine, (1999) have reported that the determination of audiogram fine structure is complicated by various problems. First, there is the intrinsic variability of behavioural measurements, which may change with the concentration and the degree of motivation of the subject. Second, it is not clear if and how ripple shape and ripple distance depend on hearing loss.

As a result of these disadvantages, the use of spectrally more complex stimuli has been advocated in order to avoid the effects caused by fine structure in the tone audiogram, and to use sounds that are more natural to children and are used in daily life. For the purposes of testing children, real-life types of stimuli are preferred over pure tones (Heise et al., 2008; Massie, Dillon, Ching & Birtles, 2005). Therefore, as a part of this dissertation, the multiple frequency Animal Sound Test (mFAST) (Coninx & Offei, 2012) was investigated as a possible alternative to pure tone audiometry for children in Ghana.

The multi-Frequency specific Animal Sound Test (mFAST) procedure contains four animal noises (cow, dog, cat and bird), with stimulation in the range 500-4000Hz which can be recorded. The four animal sounds cover four non-overlapping one octave wide frequency bands (see Figure 2). Thus, mFAST has different spectral contents with centre frequencies at 500 Hz, 1 kHz, 2 kHz and

4 kHz to estimate the audiometric thresholds. The duoTone test procedure was based on a similar adaptive procedure as mFAST, thus making all tests run independently and not be influenced by the skills or competence of the test leader.

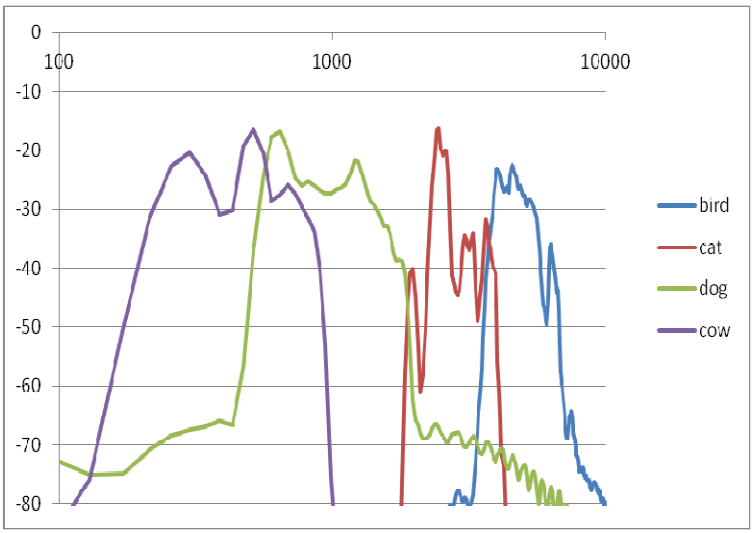

Figure 2: Spectral content of animal sounds

The mFAST emerged from the Adaptive Auditory Speech Test between 2006 and 2008. AAST was being used for screening purposes in a school for children with learning difficulties mental retardation in Germany. However, for this group of children, the 6 AAST words were found to be too difficult, apparently because the vocabulary for this group of special needs children was too limited. Therefore there was a request from the school to either reduce AAST to 2 or 3 words or alternatively to develop another version of AAST without words (Personal Communication, F. Coninx 2012).

Consequently, the first alternative test - an 'environmental sound test' - was developed and partially tested, but this was not finished since there was a major concern that some of the children were too afraid of some of the sounds (e.g.

thunder). Therefore, this first alternative test had to be revised. It was during the process of revision that the thought of an animal sound test was considered using, for example, the sound of a cow and a dog (both below 1500 Hz) and the sound of a cat and a bird (both above 1500 Hz). This test was called FAST4 ("4" because of 4 animal sounds), based on two interleaved adaptive procedures (A: cow and dog, <1500 Hz; B: cat and bird, >1500 Hz. Later, FAST4 was developed into mFAST where cow and dog were "separated" into octave band around 500 Hz and 1000 Hz, and cat and bird were separated into octave bands around 2000 Hz and 4000 Hz.

The disadvantage of mFAST, however, was that it took a much longer time to complete, because of the 4 adaptive curves. Adaptive tests require the person being tested to select the correct item (for example, a touch screen) Once on item is selected the test "adapts" itself by selecting the next item to be presented base on performance on preceding items. For mFAST, there is one adaptive curve for each of the four animal sounds. This was obviously too much to expect of a group of children with learning difficulties (Personal Communication, F. Coninx 2012).

1.7.4 Speech Audiometry

Speech audiometry is used in audiological assessment as one of the methods of providing information on the sensitivity and understanding of speech at levels above threshold (Mendel, 2008). Boothroyd (1970) observed that all tests of hearing which use speech as a stimulus may be categorized as speech audiometry. Speech audiometry may be used to crosscheck "the validity of pure-tone thresholds" (Mendel, 2008, p.546).

Speech tests may be presented in various forms such as speech sounds (e.g. Ling's Five Sound Test), word lists, sentence tests and speech discrimination tests (Gadagbui, 2003). In Ghana very few speech tests have been developed

in the local languages. Gadagbui (2003) has developed speech discrimination tests in the Eve (Gadagbui, 1999) and the Fante languages (Gadagbui, 2001). However, these tests are not used widely in clinical settings in Ghana probably because norm data for the tests are not available.

Worldwide, open-set and closed speech tests are mainly used in the screening and diagnosis of children. The effects of open and closed set task demands on spoken word recognition have been researched. For instance Clopper, Pisoni and Tierney (2006) observed that word recognition would be better in closed-set than in open-set paradigms because the increasing task demands of the open-set test may require the listener to use different strategies for processing the information. Mandel (2008) noted that "while open-set tasks force the child to compare the stimulus item to all possible words in lexical memory, closed-set tasks make only a limited number of comparisons among the given response alternatives" (p. 548).

1.7.5 Closed-set tests

Closed set tests are defined in terms of restriction on the listener to one out of a specific number of possible responses in the number of possible items, as in a multiple-choice test (Kirk, Pisoni, & Osberger, 1995). Closed set test items may include numbers, body parts, pictures or letters of the alphabet, and the test requires the child being tested to select or point at an item (Madell, 2008).

Closed-set tests may be administered without requiring the listener to provide a spoken or a written response. As a result, the tests are useful for individuals who cannot perform open-set tests because they can neither speak nor write well. Because closed-set tests use pictures rather than printed words the tests are suitable for children who cannot read. The limitation on the number of

potential responses makes closed-set tests easier to perform, and yields higher scores in comparison to an open-set procedure (Kirk et al.,1995).

Examples of closed-set test formats which are quite frequently used in auditory practice are the Word Intelligibility by Picture Identification (WIPI) test, Monosyllable, Prochee and Polysyllable Test (MTP), The Digit Triplets Test (DTT) and the Northwestern University children's perception of speech (NU-CHIPS) (Elliot & Katz, 1980) test.

1.7.6 The word Intelligibility by Picture Identification (WIPI) (Ross & Lerman, 1979):

WIPI was designed for children whose language age falls between 5 and 10-11 years old. It is a closed-set picture-pointing test with four 25-monosyllabic word lists and six pictures per plate. Kirk et al. (1995) reported findings of an investigation of relationship between WIPI words used as an open-set and as a closed-set test for normal hearing children. The findings showed that WIPI as a closed-set test improved discrimination scores by about 10%. In the WIPI test, the sensory capabilities of the child are utilized "because they cannot use a process of elimination to select a response" (Mendel, 2008, p. 548).

1.7.7 The Northwestern University children's perception of speech (NU-CHIPS):

NU-CHIPS is also a closed-set picture-pointing word recognition test designed for children whose language age is as low as 3 years, which is lower than WIPI. Compared to WIPI, the NU-CHIPS comprise 50 words familiar to 3-year old children in 4 randomizations. It also contains two recordings, one with a male and the other with a female talker.

Children with hearing impairment and a receptive language of about 30 months demonstrated familiarity with the words and pictures of the NU-CHIPS test whereas normally hearing children of different ages showed ceiling effects at 30dB sensation level. At sensations levels lower than 30dB, 10 year olds performed better than 5 year olds, who also performed better than 3 year olds. Kirk et al. (1995) attributed the age effects demonstrated at low sensation levels to language skill or experience. Elliot and Katz (1980) also found that children whose language skills are better than the target group for which NU-CHIPS was developed achieved higher scores on NU-CHIPS than on WIPI test. These findings were expected because the vocabulary on the WIPI test is more difficult (Kirk et al., 1995).

1.7.8 Monosyllable, Trochee and Polysyllable Test (MTP)

The Monosyllable, Trochee and Polysyllable Test (Erber & Alencewicz,1976) is a closed ended test that evaluates children's ability to identify monosyllabic, two-syllable and three-syllable words. MTP is designed for children aged two years old and above and is "graded in difficulty from easy to hard (MTP-3, MTP-6, MTP-12)" (Sahli & Belgin, 2011, p 387).

1.7.9 The Digit Triplets Test DTT)

The Digit Triplets Test (DTT) is a test of speech intelligibility in a background noise. The test assesses the ability to hear someone speaking when there is a background noise, similar to being in a crowded room (HearCom Website).

1.7.10 Adaptive Auditory Speech Test (AAST)

The Adaptive Auditory Speech Test (AAST) is an automatic adaptive procedure used to evaluate the speech reception threshold (SRT) under quiet and noisy conditions for children aged 3 to 4 years or older, in a fast and reliable manner. In adaptive methods, the response of a test subject to the previous test stimulus determines the level at which the subsequent stimulus is presented (Levitt, 1971).

There are various methods for running adaptive tests. One of these methods is the simple '1-down-1-up' method which comprises a series of ascending and descending trial runs as well as reversals (turning points). In this method, the level of the test stimulus is increased when the test subject does not respond and is decreased when there is a response. The test stimuli are adjusted in predetermined steps so that, when about six to eight reversals have been obtained, the first reversal is discarded and the threshold is defined in terms of the mean of the midpoints of the remaining runs. Levitt (1971) reported, however, that this method provides only 50% accuracy therefore in order to present more accurate results, there is a modification of this method whereby the step sizes in the descending runs are increased for example, '2-down-1-up' method, or '3-down-1-up' methods (Gelfand,1990).

Although AAST is designed specifically for young children, it can be used just as well to test adults. The procedure depends only minimally on words within the person's vocabulary range. AAST comprises six easy words with picture-pointing as a response task. AAST is established in several languages. The German, Chinese, Dutch and English versions use spondee words that have a redundancy comparable to short everyday sentences which also contain only two key words.

Because of the easy closed- set paradigm, the introduction time is short and learning effects are correspondingly fast and small. Average testing time is typically one minute or less per condition. Standard deviation of SRT in noise measurements is as low as 2dB for children and the steepness of the psychometric curves for quiet and speech-in-noise measurements are comparable to standardized tests such as the Oldenburger Kinder Satztest which has slopes of 6-8%/dB in quiet and 12-14%/dB in noise (Wagener & Kollmeier, 2005).

Action Plan

In this chapter some historical perspectives as well as challenges of educational audiology were discussed. Also, population statistics related to hearing impairment in sub-Saharan Africa in general and Ghana specifically were discussed. Furthermore, implications of hearing loss acquired early in life and some methods of testing hearing impairment were mentioned. Finally, some tools are commonly used to test the auditory function of children were discussed. In the next chapter the procedures involved in developing screening tools for testing infants and children in Ghana will be discussed. The tools in question are the LittlEARS® Auditory Questionnaire, the Multiple Frequency Animal Sound Test (mFAST) and the Adaptive Auditory Speech Test (AAST).

2.0 CHAPTER TWO
DEVELOPING SCREENING TOOLS FOR INFANTS AND CHILDREN IN GHANA-PROCEDURES

2.1 LittlEARS® Auditory Questionnaire translation and back translation

The first and original version of the LittlEARS® Auditory Questionnaire was in German (Coninx, 2004). This version was translated into English which has subsequently served as the basis for adaptation into several other languages. The English version of LittlEARS® Auditory Questionnaire was adapted into three Akan languages-Fanti, Akuapem and Asante- using the translation/back-translation procedure recommended by the International Test Commission (Hambleton, 2001).

The purpose of the back-translation design was to keep the variable meaning of the test items in the questionnaire and, in addition, to get a linguistically correct version (Harkness, 2003). The International Test Commission Guidelines ensure the avoidance of serious errors which could occur during the translation process.

The adaptation into the three Akan languages was done in two phases. The first was the translation phase and second was the evaluation phase by means of an expert appraisal method. The application of an expert appraisal method ensures that the translated version of the text is linguistically equivalent. This also ensures that the adaptation is of the best professional quality (Obrycka et al., 2009).

The back translation design was applied using the following steps:

- Direct translation from English (source language) into three Akan languages namely Akuapem, Asante and Fante (target languages)

- Back translation from the target languages (three Akan language versions) into English
- Comparing the original English and the three Akan back translations (Obrycka et al., 2009).

In total, ten (10) persons comprising 3 university lecturers, 1 professional translator and 6 post graduate language students were recruited to translate the test items from English into the three Akan languages. All the translators were Ghanaian natives who were competent in both English and Akan languages. They also had long experience in working with very young children and a lot of expertise in test construction and adaptation. They were all recruited from the Ghanaian Languages Education Department of the University of Education, Winneba, in Ghana.

Translations into Akan from English were completed within two weeks. Following this, another set of nine (9) native Akan speaking post graduate Ghanaian language students (three speakers for each of the 3 Akan languages) who were pursuing their degrees at the University of Ghana and who were equally competent in both English and Akan languages, were recruited to do a back translation from Akan to English. The back translations were done independently and were completed within three weeks, after which they were sent via email attachment to the researcher in Germany.

The translations and back translations were deliberately sent to professionals in different locations in Ghana in order to ensure that members of the second group did not have prior knowledge of the text. This was meant to ensure a measure of reliability of the translations and back translations. The researcher read through the translations, corrected a few typographical errors and sent the corrections back to one of the first set of translators for cross-checking. After

this cross-checking had been completed the text was returned to the researcher in Germany.

In order to judge the accuracy of the 'translated' Akan versions of the LittlEARS®, questionnaire, the researcher compared each of the items of the original English and the 'back translated' English versions for each of the three Akan language versions. This process included an item by item comparison which was aimed at finding out whether the items measured exactly the same auditory behavior (Obryka et al., 2009).

As a result of the comparison of the translated test items, two statements (9 and 10) were indentified for revision. In item 10 "Does your child recognize acoustic rituals"? the words "acoustic" and "ritual" were translated very differently from the English text. Similarly, item 9 "Does your child respond with alarm when hearing an angry voice" was also translated differently.

In relation to item '10' and also out of sheer curiosity, the researcher carried out a brief random survey of views of 10 Ghanaian adults (average age 31.5years, SDEV 4.6), on how they understood the term "ritual". The survey was conducted in Winneba, Ghana in April 2011 by respondents each of whom had at least a Senior High School level of education. Respondents were asked to respond to the Question: 'What do you understand by the word "ritual"?' Responses are shown in table 1.

Table 1: Meaning of “Ritual”.

Responses
1. a set of activities performed by a group of people on a special occasion. For example, Puberty rites (an initiation ceremony to usher young adolescent girls into adulthood)
2. a spiritual performance to pacify or appease a spiritual god
3. a sacrifice to the gods to respond to a request.
4. it is a sacrifice to the gods or ancestral spirits
5. a spiritual activity organized to initiate an activity or someone into a particular society or cult.
6. a customary performance which is initiated for a particular purpose at a particular time
7. a continuous performance of a particular activity for a specific purpose.
8. using animals or human beings and other materials for sacrifice and to appease gods
9. a means of using human or animal blood to gain power or protection
10. it is a way of consulting divinities or other gods for power

Following this review, items 9 and 10 were revised. The Ghanaian language versions therefore include modifications of the wording for item 10 of the original English version of LittlEARS®, as well as changes in some of the examples, in order to suit the Ghanaian context. Finally, the revised sets of Akan questions were evaluated.

2.2.1 Evaluation of Translations

An evaluation of the translations was done by applying an expert appraisal method. The expert appraisal method provides evidence regarding the quality of the translated version and recommends ways to improve the final version (Obryka et al., 2009). Two experts, an Audiologist and a Linguist, both of whom are experienced in working with children were recruited to appraise the test items. The appraisers were each provided with a set of evaluation forms (appendix B) to ensure that the evaluation was systematic and orderly.

The task of the appraisers was for them to compare both English and Akan versions of each test item (including the examples) in order to assess the extent to which both versions measured exactly the same auditory behavior. The experts rated each test item on a numbered scale from '1', indicating an inappropriate translation, up to '5' for an 'absolutely appropriate translation'. The ratings show that the translations were generally good.

2.2. AAST

2.2.1 Criteria for selection of words

The criterion for selection of the six (6) AAST words is as follows:

- 3-4 years old children know the meaning of the words
- 3-4 years old children recognize a picture of the words
- The words must have the same prosodic pattern (number of syllables and stressed syllable): S-S (spondee), S-W-W (trisyllable, first syllable stressed) or W-S-W (trisyllable, second syllable stressed). [S=strong, W=weak].
- The words must be maximally different at the phoneme level. Preferably, the phoneme statistics should correspond to the frequency of occurrence in the particular language. Table 2 shows the words selected for Fante

basic set. The Akuapem and Asante basic sets have minimal differences in some of the words. For example, in the Akuapem set the word for "bottle" is substituted with the word for "whiteman" whereas in the Asante set the words for "nail" and "key" are used instead of those for "bottle" and "orange".

Table 2: Words and pictures in Fante basic AAST

Word	**phonetic transcription**	**Prosodic pattern**	**English translation**
ahwehwɛ	aɕʸɪɕʸɛ	w-w-s	Mirror
ekutu	ekutu	w-w-s	Orange
tsikɛse	tsikɛsɪ	w-w-s	Bighead
bɔdambɔ	bɔdambɔ	w-w-s	Bottle
tɛkyrɛma	tɛtɕɪrɛma	w-w-s	Tongue
aborɔbɛ	aborɔbɛ	w-w-s	Pineapple

2.2.2 Frequency of occurrence of Akan phonemes

In AAST it is preferred that the phoneme statistics of all the six selected words should correspond to the frequency of occurrence in the particular language (Akan in this case). What this means is that the phonemes of all the 6 words must agree with the general distribution of consonants and vowels in the standard language (Mohammed, 2010).

Following a thorough search in the Akan literature it appears, however, that there is no phoneme distribution curve in the Akan language. A distribution curve of Akan vowels and consonants based on selected passages from a primary reader was therefore developed (Figures 4, 6, and 8).

The first two chapters of a Ghanaian childrens' reading book which has Asante, Fante and Akuapem translated versions were selected and used to develop the Akan phoneme distribution curve. Three Post Graduate Phonetics students at the University of Education, Winneba, Ghana were recruited to support the phonetic transcription of each of the words in the selected chapters. This support was needed because of native language user based knowledge. The completed phonetic transcriptions were inserted into an Excel file, sorted and put into groups. Each of the phonemes was then counted using the Excel software and the percentages for each class of phonemes were then calculated.

Following this, all the 6 selected AAST words were phonetically transcribed and distribution curves were drawn based on the phonemes. The consonant and vowel curves for the AAST words were then compared to the Akan curves. Distributions for Fanti, Akuapem and Asante text and AAST phonemes are shown in Figures 3, 4 and 5. The curves show that sound in AAST and main text were close except in Akuapem (Figure 4) where voiceless plosives and central vowels were not very close. AAST uses only six words therefore it would be expected that phonemes in AAST words may not always exactly approximate those of the mother language.

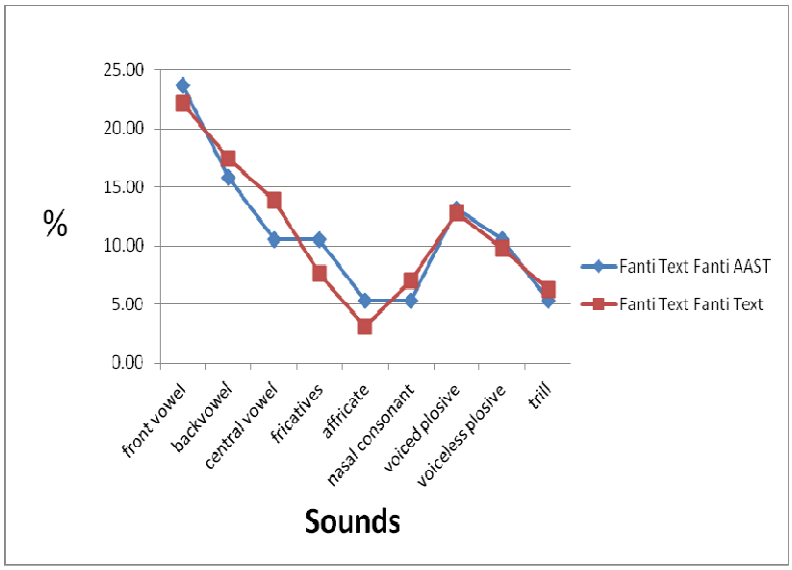

Figure 3: Fanti Text and AAST phoneme distribution

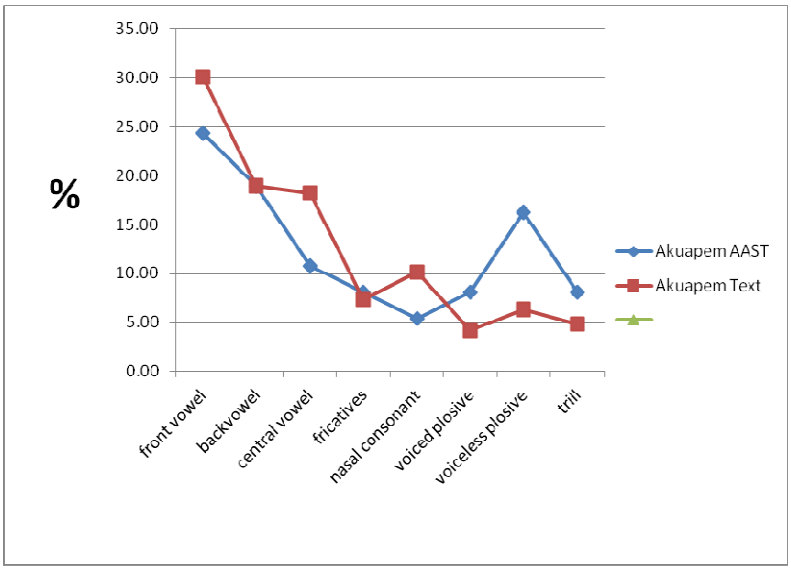

Figure 4: Akuapem Text and AAST phoneme distribution

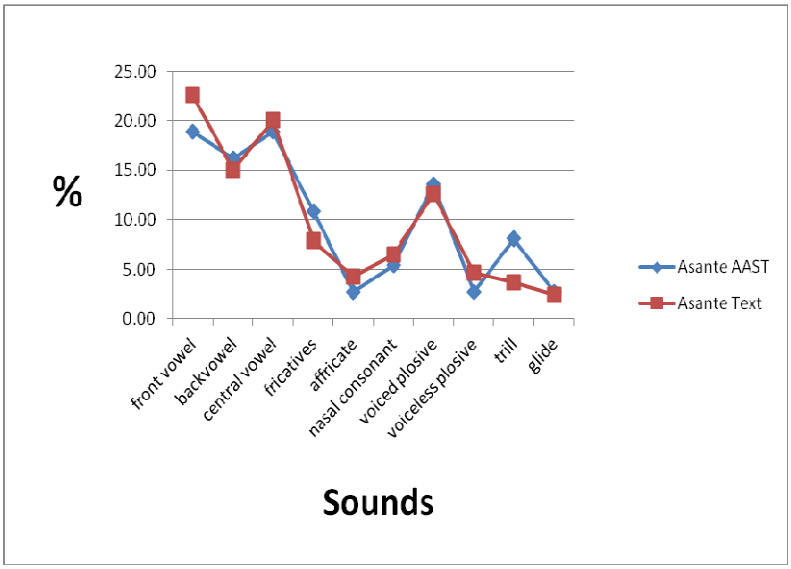

Figure 5: Asante Text and AAST phoneme distribution

2.2.3. Criteria for selection of pictures

The selection of pictures for AAST was based on the following criteria:

- All pictures were in the same style
- Pictures had the following details: JPG format, 201x174 pixels)
- Colour or black/white was a local choice

The first set of selected pictures were tested with (N= 20) children aged 3-4 years old. More than 95% of the children recognized the pictures. The pictures were therefore, deemed appropriate for the test. An interface of the pilot version of Fante AAST is shown in Figure 6.

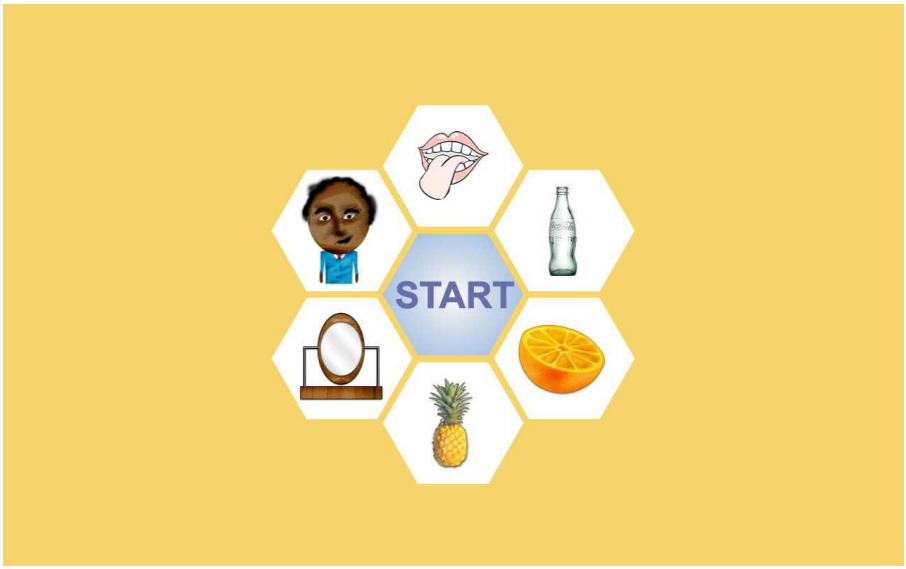

Figure 6 . AAST pilot Fante Interface

2.2.4. Recording of noise and sounds files

All the selected AAST Akan words were recorded in Winneba in Ghana using female speakers who had clear, natural pronunciation and acceptable Akan accents. A separate speaker was used for each of the three Akan versions and also for the Ghanaian English version. A female voice was the preferred choice for a couple of reasons. First, in comparison with the pitch of men and children, the fundamental frequency (F0) of the female pitch as well as the formant frequencies (F1, F2) are “in the middle”. Generally, F0-F1-F2 are lower for men and higher for children. Secondly, children have most experience with the voices of their mothers (female). So, internalized F1 –F2 information is more familiar or established for female speakers. Thirdly, female voices are more soothing.

The sound files were recorded in a sound-proofed room (with very minimal reverberation and ambient noise) with a high-quality microphone and digital

recording equipment. The files were recorded as mono (one microphone, one channel), with sounds digitized at 44.1 kHz and 24 bits, PCM... wav-file).

For the purposes of creating noise files, the same speakers were recorded whilst read aloud from a newspaper. The speech material lasted for 2 to 3 minutes. The speech was used only to measure the long term average speech spectrum so the actual content of the speech was not relevant. Tables 3,4 and 5 show the average and total root mean square (RMS) power of the AAST words. The figures show that there were no distortions and that the sound files for all the words have energy (total power) that is quite close to each other at the maximum sound pressure level (SPL).

Table 3: Average and Total power of Asante AAST words

Language	Word	average RMS power	total RMS power
Asante	whiteman	- 28.6 dB	- 28.0 dB
	Mirror	- 36.6 dB	- 35.1 dB
	Tongue	- 34.4 dB	- 33.6 dB
	Key	- 34.1 dB	- 32.3 dB
	Pineapple	- 32.4 dB	- 31.7 dB
	Nail	- 33.4 dB	- 32.0 dB

Table 4: Average and Total power of Akuapem AAST words

Language	Word	average RMS power	total RMS power
Akuapem	Mirror	- 34.1 dB	- 33.4 dB
	Tongue	- 35.0 dB	- 33.5 dB
	Pineapple	- 35.0 dB	- 33.2 dB
	Bighead	- 37.8 dB	- 36.0 dB
	Orange	- 37.5 dB	- 35.1 dB
	Whiteman	- 34.1 dB	- 33.7 dB

Table 5: Average and Total power of Fante AAST words

Language	Word	average RMS power	total RMS power
Fante	Mirror	- 38.6 dB	- 36.8 dB
	Tongue	- 39.2 dB	- 38.6 dB
	Pineapple	- 39.5 dB	- 38.4 dB
	Bighead	- 43.0 dB	- 42.3 dB
	Orange	- 42.2 dB	- 40.6 dB
	Bottle	- 35.6 dB	- 34.5 dB

2.2.5 Preparation of pilot AAST basic versions

Pilot basic and high frequency versions of Akuapem, Asante, Fante and Ghanaian English AAST were prepared at IfAP in Solingen, Germany. For the first field trial tests, data were collected from n=200 (n=400 ears) Akan speaking adults (n=50 each from Fante, Akuapem and Asante languages) who had no indication of hearing loss. Each of these adult participants was tested with AAST on both ears. The data derived from this field trial were analyzed. Based on the outcome of the analysis, the optimal word sets were determined for each of the Akan language versions. Significant changes were also made in the relative intensity levels.

2.2.6. Psychometric functions

A psychometric function represents the probability of a certain listener's response as a function of the magnitude of the specific sound characteristic which is being studied. This could be the probability curve of a test subject detecting a sound that is being presented as a function of the level of the sound. When the stimulus is presented to a listener it is assumed that the sound would either be audible or inaudible, thus resulting in a 'doorstep' function.

In real practice however, a grey area exists, where the listener is not certain as to whether he/she has actually heard the sound or not. Therefore there are clearly some inconsistent responses, resulting in a psychometric function. The psychometric function is a sigmoid function that is characterized by being ‘s’ shaped in its graphical representation (Arlinger,1991).

Psychometric curves for all words were measured twice, before and after intensity corrections. Psychometric curves may be defined as the relationship between physical properties of a stimulus and measured behavior. Within the the context of this thesis however, psychometric curves will refer to how well each word is recognized as a function of its intensity level. In an optimal case this is the same for all the words. The purpose of the psychometric measurement was for internal balancing.

The psychometric analyses show that for example, "oldman" and "blackstar" are too easy (figure 7) and these two words were reduced in intensity accordingly. After the reduction, all psychometric curves (PCs) coincided, demonstrating that the words had become equally difficult (Figure 9). As a consequence, the set of words is more homogeneous and the "total psychometric curve (PC)" becomes steeper. Before balancing the total psychometric curve was 7.8 %/dB (Figure 8) and it was 10.2 %/dB after balancing (Figure 10). The steepness is quite close to the Oldenburger Kinder Satztest (OLKISA) which has slopes of 6-8%/dB in Quiet and 12-14%/dB in Noise (Wagener & Kollmeier, 2005). Equal intelligibility of test material and steep discrimination functions are important hallmarks for any reliable test (Smits, Kapteyn & Houtgast, 2004).

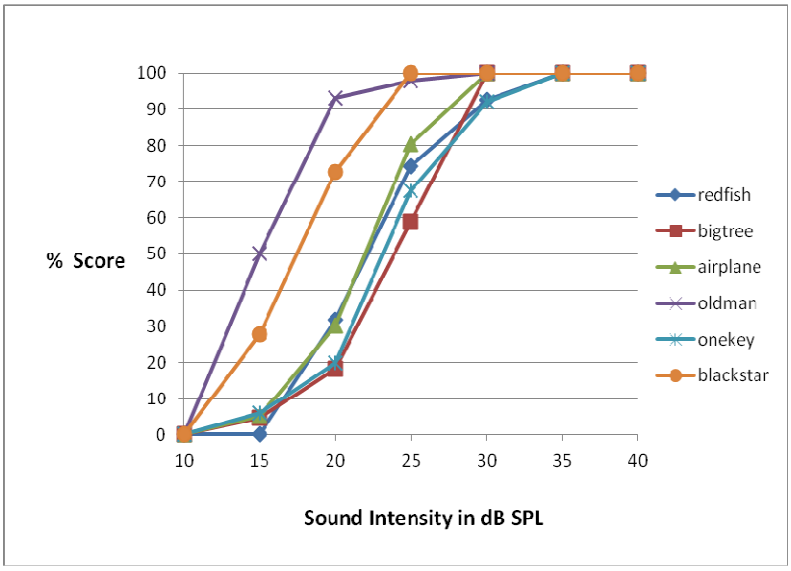

Figure 7: Psychometric curve before internal balancing

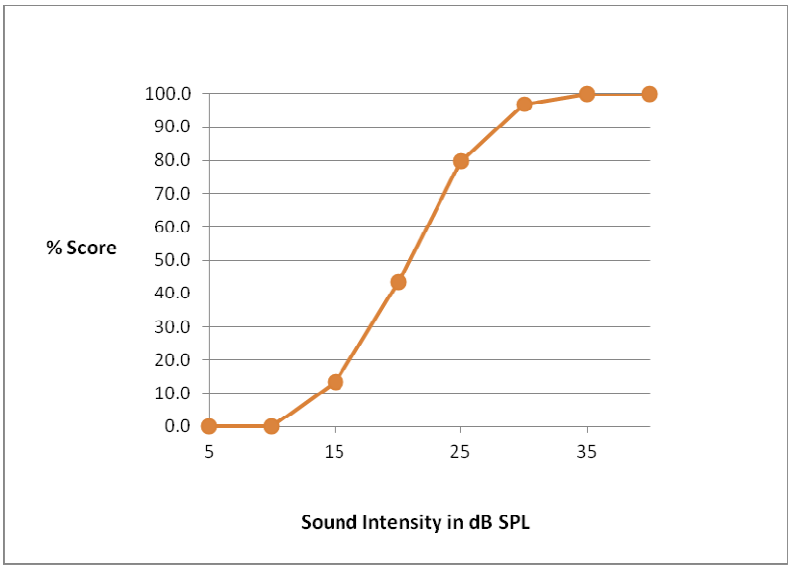

Figure 8: Total Psychometric curve before internal balancing

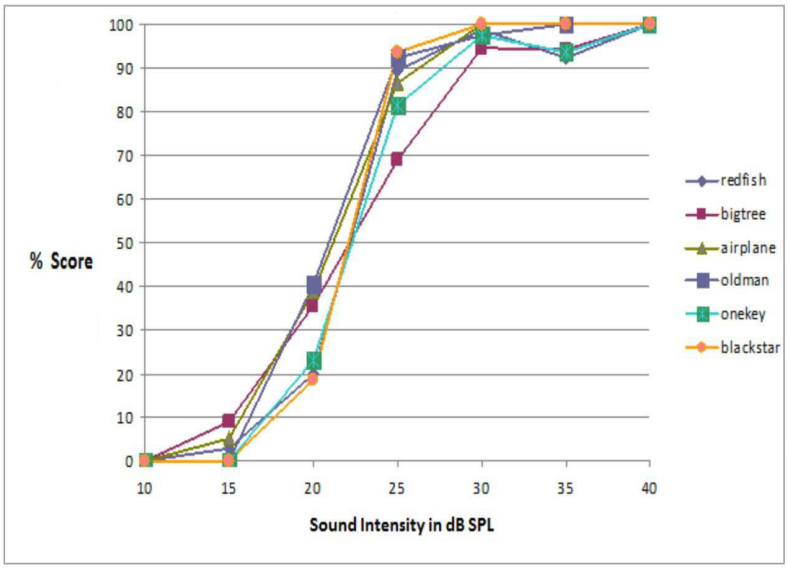

Figure 9: Psychometric curves after balancing

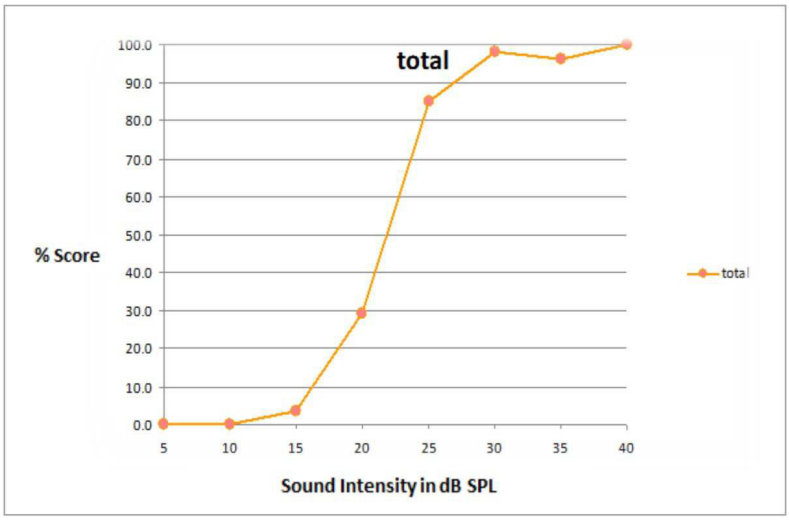

Figure 10: Total psychometric curve after balancing

2.2.7. Confusion analysis

A confusion analysis (also typically called a matching analysis) is a visualization tool which makes it easy to see if the system is confusing two words (i.e. commonly mislabeling one as another). When a data set is unbalanced (when the number of responses in different classes vary greatly) the error rate of a stimulus is not representative of the true performance of the stimulus (Mohammed, 2010). In Table 6, the rows represent the child's responses, while the columns represent the actual software stimulus.

Confusion matrices were made for all the words in the AAST Akan basic sets. The confusion analysis (Table 6 & Figure 11) for example, show that there was more confusion between "mirror" and "pineapple" than for the other words. However, this was minimal. Furthermore, "bighead" was the word that majority of the test subjects responded with "?" (Table 6). What this means is that the test subjects either did not hear the word at all or, they were not very sure about what they were hearing. Overall however, the confusion analysis tends to show that the words in the Akan AAST (Appendix G) versions are generally not confusing. What this means is that a substantial number of the children tested are not guessing.

Table 6: Fante Confusion Table

		Response						
		bighead	bottle	mirror	orange	pineapple	tongue	"?"
Stimulus	bighead	232	2	5	4	0	4	62
	bottle	1	189	1	2	2	3	30
	mirror	4	2	156	6	7	1	53
	orange	1	1	1	180	3	8	45
	pineapple	3	4	26	6	145	2	41
	tongue	1	4	1	4	0	174	44

"?". The test subject did not hear the word at all or was not sure

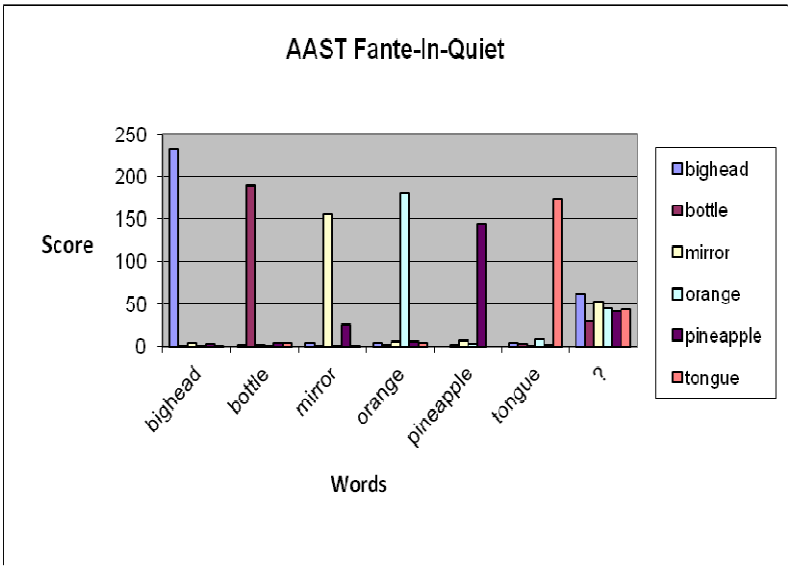

Figure 11. Fante Confusion Analysis

Action Plan:

The focus of this chapter was on the procedures used in developing screening tools to be used in Ghana. The psychometric properties of the adaptive auditory tests were described. In the next chapter, the objectives set out for this dissertation are stated and the six research questions which were raised in the light of those objectives are also discussed.

3.0 CHAPTER THREE

OBJECTIVES AND RESEARCH QUESTIONS

3.1 Objectives:

The following objectives were proposed for this dissertation:

Objective 1: To investigate the appropriateness of the LittlEARS® Auditory Questionnaire as a screening tool for hearing loss and other related educationally significant disorders in Ghanaian children aged 0-36 months.

Objective 2: To adapt and evaluate the multiple frequency Animal Sound Test (mFAST) for use as an alternative to pure tone audiometry.

Objective 3: To construct, and validate four (4) language versions (Asante, Akuapem, Fante and Ghanaian English) of the Adaptive Auditory Speech Test (AAST) in quiet and in noise.

3.2 Research Questions:

In order to achieve the set objectives, six research questions were raised.

- Research Question 1: Are the norm curves of the Akan versions of the LittlEARS® Auditory Questionnaire comparable to the German norm curve?

- Research Question 2: How does responding to either the questionnaire or the interview affect LittlEARS® Auditory Questionnaire test scores?

- Research Question 3: How appropriate is the LittlEARS® Auditory Questionnaire as a screening tool for hearing loss and other educationally significant disabilities in Ghanaian children in the 3rd year of life (24-36 months)?

- Research Question 4: What are the threshold differences between PTA and mFAST?

- Research Question 5: What are the age dependent norm values for Fante, Asante, Akuapem and Ghanaian English AAST? Are there any threshold differences between AAST Ghanaian English and Akan?

- Research Question 6: Learning effects: To what extent will improvement in test performance be due to listeners learning the test words in the Ghanaian language versions of AAST?

The LittlEARS® Auditory Questionnaire (Coninx et al., 2009) is a 35-item age-dependent parental questionnaire. It was originally designed in German in order to monitor and document parents' responses to statements based on their observations of important pre- and post-operative auditory development in infants and children up to 2 years of age who were receiving cochlear implants. However, the use of LittlEARS® Auditory Questionnaire as a tool to assess the auditory ability of children in the third year of life (25 – 36 months) has not so far been investigated. The 35 items have been sorted hierarchically and normal developing children would be expected to reach the maximum score at an age of 24 months.

The LittlEARS® Auditory Questionnaire therefore shows ceiling effects for ages above 24 months and does not document subsequent auditory development. No reference data has so far been collected for children aged over 24 months.

It is unclear whether the LittlEARS® Auditory Questionnaire score might even decrease with increasing age above 24 months. This could happen if some items are answered with “NO” when children get older. For this purpose the following basic assumptions were postulated:

1. There are two types of LittlEARS® Auditory Questionnaire items/statements
2. One type is called NY (No, Yes) and means:
    - for children < age X answer=NO,
    - for children > age X answer=YES
3. The second type is called NYN (No, Yes, No) and means :
    - for children < age X answer=NO,
    - for children > age X answer=YES
    - for children > age Y answer=NO
4. The value of age X is between 0 and 24 months
5. The value of age Y is >24 months.

To date, available norm data of LittlEARS® Auditory Questionnaire only covers the 0 - 24 months age range, so answers of type “NYN” have not been noticed. Therefore, in order to answer the question about the appropriateness of LittlEARS® Auditory Questionnaire as a screening tool for an older group of children, aged between 24 and 36 months, there is a need to investigate whether “NYN” items exist among children aged between 24 and 36 months. If any “NYN” items do occur within this age group then those items/statements have to be identified and removed from the analysis of LittlEARS® Auditory Questionnaire screening for children between 24 and 36 months of age. This is the rationale for including an investigation into the use of LittlEARS® Auditory Questionnaire as a screening tool for hearing loss within the 3rd year of life into this dissertation.

The LittlEARS® Auditory Questionnaire can either be self-administered by parents themselves or administered in an interview (May-Mederake et al., 2010). However, the effect of the mode of questionnaire administration (i.e. interview or self-administration) on LittlEARS® Auditory Questionnaire scores has not yet been documented.

In Ghana, the rate of illiteracy is quite high - about 31% of all adults have never been to school, and less than one-fifth (17.1%) attended school but did not obtain any qualifications; 39 % have Middle School Leaving Certificate (MSLC)/Basic Education Certificate Examination (BECE)/Vocational (VOC) certificate as their highest qualification, and only a small percentage (13.6%) possess secondary or higher qualification (Ghana Statistical Service, 2008). What this implies is that a significant percentage of Ghanaian parents cannot read and would therefore be unable to respond independently to a questionnaire. The effect of self administration of LittlEARS® Auditory Questionnaire was therefore investigated as part of this dissertation.

As part of this present research study three (3) Ghanaian language versions of the LittlEARS® Auditory Questionnaire were prepared in line with the recommendation made by Bagatto et al. (2011) that, if possible, language adaptations of outcome evaluation tools for different cultures must be made. Preliminary preparations of the Ghanaian versions included translations and back translations.

Pure tones have been used as stimuli for frequency-specific (detection) hearing threshold tests for many years. It is therefore considered as the "gold standard" for audiological screening and diagnosis. However, despite haven proven its general value, PTA has several disadvantages. For example, PTA reflects only the auditory sensitivity at the detection level, without providing any information concerning the suprathreshold processing of acoustic signals.

Furthermore, PTA uses tones which are not meaningful and interesting to children. As a result PTA does not reflect real-life hearing skills. The use of spectrally more complex stimuli is therefore proposed in order to use sounds that are more familiar and meaningful to children and used in daily life. For the purposes of testing children, real-life types of stimuli are preferred over pure tones (Heise et al., 2008; Massie et al., 2005). Validation tests have been conducted with populations in Germany. In this dissertation the multiple Frequency Animal Sound Test (mFAST) is validated as a possible alternative to pure tone audiometry.

The Adaptive Auditory Speech Test (AAST) has been developed to test the auditory perception of speech by young children under realistic conditions (Coninx, 2005). The focus of the test is to assess skills at the detection level as well as at the discrimination level. AAST has been adapted into four Ghanaian language versions in order to be usable as a screening tool for Ghanaian children.

Norm data is therefore required to provide a standard baseline against which the results obtained from the evaluation tool, both for normal hearing and hearing impaired children, can be compared. According to Bagatto et al. (2011), a good outcome evaluation tool should have conceptual clarity and normative data in order for meaningful comparisons to be made. AAST norm data was therefore collected from Ghanaian children using all the four Ghanaian language versions.

Learning effects are important in assessing the reliability of auditory tests. Minimal learning effects would how that the test is robust and reliable. Results of studies into learning effects whilst using the AAST on Egyptian children has been reported (Mohammed, 2010). Mohammed tested N=10 children and found no significant differences in mean speech reception threshold (SRT) (dB SPL) in

Quiet and Binaural noise conditions as a function of conducting times. What this finding means is that there is no learning effect in the Arabic AAST in both test conditions. No information is currently available on learning effects in Ghana, so in this present study, data on learning effects were collected from children in all 4 Ghanaian language versions of AAST.

Action Plan:

This chapter was dedicated to the objectives that were set for the dissertation. In order to address these objectives six research questions were raised and discussed. In the following chapter, the methods for collecting data as well as the procedures for analyzing the data are discussed.

4.0 CHAPTER FOUR

METHODS

4.1 Eligibility Criteria

In order to be able to participate in the study all the subjects/participants had to meet the following criteria:

- Absence of any known disability including any previously identified hearing loss in the test subjects.
- In the case of data collection using parents' questionnaires, parents must be willing to participate in the study.
- With regard to both AAST and mFAST literate parents give their written consent for their children to participate. Illiterate parents appended their signatures or right thumb print to a written consent.

4.2. Training of assistants and test conditions

For the purposes of administering the LittlEARS® Auditory Questionnaires five undergraduate students of the University of Education in Winneba were recruited as field assistants and were given a 3-hour training/orientation via Skype. The training emphasized strict adherence to the data collection procedures. For example, the assistants would ask the parent or caregiver (respondent) to answer all of the 35 items by choosing either 'yes' or 'no' response. Each of the test statements/items describes a specific auditory behaviour, so a 'yes' response indicates that the respondent(s) have observed that behaviour in their child at least once, and a 'no' response means that they (respondents) have either never observed that behaviour in their child, or they are not sure about how to answer that particular question.

During “self administration”, the research assistants were not to interfere with/influence the assessment process in any way. For instance, they were not to explain any of the test items to the respondent. Also, during an “interview” the research assistants were allowed ONLY to read the statement/item and their corresponding examples. They could repeat what they had read earlier on request, but should not provide any further explanation of the item to the respondents. Finally, research assistants were asked to make a note of any items which respondents found difficult to understand. If respondents did not understand any item, the assistants should ask the respondents to omit those ‘difficult’ item(s).

The total score of the questionnaire was defined as the sum of all of the ‘yes’ answers obtained from the 35 questions. To interpret the result, the total score was compared with two critical values, namely (1) expected value, and (2) minimum value. The expected value was defined as the average score for the particular child’s age, and the minimum value as the lower limit of the 95% confidence intervals (unilateral) from the validation sample. A comparison with these critical values helps to determine the stage of a child’s auditory development, and also allows for the child’s auditory age to be calculated (Obrycka et al., 2009).

4.3 Data Collection procedure

LittlEARS® Auditory Questionnaire

Data was collected from a total of N= 1113 in respect of LittlEARS® Auditory Questionnaire as follows: For validation of LittlEARS® Auditory Questionnaire norm data were collected for N=448 children. The effect of ‘administration mode’ was investigated by collecting data from N=152 parents (respondents) who completed two ‘half’ versions of the LittlEARS® Auditory Questionnaire (one

version containing the ‘odd numbered' items, and the other the ‘even numbered' items). One of the half versions was completed by self-administration and the other by interview. The order of the tests and the mode were balanced. Both self administration and interview were conducted on the same day and within the same setting.

The feasibility of using the LittlEARS® Auditory Questionnaire as a screening tool between 24-36 months was investigated by collecting data from N=513 respondents who had no indication of hearing loss.

Validity of data entry- LittlEARS® Auditory Questionnaire

LittlEARS® Auditory Questionnaire data were entered in EXCEL-files and then sent for analysis. In order to ensure the validity of the data sent, the researcher adopted a data re-entry procedure in which about 10% of the data which had been sent earlier was randomly selected and re-sent by a different person. Both sets of data were compared. An error rate of less than 5% shows that the data sent earlier was accurate.

mFAST

Validation data were collected from N=45 normally hearing students aged between 20 and 30 years. The aim of this study was to test the validity of the mFAST test as a predictor of the pure tone audiogram in children and adults.
In order to collect data, a request was made to the students during lecture periods for volunteers who could participate in the hearing tests. The purpose of the research and the test procedures were explained briefly, to the students. Afterwards, a sheet of paper was passed round for those who were willing to participate to write down their names and email addresses. Student volunteers who wrote down their emails were contacted later and appointments were arranged over a two-week period in 20 minute blocks. Appointments were

rescheduled for students who could not come for the tests on the arranged dates.

Tests were all conducted in one of the offices (room 303) at the Department of Special Education and Rehabilitation. During the tests the doors and windows were shut in order to reduce extraneous noise to a minimum. It took each person approximately 10 minutes to complete the set of tests.

On the dates arranged the students were assured of confidentiality of their data which in this case was their date of birth and gender (optional).The test procedure was explained to them in detail and they were asked to decide/choose which of their two ears they wanted to be tested. For most of the students only one ear was tested however, those who wanted both ears tested were given a 5 minute break before the second ear was tested. When the tests were completed, the results were explained briefly to them. Emails were sent later to thank all those who participated.

The students were tested using the AuriCheck® handheld audiometer and a calibrated set of HDA280 headphones. All subjects did three tests, namely (a) mFAST animal sounds (b) duotone bands of noise and (3) duotone pure tones. The order of tests was randomized.

The AuriCheck handheld device is designed to estimate thresholds in an interactive and adaptive manner. In this test, the test subjects were required to identify or recognize the correct animal sound (cow, dog, cat and bird) and select the appropriate corresponding picture (refer to 1.3.1.2).

Five students were excluded from the analysis because they were considered as outlier values. Outliers were defined as threshold values above or below 2 standard deviations. Therefore data on N=40 students (N=80 normal ears) were

analyzed. In this validation study, the mFAST thresholds were compared with thresholds based on pure tones as well as on bands of steady-state noise which have the same spectral contents as the animal sounds.

AAST

In order to determine the Akan AAST norm, data were collected from N=581 children aged between 4 and 10 years The tests were conducted outside audiometric test booths, in a variety of locations such as school libraries, churches and offices which were considered relatively quiet locations on the compounds. Noise levels averaging 52dBA (SDEV=3.5dBA) were measured with a VOLTCRAFT Sound Level Meter in the rooms. A standard and calibrated external 24-bit (Audio 2 DJ) sound card and Sennheiser HD280pro headphone and a standard notebook (laptop computer) system were used to collect norm data.

In order to determine learning effects a cross-sectional design was used to select N= 81 test subjects (children) who spoke Fante as their mother tongue, but who in addition also spoke English, Akuapem or Asanti as a second language. Each subject did AAST six times (three times in English and then three times in the relevant Ghanaian language). AAST tests were conducted both under quiet and under noise conditions. In AAST (Quiet), data were collected from 2 groups of children (groups A and B) and one adult group (group C). Group A was made up of very young children (average age 4.9 years; STDEV= 0.9), while group B comprised older children (average age 11.2 years; STDEV= 3.2). Data were also collected in AAST (Noise) for adults and children.

In Group A, data were collected from N=46 children (24 males and 22 females) with average ages ranging from 3.0 years to 6.8 years (average age= 4.9

years;SDEV= 0.9). Four participants were excluded from the analysis because they were considered as outliers. An outlier was defined as mean threshold +/- 2 standard deviations.

A pre-test was conducted in Wesseling, Germany using German Kindergarten (KG) children. Data were collected from n=19 German KG children (f=12; m=9) with ages ranging from 4.2 to 6.4 years (average age 5.3 years SDEV 0.8). Parental consent was sought for all the children who participated in the test.

In Group B data were collected from N=30 children (13 males and 17 females) with average age of 11.2 years (SDEV 3.2). Average hearing thresholds of the children tested was 30.5dBSPL (SDEV 3.2) (Figure 17). One participant was excluded from the analysis because the threshold values were considered as outliers.

4.4 Statistical analysis

LittlEARS® Auditory Questionnaire

Descriptive statistics were used to describe demographic statistics and baseline characteristics such as age and gender. Quantitative data were presented as mean (M) and standard deviation (SDEV), and quantitative data such as respondents and locations for LittlEARS® Auditory Questionnaire data were reported as absolute and relative frequencies (May-Mederake et al., 2010). Statistical analysis included a one-way ANOVA to test mean group differences based on mode of questionnaire administration and level of education of the respondents. All the data that were analyzed with SPSS IBM version 20 and statistical significance was set to $p<0.05$.

AAST

AAST data were exported from BELLS software to Excel and analyzed using SPSS and Excel data platforms. Age dependent norm values were calculated for each of the language versions. Frequencies and percentages were generated in order to describe norm data. Results were plotted in 4-frequency audiograms and statistically evaluated.

Action Plan:

In this chapter the procedures for collecting and analyzing data were discussed. The focus of the next chapter is a discussion of the results of the study.

5.0 CHAPTER FIVE

RESULTS

The results are presented based on the research questions set for the study.

Research Question 1: Are the norm curves of the Akan versions of the LittlEARS® Auditory Questionnaire comparable to the German norm curve?

For validation purposes, norm data were collected for N=448 Ghanaian children. Results of the study show that the Ghanaian language norm curves and the German norm curves are comparable. A one-way between groups ANOVA was conducted to compare the mean total scores attained by children in the Akan versions of LittlEARS and the German version. The mean differences were not significant at the p = 0.05 level [*F* (1,003) = 3, *p* = ,391].

Each of the Ghanaian language versions were compared to the German norm curve independently. Figure 12 shows the Akuapem (thin curve) and German norm curves. The Akuapem norm curve was slightly lower than the German norm curve (Thick black curve)

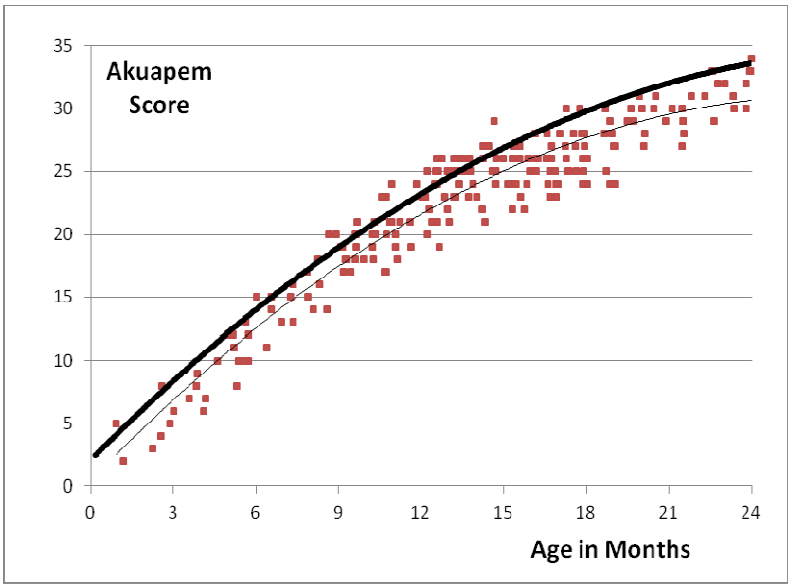

Figure 12: Akuapem and German norm curves compared

The Fante (thin curve) and German norm curves (thick black curve) are shown in Figure 13. The curves show that the Fante curves are almost the same as the German curve.

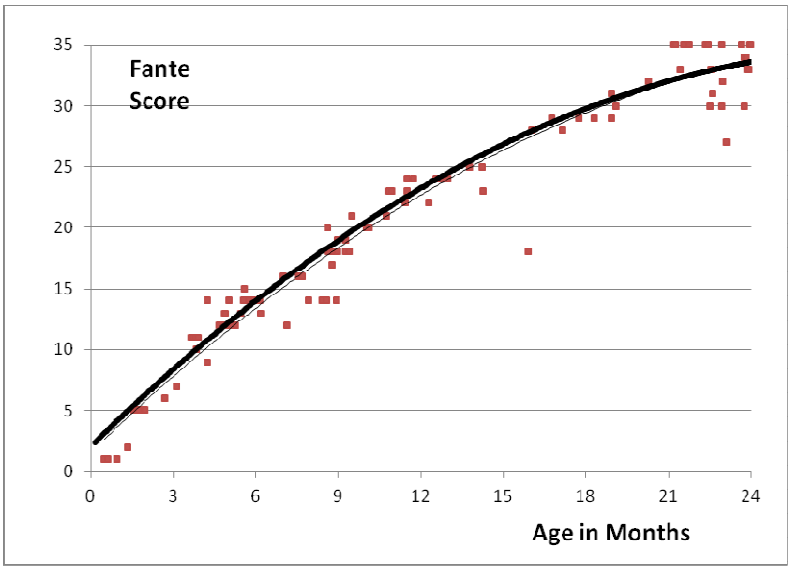

Figure 13: Fante and German norm curves compared

Figure 14 shows the Asante (faint curve) and the German norm curve (thick black curve). The curves show that the Asante curve is approximately the same as the German curve.

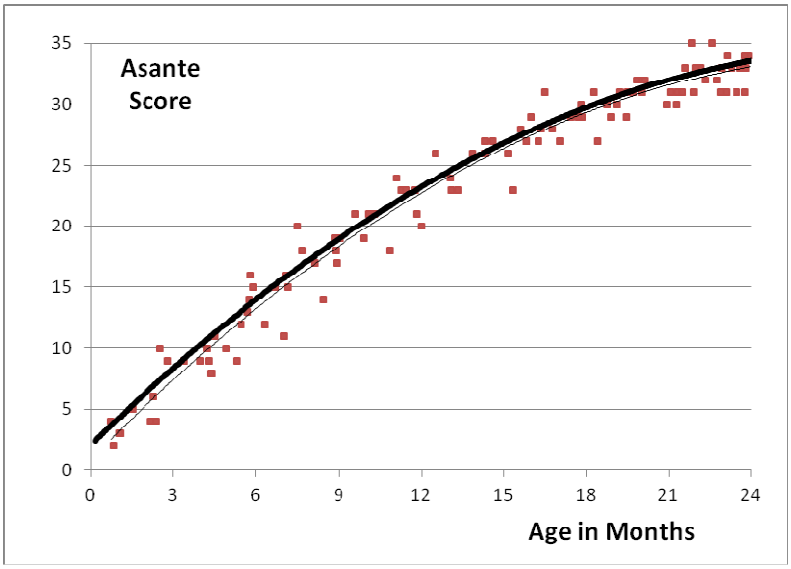

Figure 14: Fante and German norm curves compared

Research Question 2: How does responding to either the questionnaire or the interview affect LittlEARS® Auditory Questionnaire test scores?

In order to answer this research question, respondents were placed into 5 groups. Table 7 shows the various groupings with their corresponding age means and standard deviations (SDEV).

Table 7. Groups of respondents with age means and standard deviation

Group	male(%)	female(%)	Total	Mean age	Mean age (STDEV)
First Odd(SA*) then Even (IV)	13(40.6%)	19(59.4%)	n=32	10.9	4.3
First Even(SA) then Odd (IV)	15(41.7%)	21(58.3%)	n=36	10.8	4.3
First Odd (IV) then Even (SA)	21(63.6%)	12(36.4%)	n=33	10.8	4.2
First Even (IV) then Odd(SA)	20(57.1%)	15(42.9%)	n=35	10.9	4.1
IV only	9(56.3%)	7(43.8%)	n=16	10.1	4.7
Total	**78(51.3%)**	**74(48.7%)**	**n=152**		

*Self Administration, IV=InterView

In total data were collected for 152 Ghanaian speaking respondents (Table 8) comprising 74 (48.68%) females and 78 (51.31%) males, with their ages ranging from 4 – 18 months (mean age= 10.80 months; SDEV=4.221). All the respondents who were recruited completed the LittlEARS® Auditory Questionnaire. Results show that about 50% of the respondents were the biological mothers of the children (Table 8).

Table 8: Respondents for self-administration and interview (N=152)

Respondent	Frequency	%	Cumulative %
Father	17	11.2	11.2
Mother	73	48.0	59.2
Sibling	22	14.5	73.7
House-help	15	9.9	83.6
Grandparent	17	11.2	94.7
Other	08	5.3	100.0
Total	**152**	**100.0**	

LittlEARS® Auditory Questionnaire data for “self-administration” and “interview” were collected from different locations. For example, the results show that more than 60% of the data were collected in the homes of the respondents and 26% of data were collected from respondents attending church service (Table 9).

Table 9: Locations for LittlEARS® Auditory Questionnaire data collection

Location	Frequency	%	Cumulative %
Church	39	25.7	25.7
Post natal immunization clinic	14	9.2	34.9
Office of respondent	4	2.6	37.5
Home of respondent	93	61.2	98.7
Audiology clinic	2	1.3	100.0
Total	**152**	**100.0**	

In the first 4 groups, respondents completed one half (part) of the questionnaire independently (Self Administration) and they completed the other half through an interview. Only the respondents in group 5 answered all of the questions via interview. Respondents were asked to give reasons for their preference for interview rather than self-administration. A summary of verbatim responses from respondents is provided in Table 10. The results show two scenarios: First, the respondents (parents) were completely lacking literacy skills in the English language or second, the respondents had some limited literacy skills, as a result of which they lacked the confidence to respond to the questions independently (self-administration).

Table 10: Verbatim responses- "Interview only"

Respondents	Response
Respondent 1	'My mother didn't send me to school, so I can't read'
Respondent 2	'That English, I can't read'…
Respondent 3	'I completed only JHS, so I have forgotten how to read English

A one-way between subjects ANOVA was conducted to compare the effect of mode of questionnaire administration on the LittlEARS® Auditory Questionnaire final score in "self-administration" and "interview" conditions. No statistically significant difference was found between the two conditions [F (4.147) = 0.196 p = 0.940].

The literacy level of respondents was investigated. Results show that out of the 152 respondents, 90 (59.2%) had attained basic level of education, 43 (28.3%) had attained secondary level education while only 19 (12.5%) had attained tertiary level education. In order to complement data on level of education participants were further asked to indicate whether or not they read the local newspapers and if they did, how often? The results show that 90 (59.2%) of respondents read the newspapers while 62 (40.8%) did not. Of those who read the newspapers, 8 (5.3%) read them each day, 13 (8.6%) read them a few times a week while 69 (45.4%) read them only once a week.

A one-way between subjects ANOVA was conducted to compare the effect of academic level on LittlEARS® Auditory Questionnaire scores in basic, secondary and tertiary conditions. No statistically significant difference was evident at the $p < 0.05$ level for the three conditions [F (2.149) = 0.309 p = 0.734].

Research Question 3: How appropriate is the LittlEARS® Auditory Questionnaire as a screening tool for hearing loss and other educationally significant disabilities in Ghanaian children in the 3rd year of life (24-36 months)?

Data were collected for N=513 parents of children in the 3rd year of life. Data of N= 51 parents were excluded from the analysis because the children were older than 36 months. Therefore data for N=462 were analyzed. Results show that LittlEARS® Auditory Questionnaire scores reach maximum values between age 24 and 36 months (Figure 15). More than 90% of respondents scored between 32 and 35 which showed that the ceiling effects were maintained.

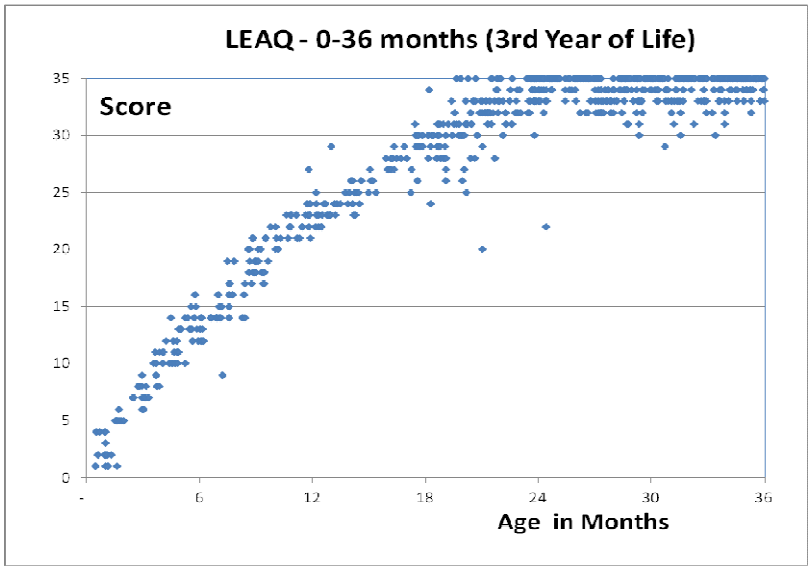

Figure 15: LittlEARS® Auditory Questionnaire: 0-36 Months

The results show that there are generally no “NYN"-type items. No-Yes-No (“NYN”) items are defined as LittlEARS® Auditory Questionnaire test items for which parents give a “NO” response when infants/children are in the first few months of life, a “YES” response when they get older and a “NO” again when children are above 24 months. In this context, a “NYN” type item would signify that such items are not suitable for testing children in the 3rd year of life.

Therefore, if the investigation had found any of such items they would be removed.

However, overall, for the children between 24-36 months, in about 40% of the LittlEARS® Auditory Questionnaire items at least one question was answered with "NO" and in 7 (20%) of the 35 items there were between 5% -10% "NO" answers. Items with "NO" answers and their corresponding percentages are shown in table 11.

Table 11: Items with "No" Responses

Item	% of "NO" responses	Description
9	5.7%	Does your child respond with alarm when hearing an angry voice?
14	11%	When your child is sad or moody can he/she be calmed down or influenced by music?
15	5.3%	Does your child listen on the telephone and does he/she seem to recognize that somebody is talking?
10	9.2%	Does your child "recognize" acoustic rituals?
19	7.4%	Does your child respond to "No" by typically interrupting his/her current activity?
33	9.4%	Does your child like being read to?
34	6.8%	Does your child follow complex commands?

Research Question 4: What are the threshold differences between PTA and mFAST?

Data were collected from N=45 adults (90 ears) to investigate the differences between PTA (pure tones), noise-bands and mFAST. Of this number only N=74 ears were included; 16 ears were excluded as outlier values. Results are shown in Figure 16; the SDEV of all data is nearly the same and varies between 5 and 6 dB. Only at 4 kHz a noticeable difference of about 7dB was found between the pure tone threshold and the mFAST / noise band thresholds. This difference was significant at the $p < 0.05$ level [F (2.218) = 29.187 p = 0.000].

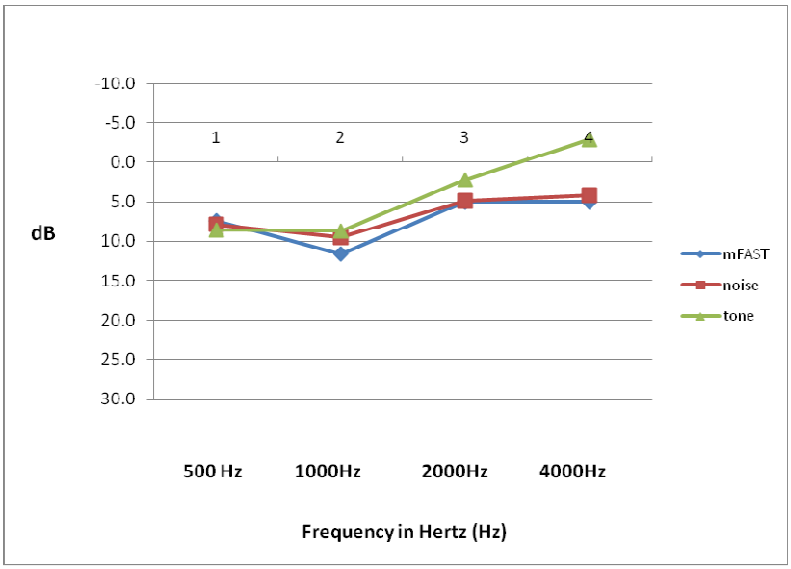

Figure 16. mFAST, noise bands and tone thresholds

Research Question 5: What are the age dependent norm values for Fante, Asante, Akuapem and Ghanaian English AAST?

AAST norm data were collected from N= 581 (male: n=286; female; n=295) children with ages ranging from 4 to 10 years. The average ages and standard deviations of the participants and their corresponding age groupings are shown in Table 12. Analysis of gender based on specific language groupings is shown in Table 13.

Table 12.Norm data age groups: average age and standard deviations

Year group	Asante (STDEV)	Fante (STDEV)	Akuapem(STDEV)	Ghanaian English (STDEV)
4y - 4y 11m	4.34(5.52)	4.21(4.19)	4.28(4.97)	4.29(6.95)
5y - 5y 11m	5.34(4.99)	5.17(6.14)	5.51(5.36)	5.28(5.61)
6y - 6y 11m	6.46(3.71)	6.54(4.82)	6.64(4.50)	6.51(6.40)
7y- 7y 11m	7.60(6.14)	7.78(5.75)	7.43(4.87)	7.63(6.52)
8y - 8y 11m	8.42(6.03)	8.54(4.81)	8.35(5.26)	8.48(4.97)
9y - 9y 11m	9.55(6.84)	9.57(6.42)	9.30(5.79)	9.42(5.37)
10y-10y11m	10.34(4.44)	10.54(4.63)	10.50(3.08)	10.31(5.91)

Table13. AAST norm data gender distribution

Gender	Asante	Fante	Akuapem	Ghanaian English	Total
Female	74	50	90	72	**286**
Male	78	62	81	74	**295**
Total	**152**	**112**	**171**	**146**	**581**

The results are presented in Figures 17a and 17b.

In Fig.17a the thresholds are expressed in dB HL. The results show that children at age 10 years have the same threshold as normal thresholds in adults (being defined as 0 dB HL). The results also indicate that there is an age dependent norm threshold difference of 7 dB between younger and older children. This is similar with findings in other languages, like German (Coninx, 2005).

In Fig.17b the average thresholds for the four languages (Fante, Asante, Akuapem and Ghanaian English) are shown as a function of age.

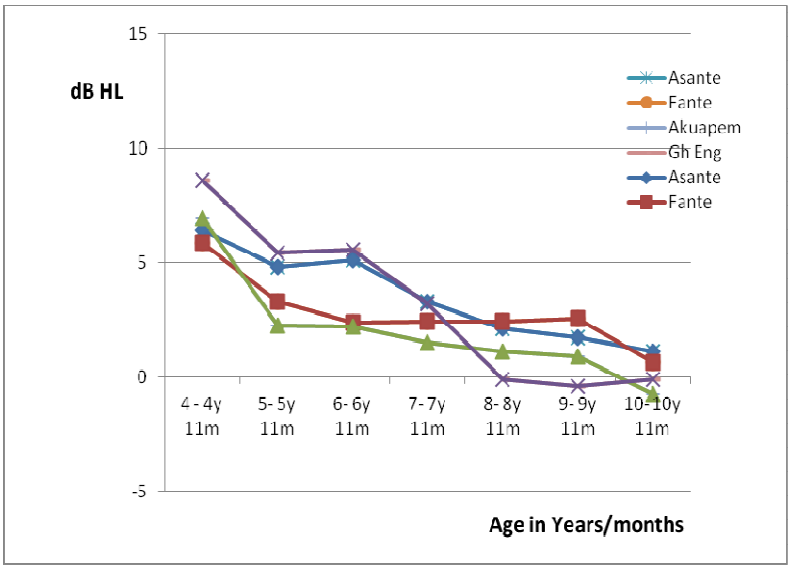

Figure 17a: Age dependent Akan and Ghanaian English AAST norm curves

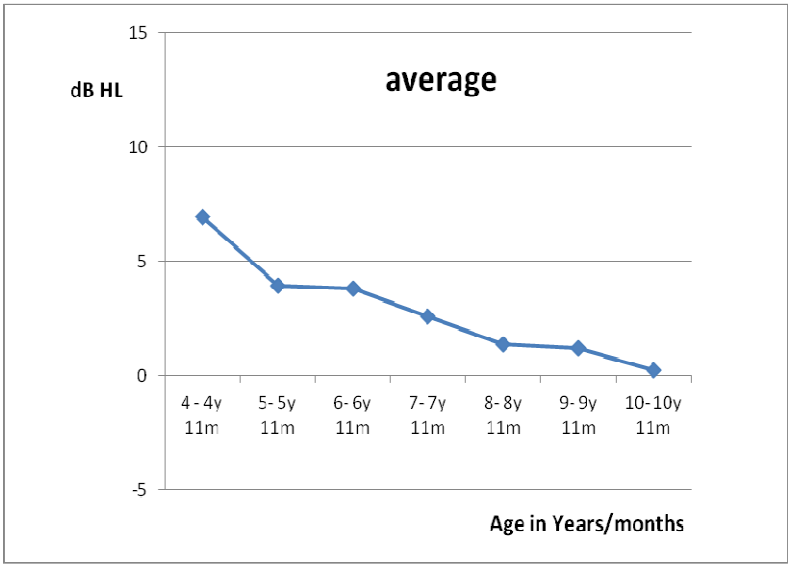

Figure 17b: Age dependent comprehensive norm curve

Research Question 6: Learning effects: To what extent will improvement in test performance be due to listeners learning the test words in the Ghanaian language versions of AAST?

In order to investigate learning effects AAST data were collected both in quiet and binaural noise conditions. In quiet conditions data were collected from 2 groups of children (groups A and B) and one adult group (group C). Group A was made up of N=46 young Ghanaian children (average age 4.9 years; SDEV= 0.9) while group B comprised N=30 older Ghanaian children (average age 11.2 years; SDEV= 3.2). The adult group comprised N=24 participants (average age 23.3 years; SDEV= 6.6).

In addition, data were collected from N=19 German Kindergarten children (f=12; m=9) with ages ranging from 4.2 to 6.4 years (average age 5.3 years SDEV 0.8) to enable a comparison to be made with the Ghanaian group of children. Data were also collected in AAST binaural noise conditions for N= 39 Ghanaian children. This group comprised 22 male and 15 female participants with an average age of 8.4 years (SDEV 2.8).

Results are shown in the figures 18 to 22 and expressed as "thresholds difference" (Δ dB) with the reference value being the threshold of the first test (test 1). The result value for test1 is consequently always 0. The results test 2 and test 3 show directly the difference to test 1 and by that, any possible learning effect.

A paired sample t-test was conducted to find the differences between the 3 test trials for all the groups. In addition, cohen's ***d*** test (Thalheimer & Samantha, 2002) was conducted to check the effect size of the differences. An effect size is small if d = .20, the effect size is large if d = .80 and the size is medium if d = .50 (Cohen, 1988, 1992). Results of the Ghanaian children in group 'A' (Figure

18) showed that there was a significant difference between the first and second test trials, $t(45) = 4.47$, $p < .05$, $d = .49$ but, the effect size was small. Results also show that the difference between the first and third trials in group 'A' was statistically significant, $t(45) = 3.93$, $p < .05$, $d = .52$. The effect size was medium. The difference between the second and third test trials was however, not statistically different, $t(45) = 0.19$, $p < .05$, $d = 0.02$.

The results of the preliminary tests of German Kindergarten children (Figure 20) also, shows that there were no significant learning effects in AAST in quiet between the first and second test trials, $t(18) = 1.80$, $p < .05$; between the first and third trials $t(18) = 2.39$ $p < .05$; and also between the second and third trials $t(18) = .261$, $p < .05$. Similarly, there was no significant learning effect in the Ghanaian adult group (Figure 21).

In group B (Figure 20) a paired sample t-test conducted to determine differences between the 3 test trials for the Ghanaian older children showed statistically significant differences between the first and second test trials $t(29) = 2.74$, $p < .05$, $d = .59$; and also between the the first and third test trials $t(29) = 3.42$, $p < .05$, $d = .66$. The differences between the second and third test trials were not statistically significant $t(29) = 0.02$, $p < .05$, $d = 0$.

What these result mean is that sometimes there are learning effects in the Ghanaian groups.

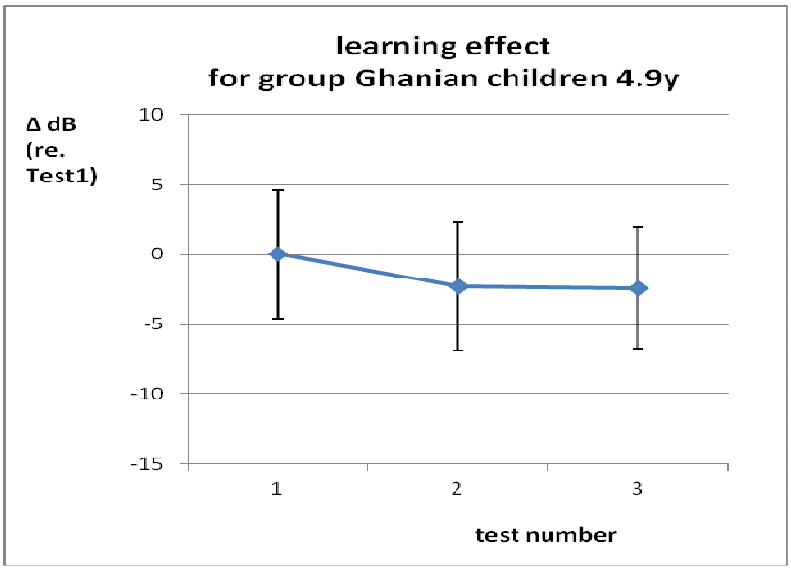

Figure 18: Ghanaian children - “group A” (N=46)

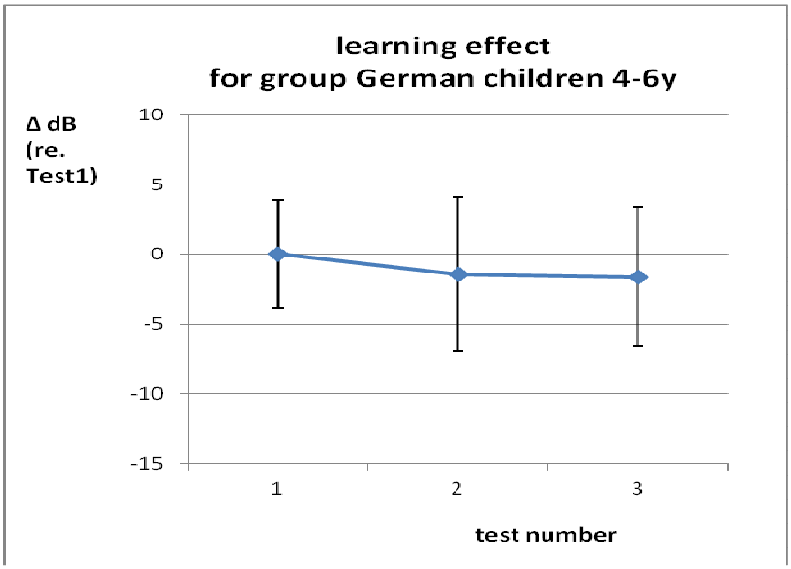

Figure 19: German KG group N= 19

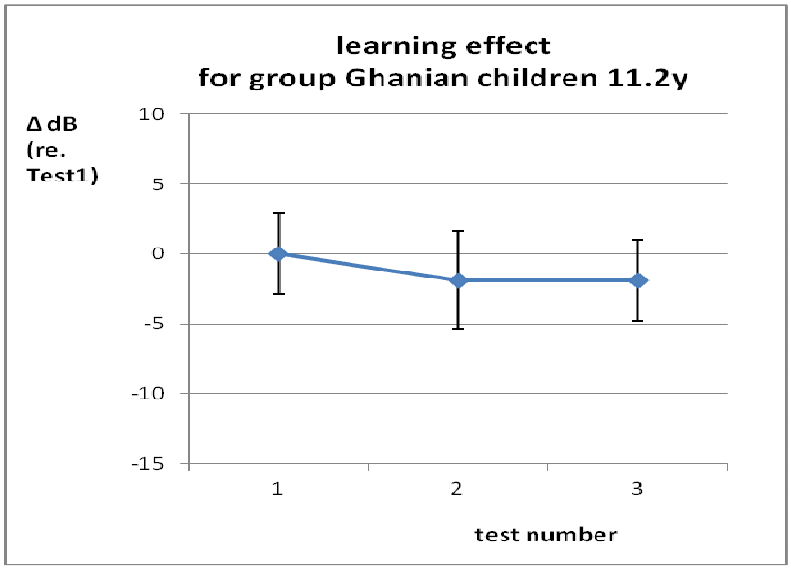

Figure 20. Ghanaian children - “group B” (N=30)

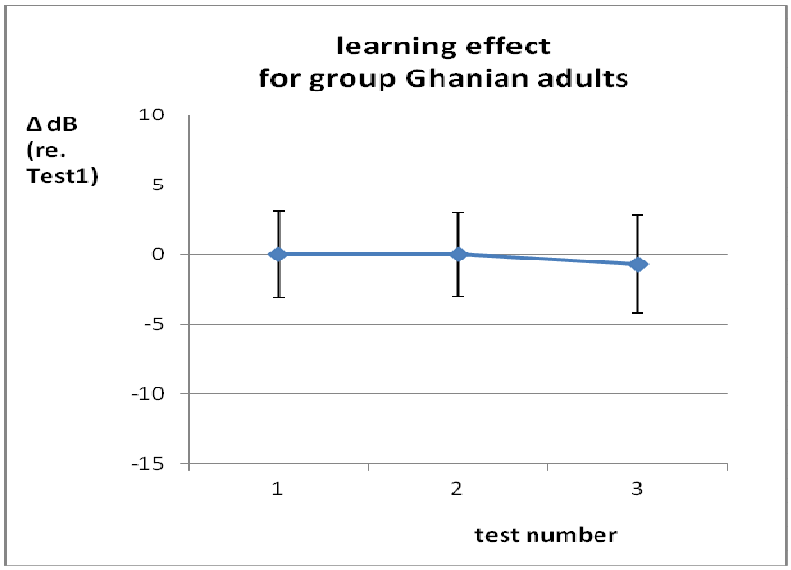

Figure 21. Ghanaian adults - “group C” (N=24)

Results of the tests in binaural noise conditions (Figure 22) showed no significant learning effects between the first and second test trials $t(36) = 0.45$, $p < .05$. There was however, a significant between the first and third test trials $t(36) = 2.96$, $p < .05$, $d = 0.6$ and also between the second and third test trials $t(36)= 2.50$, $p < .05$, $d = 0.4$. Both effect sizes were medium.

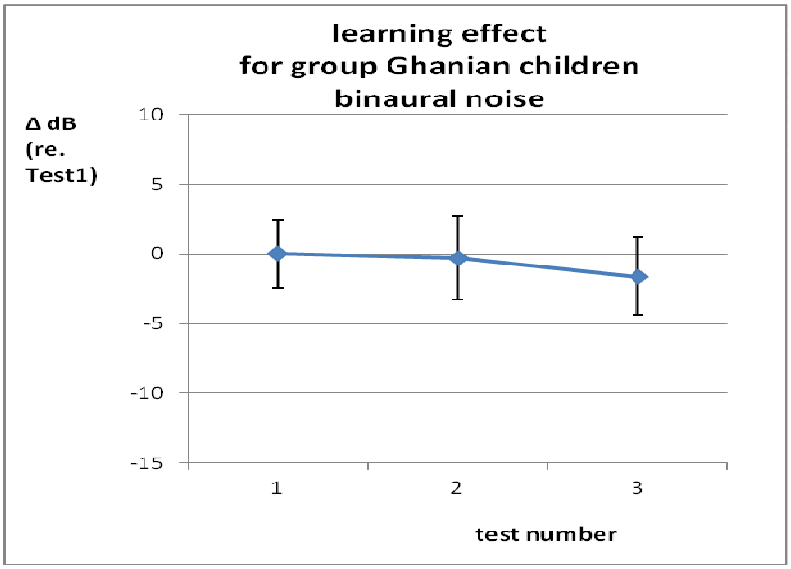

Figure 22. Ghanaian children AAST in- binaural noise N=39

6.0 CHAPTER SIX:

DISCUSSION

RQ1: Results of the norm data collected from N=448 children show that age and LittlEARS® Auditory Questionnaire score mean differences between Akan and German children are not significantly different. In other words, the Ghanaian language norm curves and the German norm curves are comparable. The implication of this finding is that Ghanaian children scored very similarly to German children on the LittlEARS® Auditory Questionnaire. Differences in mean age and score among the three Akan versions of LittlEARS® Auditory Questionnaire were also found not to be statistically significant. What this implies is that any of the three Akan versions of the LittlEARS® Auditory Questionnaire can be used to screen children, so there might be no need to use all three Akan versions of the LittlEARS® Auditory Questionnaire at the same time in Ghana.

Besides being used as a screening tool, it appears that the LittlEARS® Auditory Questionnaire is as well sensitive to hearing disorders and also to other developmental delays that are connected with early hearing and communication deficits. The LittlEARS® Auditory Questionnaire therefore provides an opportunity to detect as many infants as possible who are not developing regular listening or communicative skills and offer rehabilitation services to them at a very young age.

This is particularly relevant to Ghana, where opportunities for children to get screened for hearing disorders are very scanty. Schäfer, (2013) reported that the LittlEARS® Auditory Questionnaire is sensitive to the detection of additional disabilities. The Schäfer study which involved a group of N= 5320 children found

that within this group 6 infants had a permanent hearing loss which was identified and later confirmed. The study also found that a significant percentage of the infants investigated were living with recurrent otitis media alongside speech or other developmental dysfunctions such as autism and cognitive defects.

For logistical reasons it has not been possible to follow up on the medical history of children found to show particularly low LittlEARS® Auditory Questionnaire scores during the course of this doctoral research study. Future studies should involve longitudinal studies to follow up on children with low LittlEARS® Auditory Questionnaire scores.

RQ2: In order to determine the effect of mode of questionnaire administration on LittlEARS® Auditory Questionnaire score data were collected from 152 Ghanaian speaking respondents. Results showed that about half of the parents who responded to the questionnaire were the “real” mothers of the children. This finding is not surprising and is consistent with other research findings which show that, compared with professionals, parents, and particularly mothers are with their children longer on both a day-to-day and a year-by-year basis, and they are normally the first to detect the presence of disability in their children.

In many developing countries, including Ghana, the presence of a disabled child in the family often leads to divorce. In such cases the fathers leave the home and the care of the disabled child rests solely on the mothers. Mothers therefore generally have closer bonds with their children, and have more opportunity to interact with them under real life conditions (Ling, 1984). It is in the light of this that parental involvement is considered to be an indispensable tool in the diagnosis, education and rehabilitation of children with disabilities, particularly those who are deaf or hard-of-hearing.

The results of this study show that more than 60% of the LittlEARS® Auditory Questionnaire data were collected from the respondents in their homes. This finding is important and has implications for models for the provision of screening services for children. One important advantage of using a questionnaire as a screening tool is that it enables screening services to be provided to several people in a variety of informal settings and situations including homes.

This provides respondents with a relaxed atmosphere within which they could freely participate in the screening process. Another advantage is that when screening services are provided at the doorstep of parents they would not have any excuse not to get their children screened. Many parents in developing countries proffer numerous reasons why they would not send their children to be screened. For example, some parents who do not see anything physically wrong with their children's hearing would not feel any need to invest their time, energy and scanty financial resources to send their children to screening centres to be evaluated for problems which, in their view, their children do not have.

In addition, Ghanaian culture has a strong association with negative superstitious beliefs toward disabilities such as hearing impairment. This creates a situation where some mothers may be reluctant to volunteer information on risk factors for screening purposes, as it could unduly stigmatize or label their apparently normal babies (Olusanya et al., 2009, p. 184). This might well be the case when screening is being done in public. The use of a questionnaire which can be completed in private therefore makes it possible to widen the scope of screening services to enable as many children as possible to be identified for intervention.

The literacy level of respondents was investigated as an important variable in this study. Results show that out of the 152 respondents, 90(59.2%) had attained basic level of education, 43(28.3%) had attained secondary level education while only 19 (12.5%) had attained tertiary level education. The results also show that about 60% of respondents read the newspapers and of those who do so, only 5% read the newspapers each day, 9% read the newspapers a few times a week while as many as 45% read the newspapers only once a week.

These results are not surprising especially within the context of a developing country such as Ghana, but they raise interesting yet important educational/literacy questions. The data seems to show that a significant percentage of parents in Ghana do not have a positive attitude toward reading, in spite of their having attained a certain level of education. Certainly, a parent who does not like to read for themselves is unlikely to read to their child, and such parents would not have the motivation to develop a habit of reading in their children for the future. Put into context, this would imply that a significant percentage of parents would prefer to respond to a questionnaire via the 'interview' option rather than 'self-administration'.

However, the finding that less than 50% of respondents read news papers only once in a week might be misunderstood to mean that Ghanaian parents do not like reading. In hind sight it appears that the culture of reading among Ghanaians is not as strong as it is in many developed countries such as in Europe where it is common to find people reading almost everywhere. This position could be true however, some Ghanaians may choose not to buy newspapers to read at home because the home budget cannot support frequent purchases of newspapers. In other words, it is a luxury to buy newspapers on a regular basis in those homes.

Indeed, the daily routine of buying and reading of newspapers is generally, considered a status symbol in Ghana. What this means is that if you are seen to be buying and reading newspapers every day, it is an indication that you might be earning a good salary or wage. But it is also a common practice for departments at work places to subscribe newspapers for their staff at their offices. Therefore parents who are workers may read the newspapers at work and would not therefore need to buy them for their families at home.

The effect of academic level on LittlEARS® Auditory Questionnaire scores in basic, secondary and tertiary conditions was compared. The data showed that there was not a significant effect of parents' academic level on LittlEARS® Auditory Questionnaire scores. What this means is that, notwithstanding the level of education, parents are able to respond to the questionnaire. Taken together, what these results imply is that the level of respondents' academic attainment does not affect their scores.

Specifically, the results show that whether the respondent is a university graduate or terminated their education at the primary or secondary level does not affect the LittlEARS® Auditory Questionnaire final scores. These findings are consistent with those of Obrycka et al. (2009) which shows that LittlEARS® Auditory Questionnaire is suitable irrespective of the educational level of the parents or other caregivers responding the questionnaire.

The effect of mode of questionnaire administration on LittlEARS® Auditory Questionnaire final score in "self-administration" and "interview" conditions were compared. The data showed that there was not a significant effect of method of completing LittlEARS® Auditory Questionnaire on the final score. What this result show is that LittlEARS® Auditory Questionnaire scores do not change significantly, based on the mode of administration. Specifically, the results show that it does not make any difference in terms of LittlEARS® Auditory

Questionnaire scores whether the questionnaire was administered via interview or by self administration.

This finding is consistent with the observation that LittlEARS® Auditory Questionnaire is a good outcome evaluation tool (Coninx et al., 2009; Bagatto et al., 2011). Bagatto et al. (2011) have suggested a criterion for a good evaluation tool is that it must have alternative ways of administration. In addition, an outcome evaluation tool must not have any biases either within the items or the instrument, the responses must not be contaminated by cultural differences or social circumstances and the tool should have good test–retest reliability, internal consistency, validity, and responsitivity. Furthermore, the length and the content of the tool must be acceptable to the respondent and should be designed in such a way that it can be reasonably administered, scored, and interpreted by the clinician. Andresen, (2000) and Graham et al. (2006) added that good outcome evaluation tools must be useable in clinical practice.

This finding has a profound implication for the future education of children in that, by using both modes of questionnaire administration, many children can be screened for hearing loss, irrespective of the parents/child's literacy, economic, social or educational circumstances. When screening services can be made available to a wider group it means that significantly more relevant data on the state of childhood disabilities can be gathered. Relevant data would, by implication, provide a platform for educating parents and other stakeholders on issues concerning disabilities, such as their causes and management.

More importantly, with increased amounts of relevant data it is possible to make a strong case for specific legislation to be enacted on early identification and intervention of infants and children with educationally significant disabilities. Thus, relevant data about the state of disabilities among children is more likely to initiate the performance of pilot studies to provide further empirical evidence

which would engage relevant government ministries (education, health and social welfare) in establishing appropriate provisions for early hearing detection, and other interventions within the context of overall early childhood development in current health and education policies (Olusanya, 2008, p S11). This will have a positive impact on the educational inclusion of all children with disabilities, which is high on the agenda of the Ministry of Education in Ghana, as Ghana is a signatory to the United Nations Convention on Inclusive Education.

The use of data to influence legislation is reported in the hearing literature. In 1964, the federal government commissioned the Babbidge Committee Report (Babbidge, 1965) to report on the status of services to students in America who are deaf or hard-of-hearing. Data from this report were used to influence the passage of PL 94 –142. The education for all handicapped children act Public Law (PL 142) which was passed in the US in 175 is considered the most notable of legislation for children with disabling conditions.

The law makes adequate provision for the identification, evaluation and free appropriate public education in the most enabling environment for all children who are handicapped and who are in need of special education and related services (Johnson et al., 1997, p.9). In 1988 the federal government commissioned a second report on the progress of education of deaf and hard-of-hearing – “the COED Report” of the commission on the education of the deaf (Easterbrooks, 1999).

Even though there are few specific legislations on special education in Ghana, the practice of special education in Ghana today, is founded on the Public Law (PL) 94-142 (The Education for All Handicapped Children Act) of 1975, the PL 101-476, the Individuals with Disabilities Education Act of 1990, of the United States of America, and the Warnock Report (1978) of the United Kingdom. These laws give exclusive focus on persons with disabilities, particularly

children. Put into context, the data on prevalence is important when obtaining legislative support. Unfortunately, the insufficient data in Ghana has made it difficult to gain legislative support for initiatives related to early identification and intervention of disabilities such as the universal new-born hearing screening (UNHS). It therefore appears, sadly, that most children born in Ghana currently have little prospect of having their hearing screened.

These findings however, have notable implications. Firstly there are implications for the competence of the personnel carrying out the testing, because an inexperienced interviewer may have difficulty extracting useful examples from the parents even when the interviewer has been instructed on how to administer a questionnaire (Bagatto et al., 2011). This implies that the interviewers must be given sufficient training prior to questionnaire administration. According to Bagatto et al. interview-based scoring contributes to administration and respondent burden which results in variability with scores.

Secondly, the findings have implications for the language that is used in the interview, as well as the ability of the caregiver to observe their child. Golding et al. (2007) and, Ching et al. (2010) observed significant variations in the caregiver's ability to observe their child and concluded that this variation may be limited by competing factors in the household, such as number of children and their health, as well as the lifestyle of the family.

Nine of the 152 respondents involved in the 'self-administration' versus 'interview' investigation opted to respond only via the interview approach. The respondents were asked to assign reasons why they chose not to respond via self-administration but only through interview. Two of the respondents claimed that they were illiterate, whilst another said she had forgotten how to read. Such responses support the need for different modes of questionnaire administration (such as interview and self-administration) to be made available in order to meet

the needs of respondents who cannot or would not want to respond to a questionnaire independently, for whatever reason.

The findings also support the proposition that questionnaires should be made available in native languages. Johnson and Danhauer (2002) noted that questionnaires are more appropriately administered in the native language of the family. This is because there may be challenges for caregivers who have literacy issues. In Ghana, about 31 percent of all adults have never been to school, less than one-fifth (17.1%) attended school but did not obtain any qualifications; 39 percent have Middle School Leaving Certificate (MSLC)/Basic Education Certificate Examination (BECE)/Vocational (VOC) certificate as their highest qualification, while a small percentage (13.6%) possess secondary or higher qualification (Ghana Statistical Service, 2008).

RQ3: The appropriateness of LittlEARS® Auditory Questionnaire as a screening tool for hearing loss and other educationally significant disabilities in Ghanaian children in the 3rd year of life (24-36 months) was investigated. Data were collected for N=513 parents of children in the 3rd year of life and, results show that scores between age 24 and 36 months remained at maximum values. Meanwhile, more than 90% of the respondents scored between 32 and 35 which means that the ceiling effects that were attained between ages 23 and 24 months were maintained up to the age of 36 months. In addition, the results show that there may be very few or no “NYN-type” items which would have meant that those items were not appropriate for testing children in the third year of life and therefore had to be removed.

This finding is very important because it shows that LittlEARS® Auditory Questionnaire may be suitable for use as a screening tool in the third year of life. However, further data needs to be collected in order to establish this position. The screening of children in the third year of life poses immense

challenges, even to professionals, also, due in part to the scarcity of screening tools appropriate for that age. This finding that LittlEARS® Auditory Questionnaire could be used to screen children of this age range signifies an important leap forward for early identification of hearing loss in Ghana.

A further analysis of the data show that some of the test items had “NO” items. Out of interest these items were further analyzed. Even though the percentage of ‘NO” responses in this instance was minimal they were still significant. Test item number 14 had the highest number of “NO” responses (11%). This finding is, however, not surprising. It appears that in responding to the question *“When your child is sad or moody can he/she be calmed down or influenced by music?”* parents may have been confused about what of kind of response to give.

In Ghana it is uncommon for most parents to use music as a medium to calm down a crying child. Especially, as “music”, as it is stated in this question, seems to suggest a song being played on radio or CD rather than a song being sung by the mother to appease the crying child. Perhaps this statement contained some traces of ambiguity to the respondents and may need to be revised in future.

The question “*Does your child like being read to?”* (item 33) had 9.4% of “NO” responses. Again, this result is not surprising not least because it is uncommon to find Ghanaian parents reading to their very young children. Findings in this dissertation show that a significant percentage of the Ghanaian parent population lack useful literacy skills, and even if they did not, still a substantial percentage of parents who are literate only read the newspapers once in a week. This shows that Ghanaian parents would not often read to their children because they are not avid readers themselves.

Item 10 "*Does your child 'recognize' acoustic rituals?"*, also presented a significant percentage of "NO" responses. This finding is also interesting. There is evidence to show that the term "acoustic ritual" conveys meanings to the average Ghanaian that are quite at variance with the meaning that is intended. For example, during the translation/back translation phase of questionnaire development (see Chapter 2), this item was translated differently by the various translators and thus necessitated making some changes in the wording of the item in the final Akan versions of LittlEARS® Auditory Questionnaire.

However, in collecting data to address the research question about "interview" versus "self-administration", the English version of the LittlEARS® Auditory Questionnaire was used. The English version is the original and does not have any changes to the wording of Item 10. It would be interesting in the future to investigate "NYN" items in the 3rd year of life using the Akan version(s) of LittlEARS® Auditory Questionnaire which have a slightly different wording of this item (10).

RQ4: An important question addressed in this dissertation was whether there are threshold differences between PTA and mFAST. The difference between the PTA and mFAST is that PTA uses a pure tone stimulus type and it is test-leader dependent procedure, whereas mFAST is an automated adaptive procedure which uses complex, but familiar, sounds as the test stimuli. Results show threshold differences between mFAST /noise band and duotone (pure tones) at 4000Hz. The difference of about 7dB at 4000Hz could be as a result of possible natural resonance at 4000Hz in the average adult human ear canal.

The studies concluded that there was a good match between mFAST and PTA thresholds, and that mFAST appears to be a good, alternative to PTA when it comes to testing children. Very little data has been collected on mFAST in Ghana making it impractical to determine whether mFAST would be appropriate for use in Ghana. However, all the animals in the mFAST are familiar to the

Ghanaian child therefore, it could be assumed that mFAST could be used. Substantial data would have to be collected in future regarding the use of the test in Ghana.

RQ5: The current study investigated the age dependent norm values for Fante, Asante, Akuapem and Ghanaian English AAST. The results show there is an age dependent norm threshold difference of about 7dB between younger and older children.

An important finding in this study is that all the four Ghanaian language versions of AAST have got slopes that approximate those of the OLKISA (Oldenburger KinderSatztest, 2004) test which has a slope of 6-8%/dB in Quiet and 12-14%/dB in noise. What this finding implies is that AAST in Fante, Asante, Akuapem and Ghanaian English could be considered as reliable tools for screening children. The test is devoid of test leader bias since thresholds are calculated by the software.

Fortunately, the use of AAST could go beyond the boundaries of Ghana because in Ivory Coast (the Western neighbor of Ghana) there are tribes living there that speak Fante and Asante. The Akan language, whose dialects include Akuapem, Asante, Fante, Bron, Wassa, Agona, Akyem etc. is spoken by about 40% of Ghana's population as a first language, and as a second language by the Aowin, Nzema, Ahanta etc. to the west and by the Guan speakers to the south-east and south-west of Ghana (Dolphyne, 2006). As a result of the multi-lingual character of the Ghanaian society it is necessary that tools developed to screen young children are made to suit the needs of children in the various language groups.

An important outcome of results emanating from this thesis is that many children will be screened using AAST in Ghana because it is a user friendly, adaptive

test. Moreover, Ghanaian children enjoy playing on the computer so AAST presents an opportunity that would attract and motivate as many chidren as possible to participate and get their hearing screened.

This implies a drastic expansion of the scope of early identification of educationally debilitating disabilities in Ghana. A 2003 study in Ghana (Offei, 2003) found that the levels of early identification of hearing loss were improving. The study found that 44% of children were identified before they were one year old. The tests which have been developed or adapted in the course of this research project will serve as a basis to improve this level of early identification.

Besides, other English speaking West African countries such as Nigeria, Gambia, Sierra Leone and Liberia could as well use AAST English. AAST therefore, presents an opportunity to impact positively, the agenda to reduce the age at identification of hearing disorders in Ghana and even, abroad.

RQ6: Learning effects were also investigated as an important part of this study because learning effects constitute an important part of educational audiology and are therefore a critical educational issue. Factors which may contribute to learning effects in closed set speech tests include familiarity with the speaker (voice, articulation, accent), familiarity with the object or pictures in the test, the test procedure itself, ambient noise and phonemic awareness.

In order to determine whether there were any learning effects, AAST tests were conducted in both quiet and noise conditions. Results from the Ghanaian data show that sometimes, there is some learning effects. Although significant, the differences due to learning are small and this means that in clinical practice it might be acceptable. What this finding implies is that it might be better to run a training or learning test prior to the start of the real test to allow the child to learn.

Action Plan:

This chapter focused on the discussion of results emanating from the data collected for the study. It is estimated that with the introduction of these three culturally relevant hearing screening tools, namely the LittlEARS® Auditory Questionnaire, mFAST and AAST, to the Ghanaian infant and child population, over 90% of the population of children of school going age in Ghana will benefit from early, on-going screening for educationally significant auditory disorders. Substantial data will be generated from these populations and used as a means to educate the public and also to push for relevant legislation on early identification and appropriate intervention.

Those confirmed with losses following the initial screen will receive appropriate levels of educational, health and social interventions, such as hearing aid fitting and follow up evaluation appointments, recommendations for preferential seating in class and support for regular teachers where the disabled are being included in mainstream schools. Where minor outer or middle ear pathologies are noticed, referrals to clinics or hospitals for appropriate intervention will be made. Levels of support are becoming available in Ghana as a result of several World Health Organization (WHO) backed initiatives which are already being promoted to facilitate the provision of affordable intervention services for children with disabilities worldwide (Olusanya et al., 2009).

In the next chapter, conclusions which have been drawn based on the discussion of results are stated. Recommendations are also made for future research.

7.0 CHAPTER SEVEN
CONCLUSION AND RECOMMENDATIONS

Ghana is an example of developing countries in sub-Saharan Africa where the early identification and intervention of children with hearing loss is not given much priority. Globally, universal new-born hearing screening (UNHS) has been adequately and widely acclaimed and implemented as a very cost-effective way of dealing with the prevalence of congenital hearing loss (Olusanya et al., 2009). UNHS has been considered the best and the most preferred procedure for early detection of hearing loss both in developing and developed countries (Olusanya, Luton & Wirz, 2004).

However, in Ghana there are potential challenges with regard to issues related to early identification and intervention for children with disabilities. Firstly, the UNHS has not so far been widely implemented. The first pilot UNHS program begun at the Korle-Bu hospital, in the city of Accra in 2012. Secondly, there is hardly any specific legislation on early identification and intervention. Legislation currently available in Ghana is rather general. Thirdly, hearing screening tools are very scanty. Finally, in the absence of regulations/laws specifying the rights of parents and their special needs children, as well as the educational provisions and opportunities available to them, such parents and their children are likely to continue to be denied, as seems to be the case in Ghana today.

Late identification of hearing loss implies that children would already have lost opportunities do develop important concepts and cognitive structures which are relevant for learning in future (Olusanya, Luton & Wirz, 2004, p.287). But in the absence of UNHS, and worsened by the current inadequacy of suitable hearing screening tools, most children born in Ghana currently do not have the prospect of having their hearing screened early enough to receive optimal educational intervention. Test tools that are sensitive to assessing infants and young

children must therefore be developed as a matter of some priority. In this dissertation an attempt has been made to address part of this problem.

Significant findings have been made based on data collected for this research project. For example, 3 Akan versions of the LittlEARS® Auditory Questionnaire have been developed and the norm curves found to be comparable with the German norm.

Findings of the present study support the use of the Standard English version as well as the Akan versions of the LittlEARS® Auditory Questionnaire as a sensitive and reliable tool to assess the development of auditory behaviour of Ghanaian children aged birth to 36 months of age. LittlEARS® Auditory Questionnaire is an appropriate screening tool for children and can be used in diverse groups of children, including those in developing countries such as Ghana. Further, the data shows that it does not make any difference whether LittlEARS® Auditory Questionnaire is administered using interview or self administration, and LittlEARS® Auditory Questionnaire scores are not biased by the academic level of respondents. This is very relevant for Ghana where about 30% of the adult population has never been to school.

The results of this study also show that mFAST may be used as an alternative to the traditional Pure Tone Audiometry to screen and test young children above the age of 3 years for hearing loss. However, more data has to be collected in Ghana in order to establish this position.

A new, fully automatic, computerized, closed-set speech in noise/quiet test (AAST) has been developed in four Ghanaian language versions. The AAST uses only 6 words as speech material, and a computer with a sound card controls the test. Words with steep psychometric functions were selected and equalized in intelligibility. Thresholds of the versions are age dependent and

there are no significant learning effects in both quiet and noise conditions. The new screening tools are relevant to the cultural context of Ghana, they are reliable for use in screening infants and children with hearing loss in Ghana.

The findings show that the AAST could be a reliable screening tool. The test is devoid of test leader bias since thresholds are calculated automatically by the software therefore, there is no influence of test leader biases and (lacking) skills. Test results are therefore valid. AAST is therefore a robust tool and could be used to screen children in Ghana.The Akan versions would enable the scope of early screening to be broadened to cover several children.

Overall, the data pre-empts significant implications for the education of Ghanaian children who are disabled. This marks the beginning of an exciting era in the field of educational audiology in Ghana. As a direct result of this research project there is now available the substantial addition of three screening tools to facilitate measures aimed at early identification of children with hearing disabilities. Ghana is a signatory to the International Convention on Inclusive Education, which means efforts toward making education accessible for all, including periodic screening, must be maximized and tools must be available for the screen.

Furthermore, the educational performance of children who are identified early, and managed appropriately, will certainly improve. The more children are identified early and appropriate intervention provided to them, the less the number of children whose disabilities will result in poor educational, social and economic outcomes.

Recommendations & suggestions for future research:

Based on findings, limitations and the scope of the present study, the following research questions are recommended for future investigation/studies:

1. LittlEARS® Auditory Questionnaire:

- Options of electronic versions
- What degree of hearing loss will result in significantly lower LittlEARS® Auditory Questionnaire scores (average minus 2 standard deviations) at different ages?
- Lowest age for LittlEARS® Auditory Questionnaire:
- What is the lowest age is where LEAQ can be used as a valid screening tool?

2. Adaptive Auditory Speech Test (AAST):

- The need for other language versions in Ghana.

3. Multiple Frequency Animal Sound Test (mFAST)/AAST:

- Optimizing or validating the use of mFAST and AAST “in quiet” in school settings where there is always ambient noise. For example, by verifying the use of the “ambient noise based trial rejection protocol”.
- Validating the use of “duotone” as an alternative to mFAST?

8.0 CHAPTER EIGHT

EPILOGUE

Plans are well in advance for the LittlEARS® Auditory Questionnaire to be accepted and implemented officially at one of the Immunization centres for post natal baby care in Winneba (a branch of the Ministry of Health) as one of their test batteries for routine baby screening. The LittlEARS® Auditory Questionnaire is being administered to parents since June, 2012. Trained clinical assistants and students are present to administer the questionnaire to parents, with the support of some of the nurses. Positive LittlEARS® Auditory Questionnaire screen cases are referred to the CHSS for follow-up re-screening and diagnosis in the event of a second screen fail.

There appears to be a modest but healthy collaboration between the University of Education (via CHSS) and the Ministry of Health. Hopefully in the future this collaboration will be extended to other parts of Ghana. At the immunization centres mothers are normally given education on safe child care and children are vaccinated at these clinics. Students of the Department of Special Education are also given time slots to educate the parents on causes, prevention and management of childhood disabilities.

Currently, AAST is being implemented at the Centre for Hearing and Speech Services (CHSS), a division of the Department of Special Education at the University of Education (UEW) as part of the routine batteries for screening the hearing abilities of school children in and around Winneba in Ghana. CHSS is a unit under the supervision of the Department of Special Education of the University of Education, Winneba (UEW), Ghana. UEW is the only university in Ghana which currently has the mandate to train teachers for all categories of learners for Ghana.

The function of CHSS includes providing practical training in educational audiology for students pursuing their Bachelor's degrees in the education of the hearing impaired. CHSS also promotes and provides support services to professionals and other personnel who work with children with hearing and communication disorders.

AAST is also being implemented by Special Education Officers working with schools within the Winneba Municipal Area in Ghana on pilot basis as part of their routine regular screening of school children in all regular schools in and around Winneba. Prior to this only pure tone audiometry (PTA) and otoscopic ear examination have been available to the special education officers for their screen. An addition to their routine test batteries will provide a significant basis for improving the quality of their services to children with educationally significant hearing and related disorders. Data collected from these pilot initiatives will be presented in future studies.

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10.0 APPENDICES

Appendix A: Adaptation Memo for Rehabilitation Materials

Original Material/Product: 22685 1.0 LittlEARS Auditory questionnaire IFAP study

(Number, Revision, Title)

New Material/Product 23117 1.0 LittlEARS Auditory Questionnaire IFAP Study

(Number, Revision, Title)

Language of New Material/Product: Ashanti

Translated/Adapted by: ___

Proof read by: _____

Translator Qualifications:

☐ I hereby certify that I am knowledgeable and competent as a translator and am familiar with medical devices and the terminology associated with them.

Translator: _____

Date / Signature

Proof Reader Qualifications:

☐ I hereby certify that I am knowledgeable and competent to proof read the document and am familiar with medical devices and the terminology associated with them.

Proof Reader: _____

_____

Date / Signature

Appendix B

LittlEARS® Auditory Questionnaire EXPERT APPRAISAL: TRANSLATION OF THE LITTLEARS QUESTIONNAIRE INTO AKAN (FANTE, AKUAPEM, ASANTE)

Introduction: The LittlEARS auditory questionnaire was developed to assess auditory behaviour of infants up to 2 years of age (Weichbold et al., 2005). It was also intended to follow the auditory development of very young hearing impaired children, cochlear implants or hearing-aid users with a hearing age (time after first fitting of the devices) of 0–24 months. For the translation of the English version of the LittlEARS into Akan a back translation design was chosen according to the best practices recommended by the International Test Commission (Hambleton, 2001).**Please,** compare both English and Akan versions of each item, including the question stem and the examples, and assess to what extent both versions measure the very same auditory behaviour. Give your rates on the numbered scale below (from '1' not appropriated translation to '5' for 'absolutely appropriate translation'). Please put your comments and make suggestions in case of rating 3 or lower.

Item	1:Inappropriate translation	2	3	4	5: Absolutely appropriate translation
1					
2					
3					
4					
5					
6					
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Comments (In case of rating 3 or lower):

Appendix C: Letter of Introduction

Department of Special Education
University of Education,
P O Box, 25, Winneba
16th August, 2011

The Director of Health Services
Winneba Minicipal Directorate
Winneba

PERMISSION TO ADMINISTER QUESTIONNARE TO PARENTS: EARLY IDENTIFICATION OF CHILDREN WITH HEARING LOSS IN GHANA: A PILOT PROJECT USING LittlEARS AUDITORY PARENTS' QUESTIONNAIRE.

I write on ask for your permission to administer questionnaire to parents of children aged 0 to 36 months as part of my PhD thesis.

I am a senior lecturer in Special Education and an audiologist at the University of Education, Winneba. Currently I am pursuing my PhD studies in Cologne by distance and my thesis is on Early Identification of infants and children with hearing loss in Ghana.

As part of the project a 35 item auditory questionnaire has been adapted to be administered to parents of young children aged 0 to 36 months. It will take between 5 to 10 minutes for parents to respond to each of the questions (please see attached a copy of the Akan version of the auditory questionnaire).

Trained assistants will be sent to the immunization Centres to administer the questionnaire to parents

I should be grateful if you could permit me to administer the questionnaire to parents attending the antenatal clinics in areas within your jurisdiction.

Children who are identified as being at risk of hearing loss will be referred to the Centre for Hearing and Speech Services (CHSS) in Winneba for thorough diagnosis and management for **free**.

I anticipate that this will be the start of a new born screening programme to be piloted in the Winneba Municipal Area

I anticipate a favourable response from you

Yaw Nyadu Offei

Appendix D: Participant information sheet

Project title: EARLY IDENTIFICATION OF CHILDREN WITH HEARING LOSS IN GHANA

Researcher: Yaw Nyadu Offei, PhD. Student, Uni-Koeln, 2009-2012.

Supervisor: Prof. Dr. Ir., Frans Coninx

Introduction

I write to seek your consent to allow your child/ward to take part in a research study. Please study the following information carefully and take time to decide whether or not you wish your ward/child to take part. If you decide to take part in the study, please fill in the informed consent form attached and return it to me when your ward/child is coming for his/her appointment. If there is anything that is not clear to you or if you need some more information, please contact me.

Purpose of the study:

The purpose of the study is to develop and evaluate auditory tests and questionnaire to screen Ghanaian children. The tests include:

1. Ghanaian English and Akan versions the Adaptive Auditory Speech Test (AAST) (4 – 6 years and older)
2. LittlEARS auditory questionnaires (Birth – 36 months)

The study will involve 400 participants. Participants in the study would be required to complete parent auditory questionnaires and speech discrimination tests during their appointment. The purpose of the questionnaire is to document general progress and age appropriateness of the auditory behaviours exhibited by children/infants/toddlers with normal hearing or those who need follow up after an initial hearing screening. The purpose of AAST is to screen children at risk of hearing loss

Refusal or withdrawal

You may refuse to participate in the study. If however, you decide to take part, you may withdraw at any time without any consequences, fear or prejudice to your future treatment and management. However, if you decide to withdraw, please inform me as soon as it is possible for you.

Any discomfort to participants?

No. Participants would be required to fill in a questionnaire and/or complete a computerized speech tests during their appointment.

Benefits of taking part:

There are no direct benefits to those participating in the test. However, for children taking part in AAST there is a possiblilty that some children might have results that may require further investigation at the Centre for Hearing and Speech Services.

Confidentiality

You are assured that data treatment is anonymous. All participant information in the data will be removed immediately to ensure the confidential and anonymous treatment of data.

What will happen to the results of the study?

The results of the study will be kept at the Faculty of Special Education and Rehabilitation at the University of Cologne, Germany. Results might be a source of reference for additional or subsequent research.

Thank you for considering taking part in the study.

YAW NYADU OFFEI
(RESEARCHER)
(mobile number: +233 046 782 776; +49 152 562 474 64)

Appendix E: Participants' consent form.

CONFIDENTIAL

Participant Consent form

(To be completed independently by the participant)

Project title: EARLY IDENTIFICATION OF CHILDREN WITH HEARING LOSS IN GHANA

Please respond to each of the following questions by saying YES or NO

Have you read the Participant Information Sheet?.....

Have you received enough information about the study?.....

Have you had the opportunity to ask questions and discuss the study?.....

Have you received satisfactory questions to your questions?.....

Do you know that you can withdraw from the study without any consequences at any stage?.....

Do you agree with the publication of the result of this study in an appropriate outlet (e.g. Journal) in the future?.....

Signature:……..

Date:…….

Full Name in Capitals:……..

Thumb print if illiterate:

Appendix F: LittlEARS® Auditory Questionnaire Protocol.

Question: Do LittlEARS® Auditory Questionnaire scores differ significantly based on the mode of completing LittlEARS® Auditory Questionnaire (Self-administration or Interview)?

Respondents' Demographic/Personal information

Instruction: Please tick (√) appropriately

1. Respondent's identity:
   - Mother ☐
   - Father ☐
   - House help ☐
   - Other (please specify)……

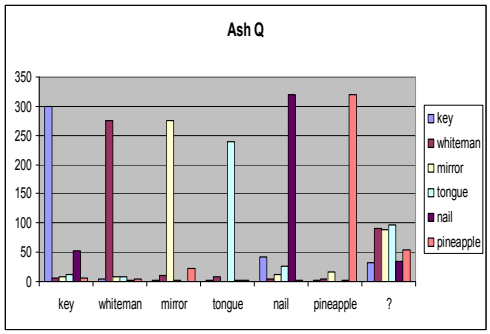
2. Respondent's highest academic level:
   - Primary School ☐
   - Junior Secondary./JHS/Middle School ☐
   - S.S.S/SHS/Commercial/Voc./Technical school ☐
   - University Diploma/degree ☐
   - Other (Please Specify) ……

4. Patients' employment status
   - Employed ☐
   - Unemployed ☐

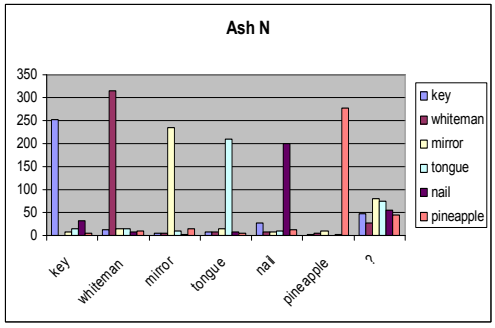
5. Do you regularly read a newspaper?
   - Yes ☐ if yes, how often?
     - ☐ Each day
     - ☐ few times a week
     - ☐ once a week or less
   - No ☐

6. If employed (4 above) please state occupation …….
7. Child' Sex:
   - Male ☐
   - Female ☐
8. Child's age (Please state in months)……
9. Child's date of birth (mm/dd/yy)…….
10. Date of LittlEARS® Auditory Questionnaire data collection (mm/dd/yy)……..
11. Where was data collected? Please state setting (i.e. Audio clinic, church, school, home, etc)……..

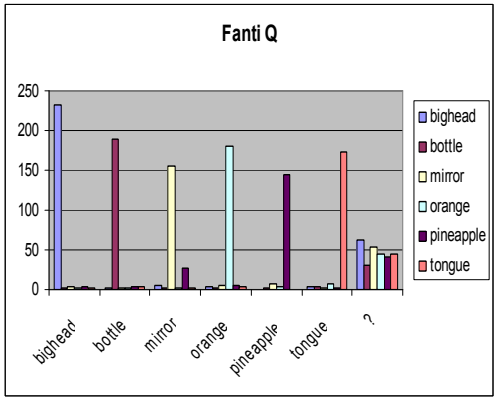
Appendix G: Confusion Analysis



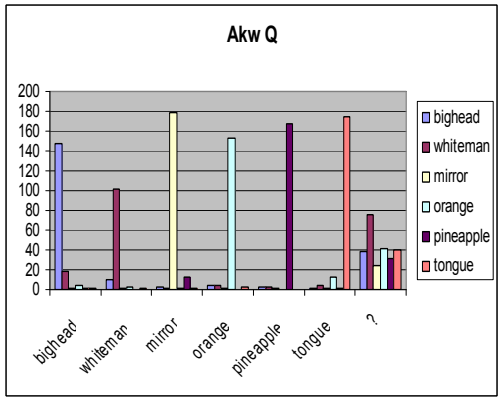
Asante in Quiet



Asante in Noise



Fante in Quiet



Akuapem in Quiet