Development and Standardization of an Egyptian Arabic Lip-Reading Test for Children

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Master Degree in Phoniatrics
by

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List of Abbreviations

NH	Normal hearing
HI	Hearing impaired
fMRI	Functional Magnetic Resonance Imaging
PET	Positron Emission Tomography
rCBF	regional Cerebral Blood Flow
PAC	Primary Auditory Cortex
HG	Heschl's Gyrus
EEG	Electro-encephalo-graphic
MEG	Magneto-encephalo-graphic
DB	DeciBel
CI	Cochlear Implantation
IQ	Intelligence Quotient
USA	United States of America
UK	United Kingdom
SPIN	Speech Intelligibility In Noise
EASL	Eyes and Spoken Language
ToCS	Test of Child Speechreading

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Abstract

Background: Lip-reading is considered an important skill which varies considerably among normal hearing and hearing impaired (HI) children. It helps HI children to perceive speech, acquire spoken language and acquire phonological awareness. Speech perception is considered to be a multisensory process that involves attention to auditory signals as well as visual articulatory movements. Integration of auditory and visual signals occurs naturally and automatically in normal individuals across all ages. Many researches suggested that normal hearing children use audition as the primary sensory modality for speech perception, whereas HI children use lip-reading cues as the primary sensory modality for speech perception.

Aim of the Work: The aim of this study is to compare the lip-reading ability between normal and HI children.

participants and methods: This is a comparative descriptive case control study. It was applied on 60 hearing impaired children (cases) and 60 normal hearing children (controls) of the same age and gender. The age range was (3-8 years). The Egyptian Arabic Lip-reading Test was applied to all children.

Results: There was statistically significant difference between the mean scores of normal and HI children as regard the total score of the EALRT.

Conclusion: The results of the study proved that normal children are better lip-readers than HI children of the same age range.

Key words:

Lip-reading, hearing impaired children

Introduction

Lip-reading, also known as speech reading, is a technique of understanding speech by visually interpreting the movements of the lips, face and tongue when normal sound is not available as in noisy environment. Although, it is usually used by hearing impaired persons, most people with normal hearing interpret some speech information from lip-reading (Woodhouse et al., 2009).

According to a study conducted at the University of Manchester, people with hearing problems could understand about 21% of speech, but if they used either a hearing aid or lip-reading, they could understand 64%. If they used both hearing aids and lip-reading, their speech comprehension rises to 90% (Davis, 2000).

Hearing impaired people are often better lip-readers than people with normal hearing (Bernstein et al., 2000). In hearing impaired people who have a cochlear implant, pre-implant lip-reading skill can predict post-implant lip-reading ability (Bergeson et al., 2005).

The importance of lip-reading for audio-visual speech perception has led to considerable research on how this ability varies across individuals and populations. Although differences in methodology make direct comparisons across studies difficult,

there is overwhelming evidence for high levels of variability in lip-reading performance. For example, accuracy has been shown to range from 0% to 94% correct for hearing impaired children , from 0% to 41% in normal-hearing children (Lyxell and Holmberg, 2000), from 0% to 65% correct in normal-hearing adults (Auer and Bernstein, 2007), and from 0% to 85% correct in adults with early-onset hearing impairment (Auer and Bernstein, 2007).

For the Arabic speaking countries specifically the middle east countries, there is no known standardized, valid test that measures the lip-reading skill. However, in the Phoniatrics Unit at the Faculty of Medicine at Ain-Shams University, in Egypt (Cairo), the Ain shams cochlear implantation rehabilitation team proposed an Arabic translation of the Craig lip-reading inventory. This translation has not been standardized up till now as lip-reading assessment depends on subjective assessment more than usage of a test.

Further, from the previous and as proved by Lyxell and Holmberg (2011) lip-reading is more cognitively demanding for HI children to allow them to develop their cognitive abilities to the same extent as normal hearing children (Lyxell and Holmberg, 2011). Thus, there is a need for a valid standardized test measuring the lip-reading abilities for the Egyptian Arabic speaking HI children and this is the aim of this study.

Aim of the Work

This study aims to develop and standardize an Egyptian Arabic lip-reading test for children that can be used to assess the lip-reading abilities of hearing-impaired children.

Lip-reading

Lip-reading or speech reading, is the natural ability of understanding speech by using only visual information accompanying speech attempts, as lip movements and tongue movements. It is mostly used by hearing impaired individuals, but also used by normal hearing individuals when sound is not clear as in noisy environments (Woodhouse et al. 2009). It is also defined as integration of visual information with auditory information for enhanced understanding of speech (Tye-Murray et al., 2010).

Lip-reading is considered an important skill which varies considerably among individuals. For people with normal hearing, lip-reading often provides useful cues in speech perception, but is not generally a crucial source of speech information (Dodd et al., 2013). For those with hearing impairment (HI), lip-reading is the primary source of speech information. The most of studies about lip-reading have been conducted with typically developing children and children with hearing loss. These studies revealed that lip-reading ability starts to develop during infancy (Hillairet et al., 2017) and continues to improve into late childhood (Ross et al., 2011). Thus, it is a skill that is age related, and it improves with age for both words and sentences (Kyle et al., 2013).

Normative data about lip-reading

Although the development of speech perception during infancy and the mechanisms underlying it are now relatively well understood (Kuhl, 2007), the development of speech production is not as well understood (Goldstein and Schwade, 2008). Despite this imbalance, it is clear that the development of speech production depends on infants' surrounding linguistic environment, its structure, and the nature of social interactions (Kuhl, 2007). This is evident in findings showing that 3 to 5 months old infants imitate simple vowels (Jones, 2007), 8 to 10 months old infants' babbling sounds reflect their specific linguistic environment and that 9.5 months old infants learn new vocal forms from their mothers' responses to their babbling sounds (Goldstein and Schwade, 2008).

Studies have provided evidence that infants attend to the source of the speech auditory as well as visually when a speaker talks to them. One of these studies is that by Lewkowicz and Hansen-Tift, (2012) who presented either native or non-native audiovisual speech (a video of a talker) to 4, 6, 8, 10 and 12 months old monolingual infants and observed whether they attended selectively to the talker's eyes or mouth. It was found that the monolingual infants showed developmental changes in their relative direction of selective attention to the eyes and mouth

of a talker. The 4 months old infants attended more to the eyes, 6 months old infants attended equally to the eyes and mouth, 8 and 10 months old infants attended more to the mouth, and 12 months old infants no longer attended more to the mouth when exposed to native audiovisual speech but they continued to do so when exposed to non-native speech (Lewkowicz and Hansen-Tift, 2012).

Another study was provided by Pons et al., (2015) who replicated the initial findings and in addition, showed that bilingual infants have directed more of their attention to a talker's mouth than did monolingual infants. Together, these findings demonstrate that once infants reach the babbling stage around the age of 4 to 6 months old, they become more interested in speech production and begin directing their attention to the audiovisual speech cues located in a talker's mouth (Pons et al., 2015).

This gaze shift is believed to have an important role in the audiovisual foundations of the speech signal or the beginnings of lip-reading. It is also observed across all ages when the auditory signal is obscured or degraded (Lewkowicz and Hansen-Tift, 2012).

Obviously, infants must begin to discover the higher-level multisensory coherence cues quickly if they are to learn about their world. Indeed, by 2 months of age infants already exhibit the ability to perceive the formal character of the audible and visible

features of isolated phonemes even in the absence of synchrony cues (Patterson and Werker, 2003) and by age of 5 months they begin to automatically integrate audible and visible speech syllables (Lewkowicz, 2000). By age of 7 to 8 months they begin to perceive the formal affect and gender (Patterson and Werker, 2002) and by around age of 12 months they begin to perceive the formal character of fluent audiovisual speech (Lewkowicz et al., 2015) and the formal language identity (Lewkowicz and Pons, 2013).

Physiology of lip-reading

Many researches were done to understand the neuro-physiological changes that occur in the brain while lip-reading. Functional Magnetic Resonance imaging (fMRI) and Positron Emission Tomography (PET) scans of the regional cerebral blood flow (rCBF) were used to study the physiological bases for the enhancing effects of lip-reading on auditory speech perception. Furthermore, activation of primary auditory cortex during lip-reading suggests that these visual cues from lip-reading may influence the perception of heard speech before speech sounds are categorized in auditory association cortex into distinct phonemes (Pekkola et al., 2005). The direct activation of the auditory cortex by information from another channel may be a consequence of the early development of a cross modal process especially for infants,

because the heard speech is usually accompanied by the sight of the speaker (Sekiyama et al., 2003).

Lip-reading is a complex cognitive skill with large individual differences in performance. The basis of these individual differences remains poorly understood. Recent advances in fMRI techniques have made it possible to examine the activity of the brain during a range of sensory, cognitive and motor tasks. Neuronal activity is coupled to a vascular response which results in local changes in the proportions of oxy-hemoglobin and de-oxy-hemoglobin. These changes alter the local magnetic fields and can therefore be detected by MRI. FMRI techniques allow brain activation accompanying complex cognitive activities to be studied non-invasively. To study the patterns of cortical activation that occur during the silent lip-reading of connected speech and to investigate whether there are detectable differences in activation between subjects with widely differing lip-reading abilities fMRI studies were done (Ludman et al., 2000).

In a study by Ludman et al. (2000), 26 volunteers with normal hearing were recruited, all of them took part in a preliminary experiment in which individual lip-reading abilities were measured. From the results of preliminary experiment, subjects are divided into 3 groups (good – average – poor) lip-readers, each group containing 3 subjects. FMRI was performed