LANGUAGE IN INDIA
Strength for Today and Bright Hope for Tomorrow
Volume 12 : 12 December 2012
ISSN 1930-2940

Mean Length of Utterance in Children with Cochlear Implant versus Normal Hearing Children

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Introduction

Children with severe-to-profound hearing loss can develop spoken communication via audition with amplification or assistive devices. In the past, though the hearing aids were widely used as amplification devices they had many limitations, like could not provide much amplification in the higher frequencies. In recent years, multichannel cochlear implantation (CI) has become more prevalent among the population of pre-lingually profound bilateral hearing impaired children who cannot acquire adequate speech with the help of powerful hearing aids. With the multichannel cochlear implantation, researchers found that the auditory skills (McConkey Robbins, Koch, Osberger, Zimmerman-Phillips, & Kishon-Rabin, 2004), speech perception (Waltzman and Hochberg, 1990), speech production (Tobey et al., 1991) as well as speech intelligibility of the CI users can be improved significantly. Moreover, it was found that when cochlear implant was fitted to a prelingually deafened child, the rate of language skills development is about the same as that of normal hearing children (Mellon, 2001).

The National Institute of Health (1995) concluded that, with respect to cochlear implants, improvements in the speech perception and speech production of children are often reported as primary benefits. If CIs are to provide functional communication skills for children receiving them, the communication gains must extend beyond speech perception and production and include the lexical, grammatical, and discourse skills of the hearing community. These are the higher level communication skills necessary for social and academic achievement in these communities. The lexical and grammatical developments of spoken languages have been very challenging to children who are pre-lingually profoundly deaf (Borg et al., 2002).

One of the most robust indices of young children's language acquisition is the number of words or morphemes in each of their spontaneous utterances, conventionally described as the mean length of utterance (MLU). The MLU constitutes a language measure that has the objective to obtain data regarding syntactic and morphologic aspects of the performances of both children with typical development (TD) and children with communication disorders (Brown, 1973). The Mean Length of Utterance in morphemes is an index for the verification of grammatical development. Studies (Rice et al., 2010) have shown a relationship between chronological age and MLU; impairment is often defined as an MLU level one standard deviation or more below the mean for the child's age level (Eisenberg, Fersko, & Lundgren, 2001). The degree of language development skills of the hearing children can be tested by means of mean length utterance. Gisela (1997) reported that language acquisition data from two children with cochlear implants show great difference with respect to rate of acquisition, construction of the German case system and syntax. Daneshmandan (2003) reported mean length utterance in 9 children with severe to profound hearing impairment was significantly lower compared to normal hearing children.

The complexity of learning a language arises from a synthesis of the many influences and activities that enable a child to become linguistically engaged. Children learn language by developing and assembling together four systems of skills. The pragmatic, phonology, semantic and syntax are separate but inter related systems that comprise the foundation of language acquisition (Rescorla and Mirak 1997).

Morphology is the aspect of language concerned with the rules governing change in word Meaning. Morphological development is analyzed by computing a child's Mean Length of Utterance (MLU). One of the most robust indices of young children's language acquisition is the number of words or morphemes in each of their spontaneous utterances, conventionally described as the mean length of utterance (MLU). The potential utility of this measure has long been recognized. Well before the advent of portable electronic devices to record children's utterances for later transcription, Margaret Morse Nice

(1925) regarded average sentence length to be "the most important single criterion for judging a child's progress in the attainment of adult language". With portable tape recorders in hand, Roger Brown (1973) and his colleagues developed new standards for transcription and morphological analyses that established MLU as a benchmark for the description of children's emergent language abilities.

MLU has been used widely to describe the early stages of syntax from the onset of two-word combinations to the genesis of complex syntax in normally developing preschool children (Bloom, 1970; Wells 1985). Although MLU simply reflects the mean number of morphemes per utterance in a speech sample, the measure has been found to be associated with a number of grammatical competencies, including the expression of semantic relations (Bloom, Lightbown & Hood, 1975), the number of diversity of grammatical categories such as Verb, pronoun or article (Newport et al, 1977), productive mastery of grammatical inflections and functors (Brown, 1973) and the emergence of increasingly complex negative and interrogative constructions(Klima & Bellugi, 1966).

Mean length of utterance (MLU) has been described as a sensitive index for the developmental level of language in typically developing children, increasing steadily through to the teenage years as it is correlated with clausal development (Price et al., 2006). Owens (2010) suggests that an average of up to 4.0 MLU is considered a good measure of language complexity, as there is less variability below this average. This is usually reached by the age of 4 in (ND) children, but continues to increase with age.

However, significant variability has been found in terms of MLU in ND children and this phenomenon is described as very typical in early language development (Dethorne, Johnson & Loeb, 2005).

The modern era of computer-assisted methods of transcript analyses (MacWhinney, 2000; Miller & Chapman, 1991) and machine calculation of MLU values has greatly expanded the utilization of this measure as a language benchmark. The normative child language literature has embraced MLU as away to benchmark the level of a child's language acquisition to age expectations and to the linguistic competencies associated with particular levels of MLU.

In clinical applications, MLU is used to diagnose language impairments in young children; impairment is often defined as an MLU level one standard deviation or more below the mean for the child's age level (Eisenberg, Fersko, & Lundgren, 2001). MLU has been used as a matching variable in many studies of clinical groups. The interpretation focuses on the potential value of controlling for general language levels, indexed by MLU, and examining whether other linguistic processes or competencies are equivalent, to determine whether there are distinctive profiles of language impairments across different clinical groups or whether there is a delayed, generally immature linguistic system versus a generally immature linguistic system plus selective areas of linguistic deficits.

The pattern of language development is sequential universally, unless and until interference is caused due to any sensory or motor deficits. Most children who are born profoundly deaf or who become deaf before the age of 3 fall significantly behind their normal-hearing peers in their mastery of the surrounding oral language in its written, read, spoken, and signed forms. Children with severe-to-profound hearing loss can develop spoken communication via audition with amplification or assistive devices.

In the past, though the hearing aids were widely used as amplification devices they had many limitations, like could not provide much amplification in the higher frequencies. In recent years, multichannel cochlear implantation (CI) has become more prevalent among the population of prelingually profound bilateral children hearing impairments who cannot acquire adequate speech with the help of powerful hearing aids.

With the multichannel cochlear implantation, researchers found that the auditory skills (McConkey Robbins, Koch, Osberger, Zimmerman-Phillips, & Kishon-Rabin, 2004), speech perception (Waltzman and Hochberg, 1990).), speech production (Tobey et al., 1991) as well as speech intelligibility of the CI users can be improved significantly. Moreover, it was found that when cochlear implant was fitted to a prelingually deafened child, the rate of language skills development is about the same as that of normal hearing children (Mellon, 2001).

The literature on language development in children after cochlear implantation has established that children who use cochlear implants develop language at a faster rate than children with similar degrees of hearing loss who use hearing aids (Svir-sky, Robbins, Iler-Kirk, Pisoni, & Miyamoto, 2000).

Children who obtain greater auditory benefit from their implant achieve more normal language levels than children who have poor speech perception post implant

(Crosson & Geers, 2001). However, the amount of speech perception needed from any cochlear implant for normal language development to occur has yet to be determined. The extent to which the language growth achieved resembles normal development and the amount of language delay exhibited by the deaf child after cochlear implantation continue to be examined. The role of communication modality in expediting language development post implant is also the focus of considerable investigation with conflicting findings that may be at least partially related to the techniques used to measure language.

One of the most robust indices of young children's language acquisition is the number of words or morphemes in each of their spontaneous utterances, conventionally described as the mean length of utterance (MLU). The MLU constitutes a language measure that has the objective to obtain data regarding syntactic and morphologic aspects of the performances of both children with typical development (TD) and children with communication disorders (Brown, 1973). The Mean Length of Utterance in morphemes is an index for the verification of grammatical development. Studies (Rice et al., 2010) have shown a relationship between chronological age and MLU; impairment is often defined as an MLU level one standard deviation or more below the mean for the child's age level (Eisenberg, Fersko, & Lundgren, 2001).

The degree of language development skills of the hearing children can be tested by means of mean length utterance. Gisela (1997) reported that language acquisition data from two children with cochlear implants show great difference with respect to rate of acquisition, construction of the German case system and syntax. Daneshmandan (2003) reported mean length utterance in 9 children with severe to profound hearing impairment was significantly lowered compared to normal hearing children.

Need for the Study

The past decade has heralded exciting technological advances to facilitate the spoken language development of young children with severe-profound hearing loss. Implementation of newborn hearing screening programs and advances in the technology available to improve the hearing experience itself has led to an era of new possibilities. Cochlear implants, in particular, have become widely embraced as an aid to exposing the deaf child's auditory system to a quality of sound experience not available with hearing aids alone. It is already known that cochlear implantation under the age of three years, a longer duration of cochlear implant use, and better pre-implant aided hearing contribute to language development (Nicholas & Geers, 2007).

As per NSSO (National Sampling Survey Organisation) survey, currently there are 291 persons per one lakh population who are suffering from severe to profound hearing loss (NSSO, 2001). Of these, a large percentage of children with severe to profound hearing loss are between the ages of 0 to 14 years. With such a large number of hearing impaired young Indians, it amounts to a severe loss of productivity, both physical and economic. Cochlear implantation in India for severe-profound hearing impaired children is becoming preferred mode of intervention, especially with the Government funded public health schemes e.g. in Andhra Pradesh Arogyashree Scheme. Still, studies regarding speech-language outcomes in Indian children with CI are lacking. Such studies will give important knowledge about comparative benefits of CI in language development in these children.

Mean Length of Utterance (or MLU) is a measure of linguistic productivity in children. A higher MLU is taken to indicate a higher level of language proficiency like the child's developing morphological skills and their syntactic skills. This study attempted to investigate the linguistic productivity skills in CI children through MLU.

Aim of the Study

The main purpose of this study was to examine and compare the mean length of utterance in children using cochlear implant and age matched normal hearing peers.

Objectives of the Study

- To investigate and compare the MLU in children using cochlear implant and children with normal hearing
- To find out the correlation between the MLU in children using cochlear implant with reference to their total auditory experience
- To find out the correlation between the MLU in children using cochlear implant with reference to their auditory experience with CI alone.

Hypotheses

- There would not be any significant difference in the MLU in children using cochlear implant and children with normal hearing
- There would not be any significant difference in the MLU in children using cochlear implant with reference to their total auditory experience.
- There would not be any significant difference in the MLU in children using cochlear implant with reference to their auditory experience with CI alone.

REVIEW OF LITERATURE

Speech pathologists have been involved in the assessment of child’s language since 1950. The intervening years have brought diversity in the theories and practices of language assessment. Changing views of the nature of language spawned new procedures for sampling and describing language and for categorization deviations from normal language. The history of language assessment has been reviewed by Lund and Duchan (1988). They have traced various stages in development of assessment procedures. This is briefly highlighted in the following section.

In 1950’s, two approaches to language assessment were developed. The first which we call “Normative” was an approach told by Johnson, Darely and Spiestersbach (1952). They emphasized on how normal children at different ages performed on measures like mean sentence length in words, parts of speech used, sentence structure and ratings of verbal output.

The second, contrasting approach to language assessment that emerged at the same time called "Pathology approach". This approach was based on a medical model. The goal assessment was to identify the "diseases" or underlying cause of the presenting symptoms and to determine the intervention procedures and prognosis.

The 1960's brought new trends in language assessment for speech pathologist, one of the being behaviouristic movement. In this approach, language behavior was seen as developing out of the interaction between currant behavior of the organism and the environmental antecedents and consequences of that behavior (Slane & Mac Aculay, 1968). Language response was viewed as under the control of both stimulus and reinforcement.

Another trend which emerged in 1960's and still prevalent is the auditory processing frame work (Kirk and McCarthy, 1961; Lasky and Katz, 1983). This approach combines "behaviorism" and "information processing theory". The general format for auditory processing conceptualization is that information contained in the auditory stimulus proceeds through several encoding steps – reception, perception categorization storage and later the information is retrieved for future processing. Thus the test batteries or specific tests have been designed to test children's auditory processing abilities such as speech sound discrimination, auditory memory sequencing figure ground discrimination, and auditory closure (Gold man, Fristoe and WoodCock, 1974). The Illinois Test of Psycholinguistic Abilities (ITPA) reflects a behaviouristic orientation by virtue of its focus on the stimulus in some subtests visual reception, auditory reception, visual and auditory association and verbal and manual expression.

Linguistic approach to assessment also originated during the early 1960's, when several important studies were done by psychologists examining children's language acquisition. Using analytic techniques and terminology of descriptive linguists, researchers in child language began to formulate grammars or rules that both described and attempted to explain child language. Reports of investigation of normal children confirmed that child language is not merely an accurate or incomplete version of adult language but a unique system governed by its own rules (Furguson and Slobin, 1973). The rules are characterized as making up the child's competence in the various levels of language: phonology, morphology, syntax and semantics.

In mid-1970s there emerged the language assessment procedures called semantics emphasis (Lakolf, 1971; McCawley, 1971). The generative semanticists tried to derive a model for the meaning of words, phrases and sentences. For those studying child languages, the emphasis on meaning led to questions about the conceptual basis of first words and two words combinations (Clark, 1977; Nelson, 1974; Roach, 1973). The semantic emphasis allowed a deep structure that was meaning based, such as having semantic cases (Antinucci, et al. 1973) semantic relations (Brown, 1973), semantic features (Clark, 1977), etc.

As a result of the focus on semantics, there was renewed interest in Piaget's cognitive theory, leading to a cognitive emphasis in assessment. They tried to associate the stages of cognitive development to those of language development. Clinicians attempted to which sensory motor understandings were precursor to language learning during the early period (Birth to 2 years) of life in normal children (Miller et al, 1980). The assessment focused on whether the language impaired child had the necessary prerequisite of cognitive knowledge for language learning.

The 1970s brought new change in the thought of language assessment. The realization that sentences derived their meanings from the contexts in which they occurred was known as the pragmatic approach. The same word and sentences could mean something different in different settings. Assessment procedures called "the speech act approach" involved input of intentions to children by looking at the form of the act as well as its results.

The 1980s however brought mainly two important perspectives. First one was "the context of interaction". The assessment approach was focused on various aspects of interaction; the ways interactions cooperated in conversation, especially with regard to turn taking, the ways they performed activities together, and the effect of language style of the interactions on child's language learning (Ferguson and Snow, 1977). The second perspective examined language in terms of its event context. Bruner's (1975) work on routine events during the child's first year of life was extended by Nelson (1981) to the study of children's acquisition of knowledge. Hence this perspective was also called the "event focus approach".

It is evident from brief historical review that divergent views of language assessment and intervention have evolved from a variety of sources. A number procedures and tests have been developed by different authors to provide general indices of various linguistic elements for an entire sample. The one which was found to be the most popular and useful with the clinical population of developmentally disabled children includes computing MLU in words /morphemes. It is a standard and objective procedures to describe quantify speech and language characteristics of children. It provides an index of syntactic complexity (McCarthy, 1954), Brown (1973). Nice was the first person to introduce MLU in terms of words as early as 1925. But Brown (1973) re-popularized the MLU and did extensive study in this field. Literature shows studies on factors influencing MLU, related to ways of computing it, the method of eliciting a representative samples for MLU, its relationship with age and other procedures like MLR, to evaluate the reliability and validity of MLU as a measure of grammatical complexity. There are various language tests including Bankson Language Screening Test (1977) which take into account MLU as a measure, Test for auditory comprehension of language (Carrow-Woolfolk, E., 1985), North-Western Syntax Screening Test (Lee, L., 1971) and Carrow (Carrow, E., 1974) which elicited language inventory and oral language sentence imitation screening/diagnostic tests (Zachman et al, 1974a, 1974b).

Brown (1973) first found that children who are matched for MLU are more likely to have speech that is at the same level of constructional complexity up to about four. He observed that chronological age was not a good predictor of language development. He found that children acquired different grammatical constructions at widely varying rates (Brown & Frazer, 1963).

MLU in terms of morphemes was to provide a satisfactory index for comparison between children and sensitive measure of a child's language development over time. Brown (1973) has reported the existence of 5 stages of language development which are designated with Romans numbers and are as follows:

Stage I: (1.75 mean morpheme unit)

Semantic role and syntactic relation. In this stage the child uses noun-verbs sequences such as "mummy give".

Stage II: (2.25 mean morpheme unit)

Grammatical morphemes and modulation meaning. The child starts to change word endings to portray as in "mummy giving".

Stage III: (2.75 mean morpheme unit)

Modalities of simple sentences. The child begins to use questions and imperative forms. For example: "mummy is giving".

Stage IV: 3.50 mean morpheme unit)

Embedding. The child begins to use complex sentences for instance "What is mummy giving now?".

Stage V: (4.0 mean morpheme unit)

Co-ordination: The child may use connectors and more functions as in “mom’s giving”.

Brown (1973) did not imply that stages were discrete, but rather that the linguistic development was continuous and that the stage allowed comparison and characterization at different levels of language proficiency.

De Villiers and De Villiers (1973) smoothed the original MLU intervals to 0.5 while retaining Brown’s stage (1973). These smaller stages were useful in characterizing advances, especially infections for the 3-4 MLU range.

In Brown’s (1973) stages, (3-4) MLU range was too wide to capture and rapid development during this age many authors have supported agreed that MLU is the best measure for language sophistication (Foss & Hakes, 1978; Chapman & Miller, 1981; Peterson, 1990; Scarborough et al, 1986; Shriner & Sherman, 1967).

MLU is also a valuable index in investigations of children with language impairments. In clinical applications, MLU is used to diagnose language impairments in young children; impairment is often defined as an MLU level with one standard deviation or more below the mean for the child’s age level (Eisenberg, Fersko, & Lundgren, 2001).

An expert panel recently recommended that MLU be used as a benchmark for cross-study comparisons of language intervention outcomes for children with autism, as one of several potential outcome measures (Tager-Flusberg et al., 2009). MLU has been used as a matching variable in many studies of clinical groups. The interpretation focuses on the potential value of controlling for general language levels, indexed by MLU, and examining whether other linguistic processes or competencies are equivalent, to determine whether there are distinctive profiles of language impairments across different clinical groups (such as Down syndrome versus Williams syndrome, for example) or whether there is a delayed, generally immature linguistic system versus a generally immature linguistic system plus selective areas of linguistic deficits. An example of the latter kind of investigation is a study by Rice, Redmond, and Hoffman (2006).

Leonard (1998) examined various properties of MLU in a group of children with specific language impairment (SLI) as compared with two control groups: a younger MLU-equivalent group and an age control group. They found strong concurrent validity for MLU at 5 years of age and strong reliability and validity for longitudinal growth patterns from 3 to 8 years of age.

There is a great need for age-graded reference MLU data for children with documented SLI. This condition is characterized by language impairment in children who show no obvious other developmental impairments—excluding children with clinically significant hearing impairment; clinically diagnosed neurodevelopmental disorders; or syndrome diagnosis, such as Down syndrome, Williams syndrome, or autism. Tomblin, et al. (1997) reported that 7% of kindergarten children show SLI. Because language impairment is primary in children with SLI, who do not have other developmental disabilities associated with language impairment, this clinical group is widely used as a model system for comparisons with unaffected children and with children carrying other diagnoses (Rice, Warren & Betz 2005).

Recent genetic studies have documented links to genetic sources of SLI (Falcaro et al., 2008; Rice, Smith, & Gayán, 2009), adding to the interest in this condition. Although MLU is widely used as part of the phenotype for this disorder, there is no repository of MLU levels broken out by age levels for children with SLI. Such a resource would be valuable for comparing across samples of affected groups used in the research literature.

Zhang and Tomblin (2000) reported that children with speech disorders are served mostly by speech-language pathologists. The speech impairment is less than 2% in the general population of 5-year-olds, and only about 5%–8% of the children with language impairments showed clinically significant speech disorders.

Shriberg, Tomblin, & McSweeny (1999) reported MLU as one of the aspects of language skills. They found that between severe to profound pre-lingual hearing impaired children and age matched normal hearing children, the MLU growth among severe to profound pre-lingual hearing impaired children was not the same and was affected by several factors and predominant among these factors were auditory perception and language growth.

Mean length of utterance (MLU) has been described as a sensitive index for the developmental level of language in typically developing children, increasing steadily through to the teenage years as it is correlated with clausal development (Price et al., 2006).

Owens (2010) suggests that an average of up to 4.0 MLU is considered a good measure of language complexity, as there is less variability below this average. This is usually reached by the age of 4 in normally developing children, but continues to increase with age. However, significant variability has been found in terms of MLU in normally developing children and this phenomenon is described as very typical in early language development (Dethorne, Johnson & Loeb, 2005).

MLU has also been advocated as a useful measure for diagnosing language impairments and monitoring treatment progress (Botting, 2002; Norbury & Bishop 2003), however the significant variation found in the utterance lengths of normally developing children (Scott & Stokes, 1995) makes this assumption questionable.

There have been many discussions on the usefulness of MLU as a diagnostic measure as both number of different words (NDW) and tense accuracy accounts for a significant amount of variance in MLU. The question is asked: *What does MLU actually measure?* Strong correlations have been found between MLU and NDW (Dethorne et al., 2005) which suggested that MLU is associated with individual measures, both in the semantics and morphosyntactic domains, with its association to NDW being particularly strong. Therefore MLU is better viewed as a global measure of expressive language ability and that it is probably affected by non-linguistic factors related to the measurement of context of language sampling.

Bishop (2004) stated that MLU in words i.e., mean length of T-unit (MLT) and MLU in morphemes are so highly inter-correlated as to be equivalent. However, Owens (2010) suggested that the mean length of T-unit (MLT) is more sensitive than MLU to the types of language differences seen after age 5, such as phrasal embedding and various types of subordinate clauses but specifically quote that T-unit values can be misleading, because complexity and length are not directly related. A phrase may for example be used in place of subordinate clauses to support conciseness, suggesting greater syntactic sophistication.

Children are dependent on the sense of hearing to adequately receive and perceive the complete network of auditory stimuli which comprise the network of speech and language. The onset of a congenital significant hearing impairment can seriously impede the ability to communicate, culminate educational background, constricts the personality development. Aural habilitation and rehabilitation represent an extremely important process whereby an individual's diminished ability to communicate helps hearing impaired children.

The amplification options available for hearing impairment are hearing aids and cochlear implants. Recent digital hearing aids help individuals with hearing impairment to improve their hearing and speech perception. Cochlear implant (CI) technology has opened up rehabilitation options for the use of spoken language among individuals with severe and profound hearing loss. The use of the CI has shown that it increases the audibility of the speech signal and consequently enables better speech perception by children using CI compared to those with a similar degree of hearing loss but who use HAs (Blamey et al., 2001; Calmels et al., 2004; Gestoettner, Hamzavi, Egelierlier, & Baumgartner, 2000 and Mildner, Sindija, & Zrinski, 2006).

El-Hakim, Levasseur, Papsin and Panesar (2001) reported vocabulary development in children after cochlear implantation, after phoneme acquisition vocabulary builds up to ensure proper speech and language development.

Mount, Stevens, and Harrison (2001) investigated whether the age at the time of implantation affected a child's performance in 112 pre-lingual deaf children with equal numbers of females & males children of varied age group, they all were fitted with a cochlear implant. The children were sub grouped into those who had received implants before and after age five. The Peabody Picture Vocabulary Test (PPVT) and The Expressive One-Word Picture Vocabulary Test (EOWPVT) were performed by children serially for approximately three and a half years after implantation. There was no notable difference between the subgroups with respect to expressive vocabulary and receptive vocabulary. However with respect to the PPVT, the language gap indices of the older group only lessened significantly but for EOWPVT, both older and younger groups language gap indices lessened significantly. Conclusively stating vocabulary is imperative in speech and language development.

A study by Patil G.S., Shireen., & Shilpa.P (2011) on the mean length of utterance in children with cochlear implant, showed that the children with cochlear implant demonstrated shorter MLU compared to age matched normal hearing children. A total of 20 participants were included in the study and were divided into 2 equal groups of children with cochlear implant (CI) and children with normal hearing. The stimulus included a comprehensive single picture card depicting the typical urban home situation.

METHOD

The present study was aimed to investigate and compare MLU in children using cochlear implant and children with normal hearing.

The following objectives were formulated for the study:

- To investigate and compare the MLU in children using cochlear implant and children with normal hearing
- To find out the correlation between the MLU in children using cochlear implant with reference to their total auditory experience
- To find out the correlation between the MLU in children using cochlear implant with reference to their auditory experience with CI alone.

The following hypotheses were formulated for the above objectives:

- There would not be any significant difference in the MLU in children using cochlear implant and children with normal hearing.

- There would be no positive correlation in the MLU in children using cochlear implant with reference to their total auditory experience.

- There would be no positive correlation in the MLU in children using cochlear implant with reference to their auditory experience with CI alone.

Research Procedure

The participants included 15 children with cochlear implant (CI) and 15 children with normal hearing. The clinical demographic profile of children with cochlear implant is given in Table 1. The normal hearing children were matched for age and gender. They did not present any history of speech, language, or hearing problems.

Table 1. Clinical profile of children with cochlear implant.

Participants	Onset /Degree/type of hearing loss	Age of identification of hearing loss	Chronological Age	Age of implantation	Prior Hearing aid use	Type of device/implant
CI 1	Congenital/ profound/SN	2 years	9years	6 years	4years	Nucleus BTE C123 R
CI 2	Congenital/ profound/SN	8months	7years	4 years	2years	Nucleus Body worn C124 R
CI 3	Congenital/ profound/SN	1½ years	8years	6 years	2 ½ years	Nucleus Body worn C124 R
CI 4	Congenital/	1 ½	8years	4½ years	1 ½	Nucleus Body

	profound/SN	Years			years	worn C124 R
CI 5	Congenital/profound/SN	6months	6years	3½ years	1yr	Nucleus BTE C123 R
CI 6	Congenital/profound/SN	1 ½ years	7years	5 years	3years	Nucleus Body worn C124 R
CI 7	Congenital/profound/SN	8months	8years	6 years	3years	Nucleus Body worn C124 R
CI 8	Congenital/profound/SN	10months	8years	6 years	3years	Nucleus Body worn C124 R
CI 9	Congenital/profound/SN	6 months	4 ½ years	14 months age	5months	Nucleus BTE C123 R
CI 10	Congenital/profound/SN	7months	8years	6 years	4 ½ years	Nucleus BTE Freedom
CI 11	Congenital/profound/SN	10 months	7 years	5 years	3 years	Nucleus Body worn C124 R
CI 12	Congenital/profound/SN	2 years	8 years	6 years	4 years	Nucleus Body worn C124 R
CI 13	Congenital/profound/SN	1 year	5 years	3 years	2 years	Nucleus BTE C123 R
CI 14	Congenital/profound/SN	2 years	6 years	3 years	1 year	Nucleus Body worn C124 R
CI 15	Congenital/profound/SN	5½ years	7 years	6 years	3 months	Nucleus Body worn C124 R

Stimulus

The stimulus included a comprehensive single picture card depicting the typical urban home situation. Some of the activities that were depicted were members of the family doing various activities – grandfather reading newspaper, mother in kitchen, child playing, father getting ready etc. Initially, a pilot study was done to determine the feasibility of using the picture card for the current study. Five children with normal hearing aged 6-8 years were recruited for the purpose. The children could describe the picture card using simple, compound and complex sentences. Also, words belonging to different grammatical categories – nouns, verbs, adjectives, functional words could be elicited during the pilot study.

Procedure for Data Collection

All the participants were tested individually in a quiet environment. The picture card was placed in front of the participant. The participants were instructed to describe the picture using sentences in as much detail. For demonstration purpose, another picture card not part of the study was narrated by the investigator. The utterances of the participants were recorded using a digital voice recorder placed at 5 cms. away from the child's seating place.

Analysis

The utterances of the participants were transcribed using the International Phonetic Alphabet. Later, the utterances were divided into separate morphemes. For the purpose of reliability of identification of morphemes, another experienced speech language pathologist not concerned with the current study also identified morphemes for the language sample. The number of morphemes and number of utterances for each participant was tabulated. The mean length of utterance was calculated as number of morphemes divided by the total number of utterances for each participant. The mean

MLU was calculated for both groups of participants with reference to auditory experience of CI, speech processor. The SPSS 17.0 software was used for statistical analysis to infer the results.

Statistical Analysis

The data obtained by the procedures was subjected to statistical software (SPSS) version 17.0. A descriptive statistical analysis was performed to obtain the mean and standard deviation of the MLU in children using cochlear implant and children with normal hearing. Independent samples t test was administered to find out the significant difference between the 2 groups. Pearson product moment correlation was used to find out the relationship between MLU of children using cochlear implant and their total auditory experience and auditory experience using CI alone. The interpretation of the data is explained in detail in the next chapter.

RESULTS AND DISCUSSION

The present study was aimed to investigate and compare MLU in children using cochlear implant and children with normal hearing.

The following objectives were formulated for the study:

- ✓ To investigate and compare the MLU in children using cochlear implant and children with normal hearing

- ✓ To find out the correlation between the MLU in children using cochlear implant with reference to their total auditory experience

- ✓ To find out the correlation between the MLU in children using cochlear implant with reference to their auditory experience with CI alone.

The following hypotheses were formulated for the above objectives:

- ✓ There would not be any significant difference in the MLU in children using cochlear implant and children with normal hearing.

- ✓ There would be no positive correlation in the MLU in children using cochlear implant with reference to their total auditory experience.

- ✓ There would be no positive correlation in the MLU in children using cochlear implant with reference to their auditory experience with CI alone.

Objective I: To investigate and compare the MLU in children using cochlear implant and children with normal hearing

The mean length of utterance range in children with cochlear implant was 2.2 to 3.3. The average mean length of utterance was found to be 2.47 (SD=0.55). In normal hearing children, the average mean length of utterance was 5.1 (SD=0.65). The MLU range was 4.3 to 5.6. The results are also depicted in Figure 1. The MLU data was compared between the groups of children with cochlear implant and normal hearing children. The independent samples T- test revealed significant difference in mean between the 2 groups of participants ($p<0.05$).

Table II: **shows Mean Length of Utterance in children using cochlear implant and normal hearing children**.

Participants	Mean	SD
CI	2.27	0.06
NH	3.09	0.07

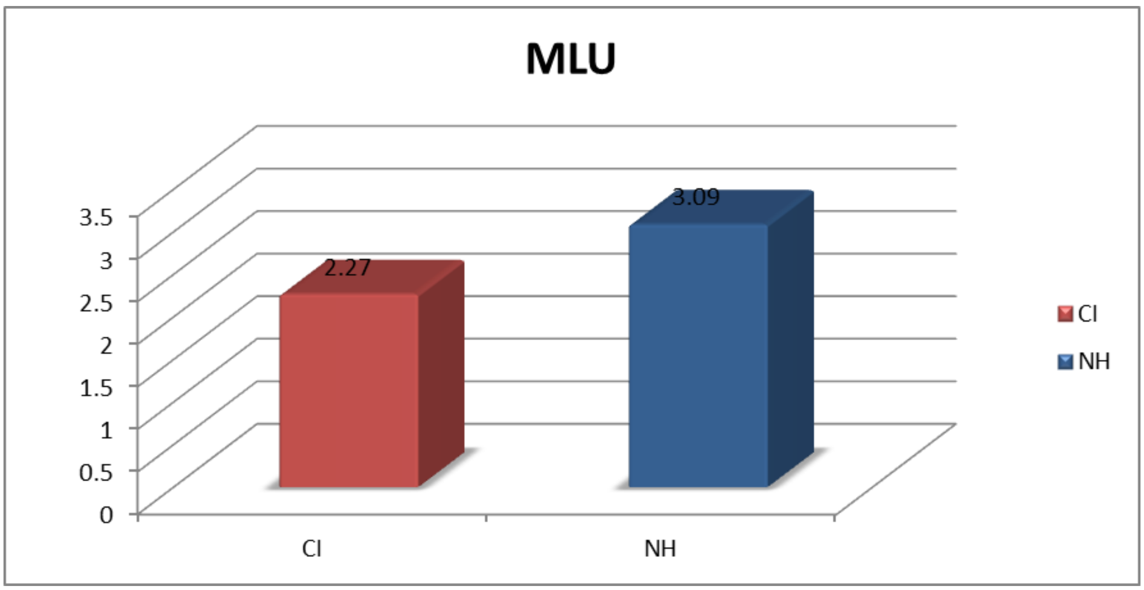

Figure I: **shows the mean MLU of children using cochlear implant and children with normal hearing**

The overall mean values of MLU obtained by CI and NH were 2.27 and 3.09 respectively. Children with normal hearing obtained higher mean values than children using cochlear implant. The mean values were subjected to Independent samples t test to find out the significant difference between groups. The results revealed that there exists a statistically significant difference ($p<0.000$) between the two groups. Thus the null hypothesis stating that there will not be any significant difference in MLU by children using cochlear Implant and children with normal hearing was rejected.

Children with normal hearing obtained higher mean values compared to children using CI. This was consistent with the study done by Christine Ouellet & Henri Cohen 1999. This could be attributed to the reason that the actual amount of information that can be transmitted to CI users is severely limited by a host of additional physical and physiological factors such as the electrode-nerve interface, nerve survival, and brain plasticity. These limitations result in 6 to 10 functional channels and poor temporal and spectral cues, compared with most normal-hearing listeners, (Kong, Cruz, Jones & Zeng, 2004 and Nascimento & Bevilaqua, 2005).

Objective II: To investigate and compare the MLU in children using cochlear implant with reference to their total auditory experience

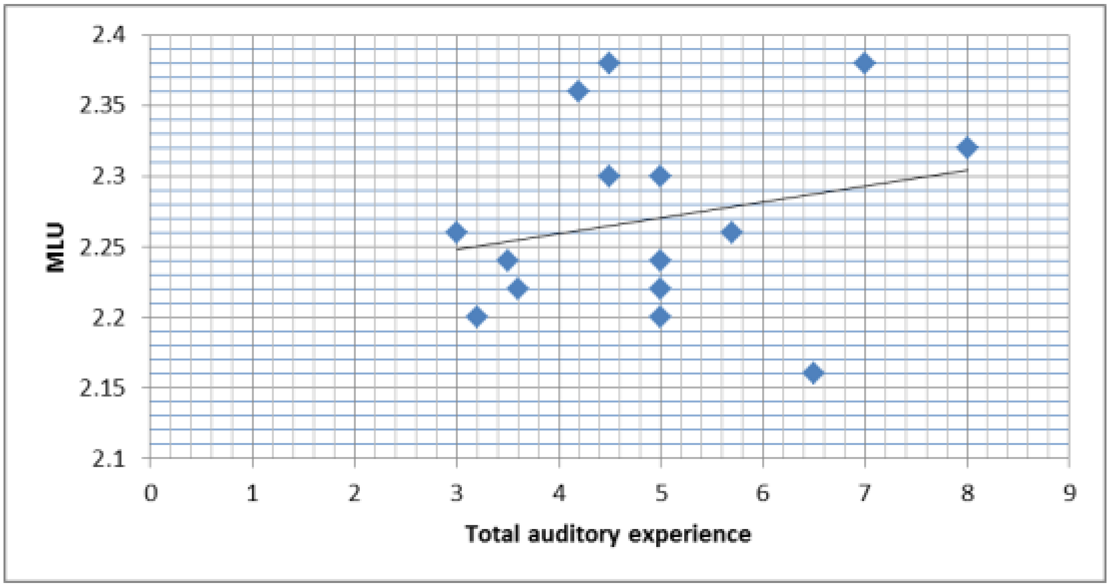

Figure II: **shows the correlation between MLU of children using cochlear implant and total auditory experience**

Pearson product moment correlation was administered to identify the relationship between MLU and total auditory age. The results are shown in Figure II, indicating a positive correlation between MLU and total auditory age. (r=0.233)

The results supports and is correlating with the study done by Derek M. Houston, Jessica Stewart, Aaron Moberly, George Hollich, Richard T. Miyamoto, 2012 that suggests the children who have more auditory stimulation before implantation demonstrated learning in verbal task faster as well as higher measures of vocabulary size compared to children who were having very less or no auditory stimulation. This study also is in analogy with the research done by Gantz et al., 2000; Dolan-Ash, Hodges, Butts & Balkany, 2000; Zwolan, et al., 1997 reporting pre implant auditory experience at critical age is associated with superior speech recognition with a cochlear implant and may provide them with more advantages of early auditory stimulation than children who have no pre implant auditory stimulation with similar age though at same point of implantation.

Objective III: To investigate and compare the MLU in children using cochlear implant with reference to their auditory experience with CI

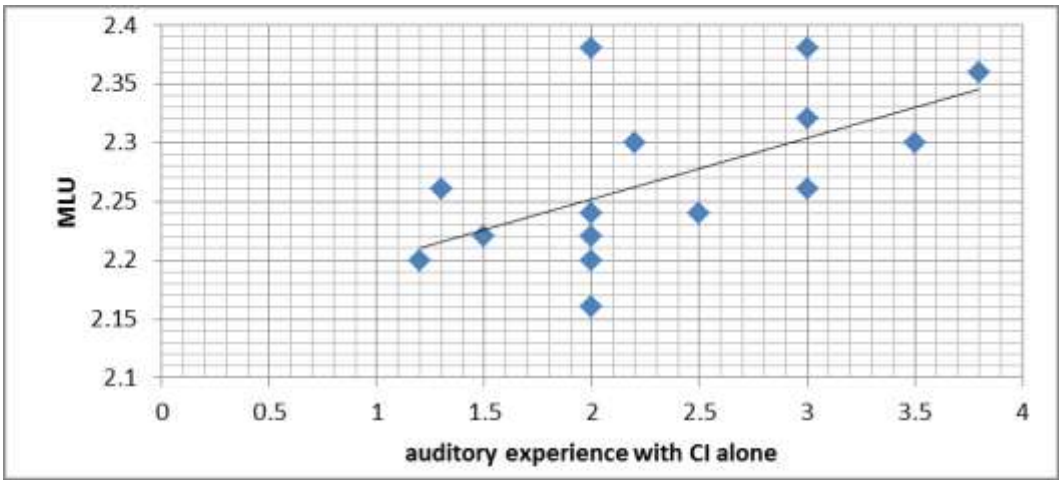

Figure III: **shows the correlation between MLU of children using cochlear implant and auditory experience with CI alone**

Pearson product moment correlation was administered to identify the relationship between MLU and auditory experience with CI alone. The results are shown in Figure III, indicating a positive correlation between MLU and total auditory age. (r=0.589)

The results correlate with the study done by Christine Ouellet & Henri Cohen, 1999 stated that language acquisition is improved after cochlear implantation in children with severe to profound hearing impairment and concludes that cochlear implants enable different degrees of improvement for deaf patients in the areas of speech and language perception, production and comprehension, depending upon the extent of their hearing loss and auditory experiences.

SUMMARY AND CONCLUSION

The MLU constitutes a language measure that has the objective to obtain data regarding syntactic and morphologic aspects of the performances of both children with typical development (TD) and children with communication disorders (Brown, 1973).

The current study was aimed to examine and compare the mean length of utterance in children using cochlear implant and age matched normal hearing peers. The participants included 15 children with cochlear implant (CI) and 15 children with normal hearing and the stimulus included a comprehensive single picture card depicting the typical urban home situation.

Objectives of the Study

1. To investigate and compare the MLU in children using cochlear implant and children with normal hearing

2. To find out the correlation between MLU in children using cochlear implant with reference to their total auditory experience

3. To find out the correlation between MLU in children using cochlear implant with reference to their auditory experience with CI alone.

Hypotheses

- ✓ There would not be any significant difference in the MLU in children using cochlear implant and children with normal hearing
- ✓ There would be no positive correlation between MLU in children using cochlear implant with reference to their total auditory experience
- ✓ There would be no positive correlation between MLU in children using cochlear implant with reference to their auditory experience with CI alone.

Results revealed that:

- ✓ Children with normal hearing obtained higher MLU mean values compared to children using cochlear implant
- ✓ A positive correlation was observed for MLU in children using cochlear implant and their total auditory experience
- ✓ A positive correlation was observed for MLU in children using cochlear implant with reference to their auditory experience with CI alone.

The data reported here provide documentation of MLU levels for children with CI and age matched normal children. The results are intended to be used for clinical purposes, as an estimate of how a particular child's performance compares with age expectations for a group of children who perform in the normal range on external assessments of language and for a group of children who perform in the clinical range on language assessments. The results of the current study suggest that although cochlear implantation improves speech perception in children with hearing loss, the speech rehabilitation by way of intensive speech language therapy is highly vital for language development in these children.

Implications of the Study

- ✓ This study helps in understanding the normal, deviant patterns language production.
- ✓ It demonstrates the syntactic competency of children using cochlear implants
- ✓ It helps in finding out the efficacy of rehabilitation options for hearing impairment in language acquisition
- ✓ It also helps the educationist, speech therapists, auditory verbal therapists, acoustic engineers for revising the intervention strategies for the inclusion of activities related to aural rehabilitation and speech intervention programs for better perception and production of language.

Suggestions for Future Research

- ✓ Future experiments of the study would be desirable with a much larger group of subjects

- ✓ The study could be carried out in CI with reference to age of identification, which would allow researchers to evaluate the effect of auditory and linguistic exposures on the ability to language production.
- ✓ The study could be carried out in prelingually deafened children using different amplification devices with different speech coding strategies having different experience levels and among different age groups.

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