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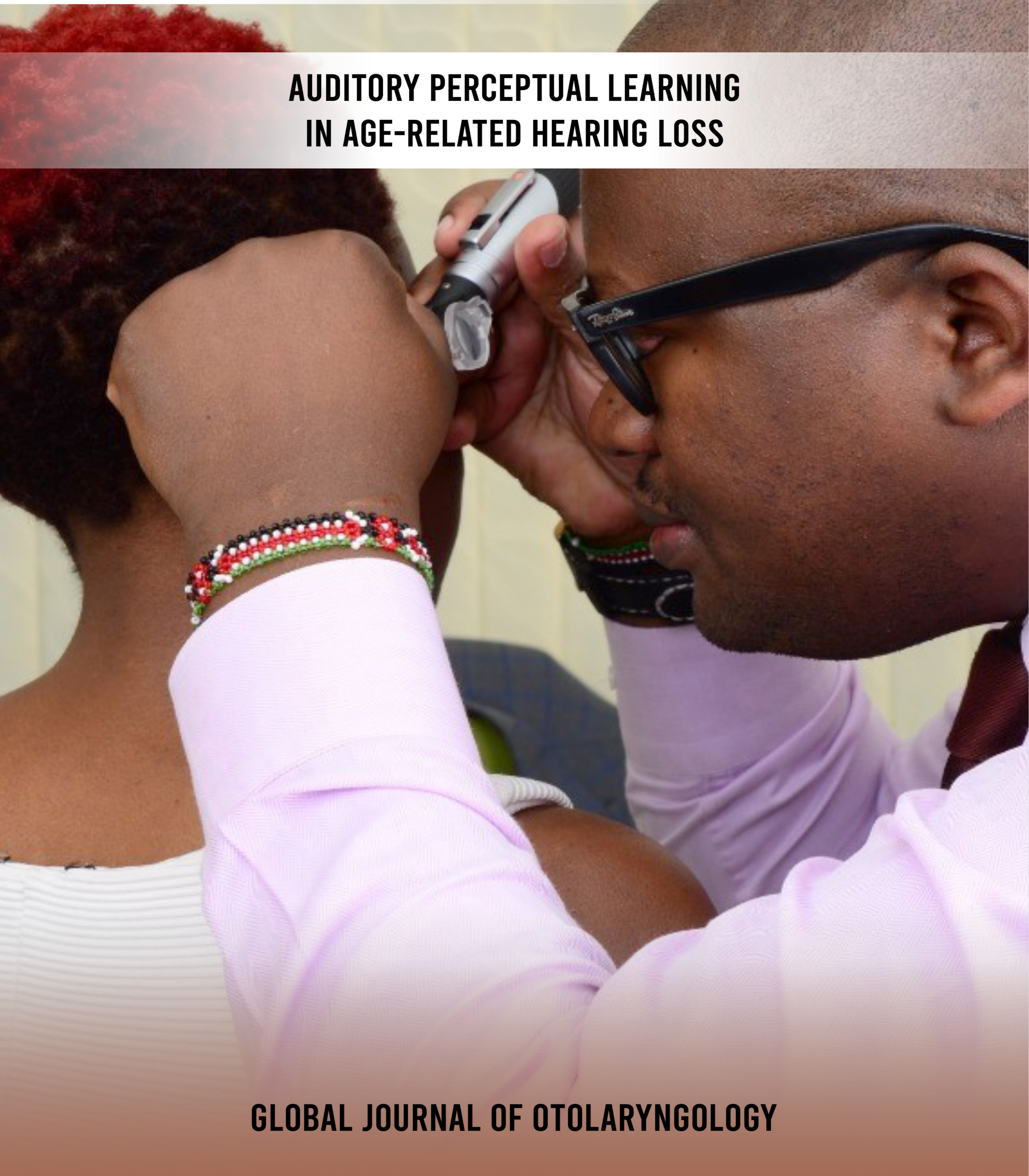
AUDITORY PERCEPTUAL LEARNING IN AGE-RELATED HEARING LOSS



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The variable of age in adults going through auditory perceptual learning is a vital indicator that provides guidance for the recognition of the Age-Related Hearing Loss (ARHL) concept as well as auditory learning separately. This study area has been highlighted by various previous studies in both content and quantitative analysis areas of study. The author reviewed these studies both in inferential and theory findings to help in making inferences in the final chapter. A review of the Literature has been conducted with the aim of maintaining focus on the questions of the study. This has however created limitations with regard to literature borrowing scopes leaving only those studies contributing to the auditory perceptual learning concepts understanding for making conclusions that further solutions which are credible in auditory perceptual learning. Borg [19] and Gil & Iorio have conducted studies related closely to this concept. However, their studies are inconclusive as they fail to establish how different factors such as age, audio logical and biological correctional interventions influence the learning outcomes. Abilities of detecting and discriminating sounds get better with practice Demany & Semal.

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CONTENT

Abstract

The variable of age in adults going through auditory perceptual learning is a vital indicator that provides guidance for the recognition of the Age-Related Hearing Loss (ARHL) concept as well as auditory learning separately. This study area has been highlighted by various previous studies in both content and quantitative analysis areas of study. The author reviewed these studies both in inferential and theory findings to help in making inferences in the final chapter. A review of the Literature has been conducted with the aim of maintaining focus on the questions of the study. This has however created limitations with regard to literature borrowing scopes leaving only those studies contributing to the auditory perceptual learning concepts understanding for making conclusions that further solutions which are credible in auditory perceptual learning. Borg [19] and Gil &Ioriohave conducted studies related closely to this concept. However, their studies are inconclusive as they fail to establish how different factors such as age, audio logical and biological correctional interventions influence the learning outcomes. Abilities of detecting and discriminating sounds get better with practice Demany&Semal.

When determinations are made to how auditory learning is generalized to tasks and stimuli not covered in training, they can provide guidance to developing programs of training utilized in improving abilities of hearing in specific populations and can also bring insight into auditory performance neural mechanisms. This study reviews new and emerging literature on auditory learning generalization with special focus on investigations that are behavioral with regard to auditory tasks that are basic. Through the review, various patterns of generalization are realized across tasks that are trained which cannot be given a simple rule summary as well as the diverse definition views as well as interpretations and evaluations on generalization. It has aided in the formulation of recommendations based onthe subject matter. For the purpose of achieving objectives of the study, the work borrows from different references with citations that are clear given herein.

Abbreviations: ARHL: Age Related Hearing Loss; UHC: Universal Health Care; ELU: EaseofLanguageUnderstandingModel; NH: Normal-Hearing; RMS: Root Mean Squares

Acknowledgement

I want to thank the Ministry of Health HMIS team, Kenyatta National Hospital registry and University of Nairobi committee for allowing me to carry out this study. I express my gratitude to my supervisor Dr. Nerea Ortega Castro for her patience, invaluable input and counsel. I would like to appreciate my statistician Peter Nelson Kamau for his expert guidance. Finally, I am especially grateful to my wife Mrs. Hellen and my children Kyla, Neylan and Allison for being by my side during the study period.

Auditory Perceptual Learning in Age-Related Hearing Loss

CHAPTER 1

INTRODUCTION

Introduction

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Introduction

The study's background is included in this chapter as well as the objective of the study, hypothesis, questions of research, and why auditory perception learning is necessary for ARHL patients or victims in the justification. ARHL refers to is the gradual hearing loss on one or both ears as an individual age. It the most common age related condition globally, affecting one in three elderly individuals. It is mainly caused by changes in the inner ear as an individual ages and medical conditions such as infection of the nerve pathways from the ear to the brain. The condition exposes the elderly to low quality lifestyles as they are unable to respond to basic things such as doctor's advice, danger warnings, cell phones, doorbells, as well as enjoy talking with family and friends. This renders them to a life of isolation. It is therefore necessary to study and address this problem. The problem statement involves auditory perceptual learning in mature who do or do not have age related hearing impairment. Nearing the conclusion, the researcher attempts to provide clearance on the research papers direction based on how they have understood the topic of research, the questions as well as the objectives. The paper is a content analysis that is qualitative. The paper borrows extensively from the Sub Saharan Africa context with Kenya as a case study and example of the developing world where components of Universal Health Care (UHC) such as quality, access and affordability are being strained due to resources that are limited. In effect, the study contributes to the shaping of literature for guidelines of the ministry of health with regard to auditory perceptual learning and ARHL in the developing world and SSA due to the uniform challenges that they undergo.

Problem Statement

Auditory Perceptual Learning: Learning refers to knowledge acquisition through visual or auditory means from another party which can either be an individual or an object. Auditory learning involves learning styles where people get to learn through listening. Auditory learners have to rely on speech and hearing as the main method of learning. Learners who are auditory make sense of what they are being told by hearing it first as it might be challenging to trying to understand instructions compared to writing which relies on logic and can be understood easily. The skills of repeating and listening they have been utilized in sorting of information. The VARK/VAK model by Fleming is widely utilized in identifying a variety of learning styles where they are ordered as writing/reading preference learners, visual learners, auditory learners, as well as kinesthetic learners who are also referred to as tactile learners Yueh [1]. Elusive contents of proponents and contenders have also been incorporated into this research topic. Recommendations from proponents encourage the utilization of various techniques in instructing auditory learners and this can include: Verbal direction, reading aloud, verbal reinforcement, as well as group discussions and activities. Putting of information in rhythmic patterns can also be utilized and this can include poems, rap and songs.

A Conceptual Flow of the Statement Problem: Contenders of the many different propositions share opinions that are contrary mainly because of the complexities, costs, timespan as well as general sustainability of such interventions of teaching. This papers' author understands such statements as critical and postulates them to be analyzed in content rather than quantitative form. Learners who are auditory have capabilities of understanding what spoken words mean when they listen to the audible tones like tone changes. For example, when learners who are auditory wish to memorize phone numbers, they say it out loudly and remember how it sounded like to memorize it. The performance of leaners that are auditory is excellent in response to audio lessons. Their performance is also good in oral exams as they listen to information delivered orally by use of lectures, speeches or oral sessions. Suggestions from proponents argue that for verbal or auditory learners to grasp something as they are reading there has to be some background sound. In such situations, having different background sounds like people talking, television or music can be helpful in enabling learners to work better. Learners who are auditory are also good storytellers (Figure 1).

Figure 1: A conceptual flow of the statement Problem.

They are able to solve problems by talking through them. Patterns of speech can incorporate voice or sound oriented information like 'when you click, I hear you' or 'its ringing a bell'. For them to be able to accomplish what they are doing, learners who are auditory can either move their lips or talk to themselves. Although styles of learning have great popularity, and individuals from different age groups express different preferences, identifying them does not automatically lead to better outcomes. Evidence has shown that the hypothesis of meshing where students are supposed to learn best when instruction is given through their learning styles is widely invalid. Studies that have been well designed have contradicted the hypothesis and claimed students benefit more from presentations that utilize mixed modalities. An example is utilizing auditory and visual techniques for all students despite their preferred style of learning which contrasts with putting focus on their right learning style.

Learning Styles Meshing Vicious Cycle: A vicious cycle is depicted by the chart on the left which focuses on students learning styles who may or may not have ARHL. For effective and complete auditory learning teaching, there is no one size fits all and that is basically the reason meshed approaches are overcome by presentations that utilize mixed modalities which expose learners to increased environment dynamics of learning (Figure 2).

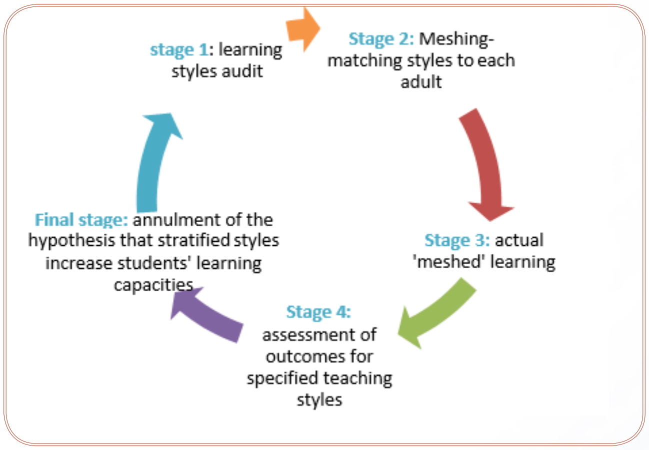

Figure 2: Learning Styles meshing vicious cycle.

Perception Problems and Age-Related Auditory Loss: Recognition has to be given to the fact that speech communication and recognition for ARHL becomes increasingly difficult in environments that are noisy as the individual's increase in age. Older adults, to be more specific encounter difficulties as they attempt to listen to speech in the presence of background noises, speech signals that are competing and rapidly made speeches Pichora-Fuller et al., Such speeches are common in everyday life and therefore adults who are older face difficulties trying to understand speech. The situation gets even worse with hearing losses that are caused by increased age (ARHL; Fitzgibbons & Gordon-Salan and that increasingly affect the elderly as a rampant chronic health condition Yueh [1]. Estimates have been made that populations of people aged 60 years and above are expected to increase by 25% Roth et al.

Individuals suffering from hearing problems that are sensorineural are capable of recuperating some hearing capacities that have been lost through the use of hearing aids Gil & Iorio. However, it has many times been found to be less sufficient for perception of speech especially in conditions that are non-optimal. This leads to the supplementation of such endeavors with rehabilitation processes that can include education that is patient centered, auditory training, and counselling with the hypothesis being that it aids in restoring auditory signals and communication enhancement. Concerning this context, various researchers have claimed that auditory training can be of benefit to individuals with ARHL. Research that involves older adults shows that even those participants that have speech perceptions that are normal as well as tone thresholds that are pure point out that it has become even more effortful to listen in everyday life Schneider [2]. This study therefore focuses on if the approach of auditory perceptual training that replicates real world issues of listening is capable of aiding in the improvement of speech perception in those with hearing impairments such as older adults as well as those with normal hearing and if learning patterns and generalizations are affected by impairments in hearing. The stratification of the investigation is through different research questions that arise from such issues.

Speech Processing Issues between Younger and Older Adults: Apart from speech and perception identification, processing of speech involves integrating the words that are heard successively, the sentences as well as the phrases for the achievement of accurate and coherent representation of the communicated messages meaning. The procedure involves processing of acoustic structures as well as discourse importance by the distinct and intuitive neural systems. The result which involves sounds being mapped for significance is dependent on the yield of coordination between the phonetic and acoustic examinations which are stored in the lexical portrayals Davis et al., In such a way the specific handling of discourse needs the use of feelings and voice signs as well as term signals and silent gaps in the perception of phonemes, as well as use envelope patterns that are temporal and identified through discourse rates and spectral data, as well as accessing and recovering sematic data Price, Pichora-Fuller & Macdonald [3]. Additionally, procedures that are subjective such as working memory, consideration to specifics and speeds at which preparation of data is done have influences on the understanding of speech Pichora-Fuller & Singh. The use of semantic and information setting like semantic and ephonological learning of words, phonemes as well as sentences can be utilized in improving perception and review in the young as well as old Stine- Morrow & Wingfield [4].

Lending from various accounts and contributions of perceptual and lower level sensory portrayals or procedures and huge intellectual processes for example, semantic procedures and working memory, to the acknowledgement of speech may be varying among horrible as well as ideal listening Rönnberg et al., According to the Ease of Language Understanding Model (ELU), approaches to speech are first handled in a natural way then a portrayal that is phonological of the flag is made. Acknowledgement of words, also known as lexical access, needs to happen if the portrayal that is made naturally is in coordination with the portrayal in the long term memory. Procedures at the lower level need to be imperiled at a degree that is more noteworthy in adults who are older in the ARHL group compared to older people who have ordinary or normal hearing. Older adults who have presbycusis for example, need a more ideal signal to noise ratio (SNR) for them to have capacities of anticipating last words of sentences compared to older adults that have normal hearing despite the fact that the context impact greatness is comparable between the two Pichora-Fuller et al.

In such cases, it is recommended that the hearing disability does not meddle with the capacities of drawing procedures that are top-down that aid in hearing but rather research shows that the auditory processing that is supra edge is decreased gradually over decades and there is a rearrangement of the cerebrum. This results in more frontal mind zones such as those enabling working memory and semantic handling to be initiated to more prominent degrees and this is in contrast compared to brains that are more youthful or where the execution between the young and the old is matched evenly Wingfield et al. In spite of the compensation to brain areas that are more elevated, adults who are older go through difficulties that are disproportionate when attempting to understand speech in conditions that are ecological which may include fast talkers and noise conditions that are sub-optimal. Therefore, auditory training that is fruitful in such populations needs to enable effective balances between signals based, bottom up, knowledge- based and top-down processes Pichora-Fuller [5].

Auditory Training

Auditory training with the aim of rehabilitating hearing capacities focuses on listening actively to auditory stimuli with the target being the enhancement of the participants capabilities of working well with listening environments that are non-optimal Boothroyd; Henderson [6]. Auditory training programs that are based at home were designed for the purpose of enabling adults that have hearing losses to participate in perceptual learning that can lead to communication that is enhanced as well as better recognition of speech Sweetow [7]. Auditory skill training effects are usually focused on the stimuli that are being trained Wright [8]. In addition, outcomes of training involve projecting plasticity of trained tasks which is made possible by task specific cognitive motivation and mechanisms Amitay [9]. Documents on training effects to skills of listening which are found in contexts of hearing rehabilitation quantify that on-task learning is defined as improving on trained tasks while generalization is defined as improving on tasks that are not directly trained. On-task learning with a basis on ARHL elderlies is usually fast generalization is usually based on tasks that are untrained or stimuli that was not directly experienced in the period of training and this does not happen frequently.

Significant effects of learning on-task have been found previously and they involve words and syllables in adults who are older who have defects in hearing Burk [10]; Stecker; Ferguson [11]. The research studies focused on world-based auditory training effects on the abilities to recognize words while background noise is present as well as with words and talkers that were varied. Training of perception distinction in such manners have assumed that if lower level sensory issues are resolved through training, then listening and communication should advance in a manner that is bottom-up. In the research process, trained tasks advancements are retained over time while generalization to words that were untrained did not happen Burk [10].

Objectives of the Study

The current study's aims included:

i. Examining the literature and determining extents of auditory losses that are related to age in SSA households and in particular Kenya.

ii. Assessing and reporting on intervention of auditory learning performed by stakeholders.

iii. Examining efficacies of auditory training schemes that are home-based as well as their improvement of abilities of speech perception in adults who are older that have normal hearing as well as impairments in hearing.

iv. Comparing learning patterns that are training induced to those of ARHL adults and normal hearing.

v. Assessing trained tasks learning as well as the transferring to other tasks that are untrained which can include non-speech and speech in the study of generalization.

Research Questions

The questions of research that were investigated included:

a) What is ARHL's reach within SSA and particularly Kenya?

b) What interventions for auditory perceptual learning have been developed and are in effect for rehabilitating and purposes of correction?

c) What are the performance responses to training tasks and protocols?

d) What responses are there on the ground with regard to auditory, speech, trained tasks and learned assessments?

e) What are the subjective outcomes and general compliance rates of ARHL interventions?

Justification of the Study

In listening conditions that are adverse, recognition of speech increases in difficulty as individual's age especially for those that have hearing losses that are age related (ARHL). Different arguments are made as to whether training can be beneficial in these difficulties as there is still no clear answer as to whether the results can be adequately utilized in the general population outside contexts of training. The recent study has the goal of assessing auditory generalization that is induced by training as well as the learning in older adults that have ARHL and those with normal hearing. The normal ones in this context act as baseline to benchmark outcomes for those undergoing auditory learning. Literature from content analysis as well as previous studies and publications on statistics is utilized. However, the study remains qualitative to a large extent while seeking to establish answers for question of research that have been posited in the paper. Of great importance is the establishment of guidelines for ARHL auditory perceptual learning since there is no preclusion of auditory perceptual learning in ARHL but the generalization is little to conditions that are untrained. The suggestion of the author is that many changes related to training need to be effected in higher levels of cognitive processes that are task specific in people with ARHL. Such will be required to justify the study as previous outcomes of studies have depicted.

Adults that have difficulties hearing need cognitive processing to be able to follow conversations in environments that are noisy, and this requires effort. Studies have shown that in listeners with normal hearing, there is a dilation response in the pupils, and this is regarded a measure of cognitive processing and can be affected by processes that are attention related. Interventions are therefore required, and they can only be made possible through written documents that try to establish ministry of health guidelines and they can also be sources of literature on ARHL auditory learning. Styles of learning categorize the various means through which people learn. Some people can have combined learning styles while others have one learning style that is dominant but are capable of using other styles. Others may realize that they can utilize styles that are dissimilar in settings that are different which means that no right mix exists.

Auditory Perceptual Learning in Age-Related Hearing Loss

CHAPTER 2

LITERATURE REVIEW

Literature Review

CHAPTER 2

In this chapter, literature that is both in empirical and theoretical format is mined and a literature review is given in the end. It discusses the literature concept whose classification can fall into category or definition and can be theoretical or empirical and a literature review is also given. Academic and theoretical subject matter from previously done studies are reviewed in this chapter as well as conceptualizations around the study's topic. Experimental and empirical literature from studies done previously is also reviewed. Study of empirical literature enhances scholarship particularly in the auditory perception learning area as well as ARHL with the contravening factor being age. Studies and research based on a framework in these areas is steadily growing. The framework is also utilized in other revised and expanded literature versions in other fields which attract academic and professional works similar to this investigative academic thesis and this can include comparative pedagogy and cultural studies on auditory perceptual learning as well as related variables.

The topic of this study calls for the utilization of the cognitive or radical constructivism theory and based on the topic of this thesis, the empirical world of the subject is largely construed on ARHL tenets as well as auditory perceptual hearing. Logical consequences of such separations in literature are evidenced in the works of Siegfried J. Schmidt, where scientific literature study and interpretation is based on radical constructivism. The literary actions system is observed from the exterior and is not experienced and its character is dependent on the continually tested hypothesis. Such conventions surrounding the ARHL research topic are the aesthetic conventions as well as the polyvalence convention which are different from the fact's convention in daily reference language. Therefore, the study's object in empirical literature with regard to auditory perception and ARHL is not just the text itself but also the action roles in the literary system. It makes contributions that are irreplaceable in developing of literature studies that are more scientific, rational and socially relevant.

Review of Theoretical Literature

This section involves reviews or summaries of literature seeking to inform the milestones of the study in its effort in remaining informed and authentic to enable extended analysis as well as recommendations and conclusions that are based on facts. It is essential to contextualize and elaborate the theoretical literature concept to ARHL and perceptions of auditory learning. Theoretical definitions are referred to in language as abstract concepts that give definitions of concepts in academic disciplines. Interesting science phenomena involve how discoveries of new techniques, findings, and theoretical understandings can produce deep research area interests. A similar scenario is seen in the perceptual learning case Gibson. Recognition of speech in listening conditions that are adversarial increases in complexity and difficulty as one gets older especially for people who suffer from hearing loss that is age related (ARHL). Different arguments are made as to the possibilities of easing these difficulties through training and it remains unclear if the results can be sufficiently generalized outside the context of learning.

The contemporary study's goals were paralleling learning that is training induced as well as generalization among older adults with ARHL and those with normal hearing. Karmarkar and Buono-mano have energized the resurgence in this issue through work that is exciting on auditory perceptual learning. Two different explanations have been given to the revived interest in this field. An initial reason involves the discoveries in neuroscience concerning the mature brains plasticity Calford. This was due to findings in the peripheral somatosensory system lesions that caused the remapping of the digit or lesioned limb in the cortex. This field has evolved in various directions to include studies of how specific, intensive training can result in cortex remapping. A second reason involves interests that emanate from trying to understand difficulties in learning particularly in children. It is from this background that data is presented by Karmarkar about learning of auditory interval discrimination tasks. It is shown in the study that as they are trained, adult listeners make decisions as to whether the divisions of test pairs of tones involved longer, or shorter intervals compared to the target pairs presented at the trial blocks onset.

Diversities that were observed between the listeners involved target intervals as well as tone frequencies. Batteries of similar stimuli were utilized in testing all listeners at both untrained and trained frequencies as well as target durations of before and after 10 training days. Additionally, in listeners who displayed signs that they had learned, results showed training generalization across tone frequencies but the same was not observed across target intervals. Training generalization to discrimination tasks whose duration was based on tone was also seen. This led to the realization that temporal information training occurs in the centralized brain circuits. Across different frequency channels is where the circuits are mainly found. The cited work aimed at ensuring that performances that were enhanced had emanated from timing that was improved and not abilities that were enhanced in storing and comparing standard as well as comparison stimulus. To enable achievement of this, researchers allowed participants to listen to the standard various times at the block's commencement only and in every trial, the comparison stimulus only was presented to the participants. Since it seemed unlikely that the presentations which were relatively few were enough for developing the standards concept, the researchers interpreted the performance that had improved to mean that a time frames dynamic representation had been made by the participants, and they therefore altered the timing basing on the reactions from their decisions.

The results can however also be interpreted to mean that their abilities of storing as well as comparing stimuli had become enhanced from trial to trial. An additional aspect that is intriguing about this work involves generalization that is cross-modal where consideration is not given to learning time itself but to learning principles. Perceptual learning research is filled with studies on vision while learning theories are also largely based on visual data. This work as well as other current auditory learning studies however aims to offer data that qualitatively differs from visual learning. Even though auditory processing difficulties have been noted as the main sensory deficiencies in LLI Ramus et al. possibilities of remedies emanating from auditory training seem potentially more promising than those emanating from visual training. Studies and research on auditory perceptual learning in both hearing and vision commonly utilize a lot of effort in attempting to differentiate between perceptual and procedural learning. Learning that is procedural is usually defined vaguely but this paper author takes it to mean understanding fully what the tasks rules are. This is without a doubt the case at the start of learning where nearly all participants experience difficulties performing or recalling tasks and they end up making mistakes that are unrelated to the perceptual difficulties of the task.

Neural Changes, Behavioral Alterations and Auditory Learning: Perceptual learning can be referred to as performance gains in perceptual tasks due to the changes that are experience dependent in neuron properties as well as in the cerebral cortex functional organization. Performance improvements have been witnessed at the period of training after various trials were presented Poggio [12], as well as several hours later Karni et al. or after a couple of days. Such time course variances over which perceptual learning occurs can be interpreted as the evolvement of neural changes over varying temporal windows. It can therefore be said that perceptual sensitivity enhancements in given sessions of training emanate from neutral changes that are fast and which are also mirrored by the cortical neuron's rapid receptive fields' modulation Kapadia et al., Gilbert et al., Neural changes that are sluggish however grow without stimulation in between training sessions. Such changes are a product of cortical representation reorganizations. In line with these hypotheses, slow behavioral improvements have been found in physiological studies that are in correlation with neuronal changes in the auditory, somatosensory and visual cortex of monkeys. Improvements in the attentive and pre-attentive discrimination of two auditory patterns that were complex were found in the current study and were determined in the sessions of training in every 12 hours as well as after a 48 hour period from the start of the training. Explanations to slow and fast behavioral improvement changes are thought to be explained by various neural mechanisms.

In line with such a hypothesis, electrophysiological variations that are diverse and in different time frames have increased possibility of being found in parallel with the discrimination tasks behavioral advancement. Findings have shown that with practice, there is development on performance in auditory perceptual abilities. The current evaluations resolve aims at making observations at how far such learning can simplify performance on tasks and stimuli that were not covered in training. Making determinations on patterns created through generalization is vital for both practical and theoretical reasons. In practice, such knowledge provides guidance on how to develop regimens for training to enable achievement of desired outcomes efficiently while for theoretical purposes it can be utilized in gaining knowledge of neural processes that training affects. Conceptually, various studies that are investigative are ongoing currently for the testing of the effectiveness and adeptness of options for auditory learning in adults affected or not affected by ADHL. Various investigations have been beneficial in explaining the impact of training on learners through their communication and neural abilities. Similar to visual system investigations as well as learning scrutiny, generalization in auditory systems still remains in its early stages. Training has been simply utilized as a means of attaining asymptotic routine in psychoacoustic testing done in old styles.

The generalization as well as the learning that was a result of the training was rarely tested but more recently the interests in auditory training influence have increased. However, even though there have been various human auditory learning evaluations Watson et al., there has been any that has reviewed the generality of such learning. Overviews of learning investigations are embraced in this literature with regard to frequency discrimination, temporal judgment, spatial hearing, signal detection and tasks on intensity discrimination. Many of such surveys utilized training in multiple sessions. Considerations have been given by the author to untrained stimuli learning (stimulus generalization), to untrained stimuli dimension judgments (task generalization), as well as to procedures of untrained testing. Also included by the author is learning simplification with regard to modalities of the sensory, auditory and motor systems. The review of theoretical literature content has enabled discovery of generalization evidence in various paradigms. Training was done on one state for every trained listener group, tailed and heralded by various settings tests and overviews were shown by untaught situations progresses between post and pre-training tests Wright [8].

Similar to (i), but with control groups that join the post and pre-training tests except in the phase of overriding training; simplification was seen more in trained listeners learning than in untrained settings controls Mossbridge. Similar to (i), but without tests at pre-training; simplification was seen in performance at post-training in situations involving training and no training with the assumption that performance at pre-training under all conditions would be the same Amitay. Two training periods that were progressive with each one having conditions that were different; progression of simplification from the first trained condition to the second was evident through learning that was reduced on the second condition compared to the first Demany.

Speech Processing in Younger and Older Adults: Processing of speech incorporates not just the identification and discernment of single words and sounds of speech but also reconciling expressions, words, and sentences that are heard progressively for the accomplishment of the exact and intelligent representation of the conveyed message. In such processes, neural networks that are unmistakable and intelligent process both significance and acoustic structure of speech. In addition, procedures that are intellectual such as particular consideration, working memory or data handling speeds can have an effect on the understanding of speech Pichora-Fuller. Significant effects of learning on-task have been found previously and they involve words and syllables in adults who are older who have defects in hearing Burk [10], Stecker, Ferguson

[11]. The research studies focused on world-based auditory training effects on the abilities to recognize words while background noise is present as well as with words and talkers that were varied. Training of perception distinction in such manners have assumed that if lower level sensory issues are resolved through training, then listening and communication should advance in a manner that is bottom-up. In the research process, trained tasks advancements are retained over time while generalization to words that were untrained did not happen Burk [10].

Empirical Literature Review

Theories of definition are aimed at giving explanations, understanding and predicting phenomena and they usually challenge and add to existing knowledge that is bound by critical assumption limits. Theoretical frameworks are structures that can support or hold a research study's theory. Review of theoretical literature focuses on theories and not how it will be applied. Review of empirical literature is involved with the original research like scientific surveys, experiments or studies in research. Such research is usually based on observation and experience and not systematic logic. Research that is non-empirical is conducted without data that is quantitative where numerical data is analyzed or data that is qualitative where data that is non-numerical is utilized such as observations and interviews for basing claims on.

Auditory and Vestibular Systems: Deficits in perceptual learning that originate from induced or biologic causes have been studied and their existence confirmed in medical literature examined earlier in the chapter. This section involves the author reporting on alterations that are associated to training in neural activities and which can precede learning that is behavioral. Auditory training efficacies are often hard to measure through behavioral methods since such groups are weakened communicatively and there may be cognitive or attention deficits. Based on findings, if variation in the neurophysiological are evident at auditory training, then the techniques of training are effectively altering the sound or speech neural representation and what will likely follow is behavior changes Lippincott. Hanin K in their study sampled 56 listeners aged between 60 and 72 years of age where 35 of these had ARHL while 21 had hearing capacities that were normal. The classification of the study was in three groups which were not training, delayed training and immediate training clusters. In a period of four weeks participants that were trained were engaged in thirteen different training sessions that were home-based. Various listening conditions were the focus of the exercise and they involved:

i. In noise speeches.

ii. Speech that was time compressed.

iii. Speakers that were competing as well as training outcomes that were compared between ARHL and normal groups.

Everyone taking part in the study finished the post and pre-test sessions. The study's results had a basis on all untrained and trained conditions which had designs of facilitating assessments of non- speech and speech conditions. There was a display of great improvements in the outcomes across all conditions of training among adults without the ARHL affliction in the period of training. Those who had hearing capacities that were normal had greater understanding compared to the ones with ARHL in conditions involving in-noise-speeches, but the same patterns of learning were also observed when the conditions were different. Advancements in post and pretests were evident increasingly in the trained conditions compared to the untrained ones. In addition, the group of ARHL trained listeners had their abilities of discriminating pseudo words that were deferent in noise also improve. With regard to the group with ARHL, no generalization could be obtained related to the untrained conditions. Claims predicted in the study involved trained related generalizations taking place at cognitive processes that were higher for both clusters. These were however heightened by perceptual representations that were of a higher class in the group that had normal hearing.

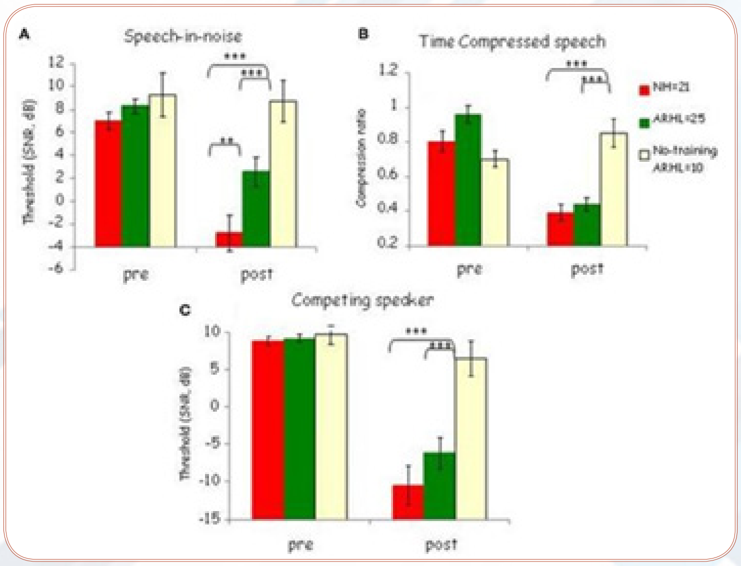

Figure 3: Outcome effects of pre to post learning; performance after pretests and posttests in normal hearing that is trained as well as trained ARHL and ARHL groups that are not trained for the various conditions: (A) speech in noise (B) speech that is time compressed and (C) speech in speakers that are competing.

Abilities of recognizing communication and speech in environments that were noisy became more challenging as the age increased. People who are older found it more challenging to make sense of speech with the presence of noise in the background as well as the presence of competing and rapid speeches Pichora-Fuller. As a result, people who are older have challenges in perceptions of speech in their everyday lives with such difficulties being worsened by the presence of hearing losses that are related to age (ARHL; Fitzgibbons and this is a health condition that is chronic among the elderly Yueh [1]. As the population gets older, its incidence is also expected to increase with 25% of those aged 60 years and older expected to get affected Roth. Apart from ARHL being the most prevalent cause of speech perception difficulties, research also shows that functions that are cognitive such as attention and memory can also cause such challenges Pichora Fuller [3] (Figure 3).

CHAPTER 2

The figure above shows outcome effects of pre to post learning; performance after pretests and posttests in normal hearing that is trained as well as trained ARHL and ARHL groups that are not trained for the various conditions: (A) speech in noise (B) speech that is time compressed and (C) speech in speakers that are competing. For the sampled patients, ratio thresholds of mean to noise as well as standard deviations are shown for conditions of competing speakers and speech in noise as well as ratio thresholds of mean compression and standard deviations for the condition of speech that was time compressed ***p<0.001, p**<0.01. Documents on training effects to skills of listening which are found in contexts of hearing rehabilitation quantify that on-task learning is defined as improving on trained tasks while generalization is defined as improving on tasks that are not directly trained. On-task learning with a basis on ARHL elderlies is usually fast generalization is usually based on tasks that are untrained or stimuli that was not directly experienced in the period of training and this does not happen frequently.

Significant effects of learning on-task have been found previously and they involve words and syllables in adults who are older who have defects in hearing Burk [10], Stecker, Ferguson [11]. The research studies focused on world-based auditory training effects on the abilities to recognize words while background noise is present as well as with words and talkers that were varied. Various investigations have also pointed out that training of ecological tasks that include whole sentences that underline procedures that are top-down such as creation of desires that are semantic, working memory requirements as well as particular consideration can enable generalization that is extensive compared to training stressing on specific auditory limits Sweetow [13]. These comprise of modules aimed at building of exactness and speed of auditory processing as well as correspondence and listening improvements Sweetow [13] that provide assortments of versatile and intelligent tasks in different categories like cognitive skills, degraded speech and methodologies of correspondence. Programs also involve listeners training on recognition of speech in various conditions like speakers that are contending, speech that is time packed and in noise speeches which imitate real world listening difficulties.

Past studies have conducted evaluations on home based ecological training effects with participants that have ARHL Sweetow [13] as well as hearing that is normal Anderson [14]. Findings showed that training altered neural processing of speech and improved perceptual as well as psychological abilities. Examinations done by Anderson [15], showed that participants enhanced both perceptual evaluation and physiological abilities after 40 automated speech training home based sessions. An alternate study by Anderson [14] compared ARHL group learning with learning in adults with normal and found that increased training resulted in in noise speech recognition changes particularly for those in the hearing debilitation group while there were no comparable changes in the group with normal hearing. Sweetow [13] examined older, hearing aid using adults on untrained and trained measures of in-noise speech. Learning effects on tasks that were displayed were noteworthy, but the generalization effects were little. In addition, Hanin K examination involved investigations on adults with moderate to mild sensorineural hearing loss who experienced difficulties in hearing but had not searched for medication as well as those who had hearing abilities that were normal. The study was primary in leading to research on home-based training in situations of everyday listening and it was also the first with regard to speakers of local dialects. It additionally investigated whether complex sounds training compounded acoustic tasks that were straightforward through the testing of participants on auditory discrimination tasks that were non- verbal. Objectives in the study included:

a) Examining efficacies of auditory training that was home-based for the improvement of abilities of speech perception in older adults with hearing that was normal as well as those whose hearing was impaired and non-aided.

b) Paralleling training induced learning forms among adults with ARHL and those with hearing that was normal and

c) Measuring of learning on tasks that were trained as well as their transference to other non- speech and speech untrained tasks.

Investigations Employing Multiple-Session Training

A. Frequency Discrimination: Learning generalization has received verification extensively in decisions involving spectral attributes of sound and this includes frequency discrimination that is pure tone as well as fundamental.

i. Pure-tone Frequency Discrimination: In discrimination of frequency that involved pure tones, examination of simplification was done across ear, task, stimulus attributes and styles of presentation. Experiments shown below involved evaluation of listeners' capacities in distinguishing differences that were small in the pure tone frequencies. Unless noted otherwise, training involved 750–1200 trials every day for four to twelve days with 100–300MS standard tones. Various methods were utilized in evaluating generalization.

Generalization Across Frequency: It has been found that frequency discrimination learning takes various views to frequencies that are untrained but that there is rarely any comprehensiveness in the generalization. In various tests conducted, it was found that listeners that had been trained on particular frequencies also had enhancements in the frequencies that were untrained. Improvements that were small were also seen in the frequencies that were untrained than the trained ones in other examinations, but the authors associated this variation to the trained frequencies being tested first continuously Roth et al.

In another study, listeners trained at 250, 88 or 1605 Hz presented progress that was related in all three frequencies Grimault. It is however uncertain whether improvements in every frequency was due to training at the particular frequency or due to other frequency generalizations since the data from the three trained groups was in combination during investigations. The researchers themselves point out that the improvements that were related across the frequencies were due to exposures to each of the frequencies at the tests of pre-training and not due to simplification over the frequencies at the time of training and this is because trained condition performances improved swiftly improved during the first sessions of training (3150 trials), and not at later times.

CHAPTER 2

Generalization Across Stimulus Duration: Suggestions have been made that learning of frequency discrimination takes views that are broad at least with regard to intervals of untrained stimulus. It can also apply to untrained temporal interval stimuli. Training of frequency discrimination through a single stimulus that is standard created performance enhancements at post and pre-training for untrained periods stimuli such as trained 200 ms versus untrained 100 and 40ms Delhommeau et al. or temporal intervals of the untrained at trained 100ms versus untrained 50ms Wright & Fitzgerald and in addition the collected data subsequently showed generalization. The statement is in support of the notion that the generalization of learning frequency discrimination in durations of untrained stimulus is incomplete.

Generalization Across Ear: Frequency discrimination learning is seen as generalizable from a trained to an untrained ear. Enhancements were evident in untrained ears after training on frequency discrimination in the opposite ear in all cases that were verified, and this demonstrated the presence of cross-ear generalization Delhommeau et al. In both cases, generalization seemed complete as enhancement amounts were similar in both ears for untrained as well as trained stimuli to frequencies that were untrained Delhommeau et al. and noise conditions that were untrained Micheyl et al. However, in two other circumstances, suggestions were made that there was inadequate generalization and the conclusion was due to other evidence. Roth et al. pointed out that larger developments between post and pre-training tests in the untrained than the trained ears at every frequency that was tested and the dissimilarity across ears was associated with the trained ear always being tested first. Remaining circumstances showed generalization of across ear learning with stimulus that was trained seemed to be unfinished between the post and pre-training tests. An interesting observation was that the generalization that was half-finished was only evident in trained and not the untrained periods of the stimulus.

Generalization Across Presentation Style: Evidence has shown that frequency discrimination learning to a large extent generalizes among conditions where standards of pure tones are set at single frequencies or ranges among various frequencies. In the above experiment by Amitay et al., training of listeners was through characteristics of frequencies that were fixed or those which were roved between sets of either widely spaced or narrowly spaced frequencies. Routines of post-training on conditions that were static did not fluctuate between the three trained groups and this showed that there was generalization of learning from both fixed and roving conditions. Distinctively, there was generalization of learning from the conditions that were fixed to the conditions that were narrowly roving in the listeners not good or poor. Results of the post- training on the condition that was roving narrowly seemed healthier compared to the groups that gad fixed training in a third of the listeners with the initial verges that were the highest but they were similar among the two groups for the two thirds of the listeners that were remaining.

i. Generalization Across Tasks: Finally, one of the examinations points out that there is generalization of frequency discrimination with fundamental-frequency discrimination where there is harmonic complexity but not in amplitude-modulation rate discrimination. Grimault et al. conducted training in three differing listener sets on frequency discrimination at either 250, 88 or 1605 Hz (nZ3 per group). Based on data obtained from the three groups, it was evident that the listeners developed fundamental-frequency discrimination on the fundamental frequencies of 88 and 250 Hz, and this showed that there was generalization to fundamental-frequency discrimination. However, learning was found to be more significant when detachment of individual harmonics was possible than when it was not.

ii. Fundamental-Frequency Discrimination: This refers to tasks that are pitch based where examination of learning generalization occurs. The tasks involve listeners being requested to distinguish between small differences in fundamental frequencies of harmonic sets. Findings from two reports that were separate show that fundamental discrimination learning generalizes to harmonic frequencies that are untrained as well as F0s regions, but the same is not evident with frequency discrimination in pre tones and is only partly specific to statuses of harmonic dispensation in the auditory systems peripheral. Grimault et al. in an experiment trained listener for nearly 1800 trials per session for 12 sittings on F0 discrimination through the utilization of either 88 Hz (nZ4) or 250 Hz (nZ4) and harmonics in regions of mid frequency. There was development of the trained listeners among examinations ate post and pre-training in all the F0s, regardless of harmonic presentation at mid, low or high regions of frequency while the untrained controls displayed no improvement. It is therefore problematic to make conclusions as to whether improvements seen were from F0 training or from the F0 that was generalized. Interestingly, advancement quantities were larger on conditions that were untrained that were similar to trained ones with regard to unresolved and resolved harmonics and this suggested that there were specificities to particular harmonic type components.

Temporal Judgments: Learning generalization has also been evident in various tasks that involve temporal judgements, and this include temporal-interval discrimination, discrimination of amplitude rates and tasks relative-timing.

Temporal-Interval Discrimination: Auditory temporal learning generalization in temporal-interval discrimination is evident in various stimulus attributes and across motor systems as well as sensory modalities. Descriptions are given below of experiments where listeners were charged with differentiating time interval differences among two auditory markers that were momentary. The training involved 500–900 daily trials for around 10 days with ranges of five to sixteen days on conditions of temporal-interval discrimination. Assessment of generalization was done through development paralleling between tests at pre and post-training on the conditions that were untrained and trained. Recent indications propose temporal interval discrimination learning is not generalizable to intervals that are untrained but can generalize to frequencies that are untrained as well as various kinds of interval markers. Learning that occurred due to single standard stimulus training failed to make progressions on temporal intervals that were untrained.

i. Relative-Timing Tasks: In some of the cases, auditory relative timing learning of tasks was found to be exact to the ones that involved tone pairs that were trained as well as temporal positions and judgement types. Mossbridge et al. performed scrutinies on generalization and learning of temporal- order discrimination as well as discovery of asynchrony at onset and offset of sound. The tasks incorporated asynchrony-detection where the listener dictated in which presentation the complex onset two tones began or offset or ended at times that were dissimilar and contrasted with the same times. In the tasks of temporal order discrimination, the listener also made decisions as to which of the two presentations the tones of the higher frequency began or stopped early as opposed to later among the tones.

B. Amplitude Modulation Rate Discrimination

For discrimination of rates of amplitude modulation, learning generalization was scrutinized across tasks, rates and carriers. Reports that are contradictory have been presented with regard to the generalizability of such learning to rates of modulation that are untrained. Fitzgerald & Wright in their study conducted training of listeners on rates of amplitude modulation discrimination which involved 720 trials every day for six to eight days with 150 Hz standard rates as well as broadband carriers. Later comparisons of performances were conducted with the controls that had not gotten any training. Those who had been trained were found to advance faster than the controls. Such conclusions should however be taken with caution as they are based on parallel progress scrutiny's with similar rates among combined listener groups where half of them are trained at equal rates without any consideration between untrained and trained listeners in every rate.

C. Spatial Hearing

Learning generalization has also been seen on tasks involving primary signals to source sound locations on planes that are horizontal such as interaural differences in time (ITD's) as well as interaural differences in levels (ILDs) Wright & Zhang. The single investigation conducted on training effects on discrimination in ILD describes learning as specific to cue and frequencies utilized in training, but generalization occurs in standard ILD values that are untrained. Listeners (nZ8) practicing at 720 trials every day for nine days on discrimination in ILD with tones of 4 kHz as well as ILD standards of 0 dB were seen to have increased development compared to the control group where no training occurred. Additionally, listeners who were trained also showed more improvement than controls when untrained standards of ILD (6 dB) were utilized but not when untrained frequencies of 6 or 0.5 kHz or on ITD discriminations at 0.5 kHz with a 0 ms standard ITD. With reliance on these two inquiries, it can be seen that ITD discrimination learning generalizes to stimulus types that are untrained as well as stimuli that contains or does not contain differences in interaural carrier-frequency.

D. Signal Detection and Intensity Discrimination

i. Signal Detection

This papers author is aware of the only surveys that are uncommon in learning generalization after tone detection training with every one of them utilizing tasks that are different and this involves detection of tones in environments that are quiet, noisy and with sequences of tone. Detection of tones in quiet conditions involves learning curves gotten in three training sessions involving 0.1 kHz tones where the listener had four prior training sessions with 1 kHz tones (nZ8) and these were similar in those listeners without any prior training and this suggests that there was no generalization between 1 to 0.1 kHz Zwislocki et al. Such an outcome calls for the specificity to stimulus periods that are untrained. Finally, to enable tone detection in sequences of tones, listeners were trained expansively on the identification of tones embedded in single sequences of ten tones with positions of target tones being randomized trial after trial Leek & Watson.

The development of the listeners was guided by trained orders and untrained conditions where six new sequences that contained the similar ten tones as the trained ones were presented indiscriminately. Learning with trained sequences was therefore generalized to the sequences that were new as well as greater hesitation to stimulus. Initially during training listeners learned perceiving of tones at one position in specific time orders which suggested that generalization was absent across positions of tones. Secondly, listeners that experienced struggles that were significant in the detection of tone in specific temporal positions during the random position training showed prompt development when given practice that involved target tones of longer periods that could only be obtained in that position that was temporal. The listeners at later stages continued with the performance that was respectable when verification was later conducted in the former conditions showing that learning generalization occurred from easy to difficult conditions.

ii. Intensity Discrimination

One solitary study offers evidence on intensity discrimination learning generalization involving abilities of differentiating among small differences in stimulus intensities. Marginal improvements of listeners in the outcomes were observed. However, no intensity discrimination was developed by the listeners at quiet target tones despite the condition being verified at the beginning of each training session. The result shows that there was no generalization of learning from the condition that was disguised to the quiet one.

Rapid Learning

Despite many studies on auditory learning generalization utilizing training of multiple sessions, there are few but growing works on learning generalization due to training sessions that are usually single and brief.

a) Pure-Tone Frequency Discrimination

For frequency discrimination of pure tones, learning obtained from training durations that are relatively small seem to be generalizable across frequency, ear, as well as procedures of testing. In one of the studies Demany, listeners who underwent training for 700 trials over double periods which were at 2.5 kHz or 0.36 (nZ16) were seen to develop between the post and pre- training sessions similar to those that underwent training at 0.2 kHz (nZ16), and this showed that there was across frequency generalization. However, listeners that underwent training at 6 kHz (nZ22) failed to present any development at 0.2 kHz, and this suggested that there was a restriction of generalization to frequency ranges that were definite. Another study that involved generalization across frequencies Amitay et al. [16] showed that those who developed frequency discrimination at 4 kHz for 800 trials with single periods had improvements among the tests at pre and post training at 1 kHz. Of interest is that compared to learning of frequency discrimination that was gotten through discrimination paradigms that were typical, learning from training with the absence of frequency differences between signals and standards can be seen to be more specific to frequency. Frequency- discrimination learning that is as a result of training that is short generalizes across procedures of testing and ears but not with tasks. Listeners experiencing frequency discrimination in training sessions involving single 700 trials with standards of 1 kHz either in the right or left ears showed performances that were similar which showed that there was generalization across ears Roth et al.

b) Spatial Hearing

In spatial hearing, three rapid learning generalization inquiries can be found with each one having inspected generalization in various dimensions. Russell, in his inquiry performed training of various listener groups (nZ78 total) in 200 trials that involved free-field localization on planes that were horizontal that had earmuffs that were bilateral as well as altered spectral sues and reduced sound levels with others having normal cues of open ears. Improvements were seen in all groups between tests of post and pre-training with regard to the respective conditions of training. Additionally, groups that were trained in the condition of open ears showed development in the condition of ear plugs and vice versa. However, the group trained in the condition of earmuffs failed to show improvement with regard to the other conditions and vice versa. It therefore seems that the development in performance of sound localization on planes that are horizontal did not show generalization over alterations in spectral cues. In experiments that are more recent, Spierer et al. conducted training of listeners (nZ10) in differentiating between fixed ITD value pairs for 40 min periods through utilization of stimuli involving white noise. With ITD pairs that were trained, development occurred but with the pairs that were untrained, the same was not observed.

The present review reveals that the auditory learning generalization literature is fairly limited. In various tasks, very few if any inquiries about generalization have been conducted. It is therefore a problem to try and make deductions that are dependable with regard to generalization patterns. In the cases that are scarce where there is more wide generalization scrutiny, various training and testing methodologies have been used which constraints evaluations that can be done across experiments. In general, the data obtained does not show any rule that is simple for forecasting the generalization pattern in any particular task. However, the existing literature examination enables opportunities that are valuable for comparing various approaches and gives clarifications to the various assumptions utilized in interpreting and evaluating generalization.

Evaluation of generalization

With regard to generalization evaluation, various points that are stimulating arise from the review. It can first be seen that generalization has two definitions. Various inquiries gauged generalization with regard to listeners' data that showed improvements had been made in the sessions of learner training Wright [8]. From this perspective, the generalization definition can be understood as enhancing of conditions that are untrained which emanate from improving of trained conditions which is generalization as a result of learning. The definition points to the fact that improving in conditions that are untrained for listeners that did not show improvement while training is not considered generalization. Calculation of generalization in other studies utilized all trained listeners data regardless of whether all individuals showed improvement on the condition being trained Wright et al.

In such cases, the definition of generalization can be said to be progressing of conditions that are untrained which can be due to any change that training induced even if the changes are not evident in the performance. The definition shows that any untrained condition improvement can be considered generalization. Secondly, models utilized in evaluating generalization can be varied when three elements are added each of which brings different advantages. Training durations are conjoined in all the models as well as consequent performance tests with regard to the conditions not being met at the training period.

Varying of the models depends on the various elements being absent or existing and this include:

i. Pre-training performance tests on conditions that are untrained.

ii. Participation of controls in the tests at pre and post training but not in the in between training and

iii. Training done consequently on conditions that are untrained which can include tests at pre training allowing assessment that is direct on the improvement amounts on untrained and trained conditions that prevent the need for assumptions of performance that is equal over conditions before training.

Possible drawbacks include pre-training testing on the conditions that are trained may limit abilities of evaluating training influences on any conditions therefore causing limitations on evaluating training influences on that condition. Controls of testing who fail to contribute to the training enable quick learning separations emanating from being exposed to tests at pre-training due to slow learning in the period of training. Investigations on the consequences of training's success on conditions that are untrained enables the assessing of immediate generalization of immediate conditions that are untrained with a basis on commencement of training that is successful as well as significances that are long term on those conditions' performance. Thirdly, two understood interpretations that are different with regard to the establishment of generalization that is comprehensive. In accordance to one view, generalization can be considered to be comprehensive if the learning on the condition that is untrained is the same as the training on the condition that is trained where the condition that is trained has given all that it can possibly give. In cases like those, evaluation of the generalization degree is performed through paralleling either the improvement amounts between post and pre-training or only the performance at post-training where the tests at pre- training are absent between the conditions. In such cases, evaluating of the generalization's extent makes it necessary to train on the ailment that is untrained.

Interpretation of Generalization

Generalization designs are utilized in making interpretations with regard to what was learned as well as highlighting brain parts that underwent modifications in the sessions of perceptual training. With regard to the generalization's extent, there has been separation of learning into two categories that are broad which include procedural and stimulus learning. Stimulus learning involves learning made up of a set or single quality of the stimulus that is trained with specifications by specificity in some stimulus respects. Alternatively, learning that is procedural involves learning factors which are autonomous of the stimulus being trained such as the method of testing and the environment of the laboratory and this can be seen through generalization that is extensive over various tasks and stimuli. Improvements are attributed by investigators to happen swiftly at the training's commencement to learning that is procedural. It should also be noted that splitting of the improvements into procedural and stimulus perceptual learning does not give specifics to neural alteration locations like if the occurrence is at the stage of sensory training or some other stage of higher processing.

Review of the Generalization Literature

It should also be indicated that single condition training is capable of inducing alterations that are multiple in neural processes involved with the condition's performance. An example is generalization across frequencies of learning frequency discrimination that are seen to vary from fractional to seemingly complete to absent and this shows that modification of training over different extents or across experiments. The notion emanates from observing that learning on visual tasks broadly generalized to stimuli that is untrained at difficulty levels that are very low but have increasingly become more specific with increases in the levels of difficulty. Such findings propose that easy task learning takes place at stages that are more vital where there is large tuning of visual neurons while the one for tasks that are more difficult takes place at stages that are more peripheral where there is more specific tuning of neurons. Evaluations are yet to be made to the extents by which visual learning deductions can be applied to auditory systems. Literature enables the following through of diagnosis processes to patient admissions and into training of learning for those that have or don't have ARHL, to the correctional and training interventions for management of conditions as well as learning outcomes that are positive as well as discharge. This can be best shown in the conceptual framework illustrated below:

Study Conceptual Framework: (Figure 4)

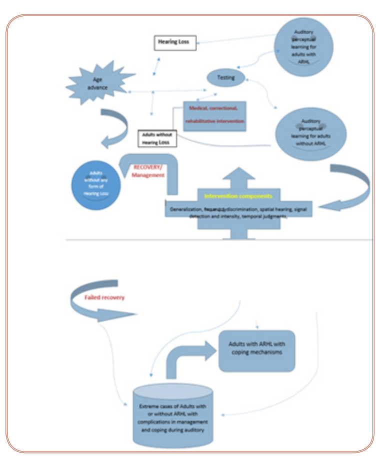

Figure 4: Study Conceptual Framework.

Auditory Perceptual Learning in Age-Related Hearing Loss

CHAPTER 3

RESEARCH METHODOLOGY

Research Methodology

Introduction

This chapter involves giving a description of the research design methodology to be utilized in carrying out the auditory perceptual learning study for adults that have and don't have ARHL. It aims at discovering solutions and answers to objectives and research questions that have stated in this paper first chapter. The research design is discussed in this chapter's section 3.2 while the sampling design and population is discussed in this chapter's section 3.3 while a dissection of secondary information as well as the methods of analyzing data is carried out in section 3.4. Section 3.6 gives a summary of the chapter. This whole chapter covers the design of the research, case studies used in the study, the population that was targeted which was ageing adults that have and don't have ARHL, the procedures of selecting the auditory perceptual learning sample, the assembly of secondary data as well as measures of validation, reliability and validity pre-testing of the literature and secondary data, its collection as well as analysis. Attempts are made in the chapter for making deliberate sense of the supporting literature and research questions methodologically. Discussion and display of the output are found in the historical and content data analysis section.

Research Design

The design of research involves the action plans intended to be utilized by the researcher in answering the study's specific objectives. It incorporates all steps the researcher followed from the research proposal creation point to the final point of auditory perceptual learning and ARHL literature analysis Sukamolson. Odoh and Chinedum et al., have given the definition of a research design as arrangements aimed at the discovery of answers for the questions of research raised in the study. The design of the author in approaching the objectives and questions of research is a study analysis that is theoretical and empirical by qualitatively validating studies done previously for the purpose of helping reject or accept the null hypothesis posited in the research questions affirmative form. Such an arrangement enables analysis of content from auditory perceptual learning reviews as well as studies done previously that shed light on successes or failures that have measured with regard to learning in adults with or without ARHL.

In general, the framework of research designs acts as a guide for collecting and analyzing data and information. In this study, the intention of the researcher is to utilize both descriptive design and content analysis. Such techniques of research basically give detailed descriptions of subject populations characteristics Creswell. The descriptive design will aim at measuring causal relationships between learning process performance and auditory perceptual learning in adults that have or don't have ARHL. Variables involved include ARHL and auditory perceptual learning while age will be the control variable to enable simple inferential content analytics.

Population and Sampling Design

Population: Singh and Masuku point out that population refers to the total elements sum that enable the drawing of conclusion. With regard to this study, population comprises of the entire availed DHIS data about auditory learning. Odoh et al., gives description of a study's target population as the focus point from which the research findings generalizations are made. In this study, the population includes:

a) Patient numbers in general as cited in case studies and used in reports as well as empirical literature.

b) Sample population of schools where tests are performed in the reports cited; (fetched data from primary data mining and ENT records at school levels) as well as patients involved in auditory perceptual learning and those with ARHL.

Sampling Design: Samples refer to the study populations' fraction. Sampling design therefore refers to procedures utilized by the researcher in selecting population items that make up the study's sample. In this study, no procedures of selection will be applicable. Alternatively, sampling of the total population will be applied since all adults with ARHL as well as those without have been utilized in studies borrowed by the author for analyzing outputs of perceptual learning and ARHL workload.

Frame Sampling: Sampling frames refer to source devices or documents from which drawing of the sample occurs. They involve lists of the populations' sampled elements. This study included adults that have ARHL, that don't ARHL, acclimatized or recovered patients as well as sampling that reflects demographic areas and sampling institutions.

Sampling Technique: Etikan, Musa & Alkassim point out that technique of sampling refers to methodologies utilized in the selection of set elements from the populations' entirety which can be considered as the total populations' representation. The formula utilized in arriving at the study's applicable sample size will be described by the researcher. Since the research adopts a total population sampling technique, all ENT data and particularly hearing loss data with age stratifications where possible will be utilized in the study. All facility data lists will therefore constitute the study's sample size and will be obtained from national workloads as well as other taken samples used in primary studies on school pupils, facilities and elderly homes. McMillan & Schumacher point out that the technique of total population sampling takes into consideration all population study members.

Sample Size: This study utilizes secondary data borrowed from other studies outcomes as the abstract highlights. Analytical output and data are therefore utilized from ENT related publications of the government as well as other papers on auditory perceptual learning from various authors. Differences among authors exists and this study borrows from the ones that have achieved the understanding and criterion of sampling data below: that the size of the sample involves exact numbers of participants that have been approached by researchers physically with aims of answering particular questions through instruments of research collection Webster. Sizes of samples in studies should not be too small or too large but should be realistic enough to enable the desired widths confidence intervals Kothari & Garg. Margins of error (e) amounting to 5% at 95% confidence levels as well as population (N) of 84 the determination of the size of the sample (n) was done through the equation shown below. Through the utilization of the Sloven's formula shown above, sample size utilized in the collection of data is likely for studies that have over 32 respondents from various facilities in particular case study areas.

$$n = N$$

$$1 + N\,(0.05)2$$

$$n = 35$$

$$1+35(0.05)2$$

$$n = 32.18$$

CHAPTER 3

Data Collection Methods

Methods of collecting data involve processes that are logical utilized by the researcher in the study's data collection Alshenqeeti. Data can be either from secondary planning or primary studies from SSA or the Kenyan health systems. Data is vital in research since it acts as the foundation of the analysis. Methods of collecting data are techniques utilized in obtaining the data that is relevant for the research. This study utilizes both secondary and primary data. Questionnaires that are closed ended and structured were utilized in collecting primary data in the studies assessed by the author and from which he intends to borrow from. Three sections are utilized in dividing and structuring the study. The first section investigates secondary data from platforms of national planning as well as data from facilities; the second section captures from various studies conducted previously on auditory perceptual learning and adults that have and don't have ARHL; the third section provides inferences on summary findings as well as previous studies for utilization in the final chapter of recommendations and conclusions.

Research Procedures

Procedures of research refer to guidelines utilized by the researcher in conducting the study. It incorporates procedures of collecting data, respondent sampling that is correct, ethical permission seeking from the university among others. The study began by first obtaining approval from the department of the university involved with all organization's health records needed for the study. Studies that are relevant and that will be borrowed for content analysis or review of literature and data will be discussed with the supervisor involved one on one. Previous exercises findings will be utilized in making required inferences for the hypothesis and research questions. Calls of follow up will be made to every facility and institution for any report data to ensure authenticity and quality where possible in an effort of avoiding the use of invalidated data.

Secondary Data Validation

With regard to secondary data to be utilized in the study, the relationship between adults that have and don't have ARHL and auditory perceptual learning will be tested by the researcher. Permission was sought from the research office of the university to enable carrying out of the study on ARHL and auditory perceptions. Secondary data will be sought by the researcher from unlisted as well as other unlisted sources of medical data that have approvals from the WBG and the WHO to eliminate non-empirical, unratified and nondescript sources. The researcher will finally conduct an analysis of the data on how different approaches of learning perform from the various sources.

Auditory Perceptual Learning in Age-Related Hearing Loss

CHAPTER 4

DATA ANALYSIS SUMMARY OF FINDINGS

Data Analysis Summary of Findings

CHAPTER 4

Introduction

Various findings from qualitative, content and quantitative analysis are investigated in this chapter with regard to auditory perceptual learning for adults that have or don't have ARHL. Other chapter outcomes are reviewed in this section in totality of findings in the different topic areas that the author brings together. Different studies with post analysis visualizations and discussions of output content and processed data are the focus of the study and inferences from them are utilized in this study for opposing or validating components of age in loss or hearing as well as variables of auditory perceptual learning. Analytical discussions have been borrowed and sustained and used by the author in making inferences to reject or accept the different hypothesis the cited papers adduced.

Conclusions in Analytical Output by Various Studies

Hanin K et al., conducted a conclusive study where it was noted that recognition of speech in listening conditions that are adverse increases with difficulty as people age especially for those that have hearing loss that is age related (ARHL). With regard to methods and materials of participant deployment, the outline below gives the process of sampling. The study recruited 71 adults which included 44 women, and all were aged between 60 and 71 years with the mean age being 66.5 years plus or minus four months and they all did not have a history of any ailments that are neurological. Recruitment was performed at the Haifa University from the Speech and Hearing Center at the Rambam Health Care Campus, found in the Institute of Clinical and Audiology Neurophysiology and this was done by advertising at the Rambam University. Conditions for recruitment included hearing impairment or normal hearing with no disorders that are neurological, being between 60 and 70 years of age, as well as having Hebrew as the native language. Study eliminations were also based on various audiometric results of conductive or asymmetric hearing loss (n=4), inabilities of controlling computer mouse's (n = 2), not being willing to participate (n = 4) and being a user of hearing aids (n = 5). Informed consent was given by the participants and their time was rewarded. Audiometric thresholds of pure tones were jointly obtained for conduction of air at 250-8000 Hz octave frequencies and at 3000 and 6000 Hz while octave frequencies for bone conduction were at 250– 4000 Hz.

56 participants in total including 35 females met the criteria for inclusion above and their data in incorporated in this manuscript's reported analysis. Through the audiometric thresholds those who participated were grouped into normal-hearing (NH, mean age = 64.6 years ± 4.3, n = 21) and ARHL (mean age = 67.6 years ± 3.3, n = 35) groups; and no age differences that were significant were found in the groups [t (54) = 0.7, p = 0.59]. Hearing thresholds of the participants with hearing that was normal were ≤ 25 dBHL through 6000 Hz and ≤ 30 dBHL through 8000 Hz. Those who had ARHL were found to have symmetrical hearing loss that was moderate to mild from ≤60 dBHL through 8000 Hz, and they did not utilize aids of hearing previously or during the study. Additionally, no differences that were significant were found in the thresholds of bone conduction between the left and right ears [t (110) = 1.03, p = 0.305]. All involved participants (AHRL and NH) were examined in cognitive tests that were standardized and obtained from Wechsler Abbreviated Scales of Intelligence (WASI, Similarities, and Block Design) as well as the subtest of Digit span memory from Wechsler Intelligence Tests Wechsler [17] and cognitive functions that were normal to their ages were observed. Another study involving attention effects to thresholds of speech reception as well as response rates of pupils was undertaken by Thomas Kolewijn et al., and its methodology involved. The study outcomes showed that pupils and people that had impaired or normal hearing showed disparities in their rates of response to attentiveness of speech reception. Additionally, no aids of hearing were worn by those who participated during the tasks of listening as they tested their speech deciphering capacities.

Study with Design on Auditory Perceptual Learning ARHL: Controlled, randomized, quasi-crossover designs were utilized in the study which was similar to the ones used by Ferguson [11]. Three sessions of tests were completed by the participants (Figure 2). Participant subgroups were also taken through auditory training in between the various sessions of tests so that in the end, the participants acted as their own controls that were untrained. Everyone who participated (ARHL and NH) was taken through various tests in session 1 (t1), after which there was random assigning to either the completion of the phase involving auditory training (immediate-training, mean age = 65 ± 4.3, n = 24; NH = 10, ARHL = 14) or to the phase of waiting (delayed-training, mean age = 66 ± 3.1, n = 22; NH = 11, ARHL = 11). Other participant groups that had ARHL received no training (no-training ARHL, mean age = 67 ± 3.4, n = 10) and were only involved in two sessions of training.

Hearing air conduction means verge over ears and the plotting of those who participated was done with regard to Age-Related Hearing and Normal-Hearing (NH). Bars of error were representative of standard deviation. Every one of the participants went through another session (t2) four weeks after t1. The occurrence of training was between the t1 and t2 times for the participants that underwent training that was immediate while those who underwent training that was delayed it was between t2 and t3 times while the period of retention was between t2 and t3 times for participants that underwent training that was immediate. Composition of data from both periods of training was conducted (t1–t2, t2–t3); and 46 participants in total took part in the phases of training (which was in the Methods, Materials and Results section NH, n = 21 and trained ARHL, n = 25). The retention duration data will be discussed in the current paper.

Details of Test Sessions for Each Group: Settings of the three tests were at Haifa University and they incorporated trained tasks tests for assessing effects of training like learning on-task as well as a series of tasks that were untrained for evaluation of generalization. No-training and immediate training groups underwent verification on the untrained and trained tasks in t2 (posttest) and in t1 (pretests). For the group in immediate training, t3 incorporated untrained tasks examinations for assessing of retention. The group in delayed training was only tested on tasks that were untrained in t1 and were later tested on both untrained and trained tasks in t3 and t2. Indices and features of cognitive function and demographics (in t1) were found to be the same over all the five ARHL and NH groups [$F(4, 51) \leq 1.4$, $p \geq 0.25$]. Similarly, the cognitive and demographic characteristics were the same across delayed training, immediate training and the no training groups [$F(2, 53) \leq 0.92$, $p \geq 0.86$].

a) Design of the Study: Three sessions of testing were undertaken for the delayed training and immediate training groups (t1, t2, t3) while two sessions of training were undertaken for the group in no training (t1, t2). The group in immediate training was trained between t1 and t2 times while that of the group in delayed training occurred between t2 and t3. The top or blue circles stand for trained tasks training while the bottom or yellow circles stand for tasks that were untrained.

Outcomes in Training Protocol and Tasks: The groups that were trained finished 13 sessions of auditory training that was home based with every session running between 20 to 30 minutes and being spread over four week periods. The program of training was aimed at improving perception of speech in three conditions of listening (A) Speech in noisy conditions (B) speech that was time compressed and (C) speech with speakers who were competing. In principle, the tasks of training were the same to the procedures of training that Song et al., and Sweetow [7] introduced. One condition was dedicated to one setting, and this involved three block practices except for the final session which involved all three conditions being trained (each condition was given one block). Recordings on various topics were utilized in keeping listeners engaged and in every block, a topic that was different was presented. Materials for auditory training involved Hebrew passages that were thematic running for 3 to 6 minutes being read by one female and four male voices from science articles that were popular. A question with multiple choices followed each unit with regard to the sentences content which had visual presentations. Feedback of incorrect or correct responses with the answers was also visually given.

All sections of noise had been standardized to general root mean squares (RMS) levels of 70 dB through level 16 Tice & Carrell [18]. Parameters of adaptation were the ratio of signal to noise where levels of noise altered by 1.5 dB. Adaptive parameters for speech that was time compressed involved the rate of compression and in the condition of competing speakers, there was a concurrent presentation of sentences by male and female voices and there was training of listeners to respond to target speakers with the adaptive parameter being the two sentences noise to signal ratio. Average thresholds of SNR for every block were determined for every member in the conditions of competing speakers and speech in noise while ratio thresholds of mean compression were determined for every block in the condition of speech that was time compressed. The experimenter installed the program of training on the personal computers of all trained participants and they conducted practices in their homes. The table below shows the cognitive and demographic measures standard deviations and means over all groups with divisions into groups with hearing loss that is age related (ARHL) and normal hearing (NH) (Table 1).

Table 1: Cognitive and Demographic measures standard deviations and means over all groups with divisions into groups with hearing loss that is age related (ARHL) and normal hearing (NH).

	Normal-hearing		ARHL		
	Immediate-training	**Delayed-training**	**Immediate-training**	**Delayed- training**	**No-training**
N	10	11	14	11	10
Age	64 (4.59)	65 (4.5)	66(3.08)	69(2.53)	67.6 (4.42)
Male/female	4/6	8/3	8/6	6/5	7/3
Cognitive Function					
Digit span scaled scores	9.5 (1.7)	8.1 (2.08)	9(2.2)	8(2.4)	8 (2.6)
Similarities	15.1 (0.8)	14.3 (2.5)	14.3 (2.5)	14.2 (2.9)	14.4 (2.9)
Block design scaled scores	11.1 (1.8)	10.7 (2.3)	10.8 (2.04)	9.3 (2.4)	10.3 (2.1)

Scenario 2: The design of the study. Three periods of testing were undertaken for the delayed training and immediate training groups (t1, t2, t3) while two periods of testing were undertaken for the no training group (t1, t2). Training was experienced by the group in immediate-training between t1 and t2 times while the group in delayed training experienced it between t2 and t3 times. The top or blue circles stand for testing tasks that were trained while the bottom or yellow circles stand for testing tasks that were untrained that the participant faced (around 45o). Sound levels were set at listening levels that were comfortable that the trainee had decided on before every session of training began. Data from the training phase was analyzed and it included data from all participants that were trained and whose collection occurred between t1 and t2 for the group that was immediately trained and between t2 and t3 for the group in delayed training. A univariate ANOVAs series displayed no differences that were significant in the results from pre and post training between the delayed training and immediate training groups [$F(1, 19) \leq 1.61$, $p \geq 0.22$], as well as the ARHL groups in delayed and immediate training [$F(1, 23) \leq 1.86$, $p \geq 0.19$], which made a combination of the two groups possible. 25 ARHL and 21 NH listeners in total completed the training and were referred to as trained groups or trained listeners in the entire section of results.

Pre and Post Training Assessments: The undertaking of pre-training and post-training happened in a margin of four weeks. Data from the sessions was utilized in assessing learning which was based on performing in tasks that were trained but with content that was different and learning generalization to tasks that were untrained.

Learning Outcomes: Trained tasks performance but with passages that were different was utilized in documenting learning and determining the significance of changes related to training compared to listeners that were untrained. In this analysis, collection of data was instantaneous before the pretest or first training and it was also done immediately after the posttest or final training which corresponded to t1 and t2 times for the no training and immediate groups as well as t2 and t3 for the group in delayed training. The analysis reported in the section of results on pretest and posttest learning on the tasks that were trained therefore includes data for the 21 NH participants that were trained, 25 ARHL participants that were trained and 10 ARHL participants that were untrained. The tasks data was not collected from NH listeners that were untrained as the main objective was examining existence of changes in learning in the group with ARHL. Verification of participants was done on two blocks of every condition that was trained in every time point. Relation among the groups was then done on the differences between pretests and posttests.

Generalization

In examining potential improvements transmission that was induced by training to other non- speech and speech conditions (generalization), untrained tasks performance was utilized. Completion of tasks was done by all groups and it incorporated (A) discrimination task of speech in noisy conditions pseudo words, (B) sentences task for speech in noisy conditions, C) discrimination tasks of duration.

A. In the discrimination task of speech in noisy conditions pseudo words, those who participated undertook different or similar tasks of discrimination where there was presentation of 60 two syllable pseudo word pairs by female speakers who were native with similar numbers of different and same trials. There was embedding of the pseudo words in background babble noise made by four talkers. The utilization of pseudo words was aimed at eliminating context effects provided by words that are familiar which has been found to be strong in people that have compared to listeners that have hearing that is near-normal Pichora-Fuller et al.

B. In the sentences task for speech in noisy conditions, listeners had to make judgements of plausibility on 45 sentences in Hebrew that had been embedded in babble noise of four talkers. Listeners had to make determinations to the semantic plausibility, false or true, of the sentences after they heard them. Both tests of speech in noisy conditions were conducted at levels that were most comfortable for those participating beginning at SNR values of +5 whose adoption was dependent on responses. The SNR was the adaptive parameter where levels of noise were altered by 1.5 dB steps.

C. Tests of duration discrimination were conducted through 1000 Hz tones of reference with durations that were standard at 200 ms in oddball procedures. In every test, two standard tones that were identical as well as one target tone were utilized with inter stimulus intervals of 800- ms. Odd tones durations adoption was dependent on how they performed with staircase procedures of a one up or three down multiplicative.

D. Testing of discrimination of frequency was done through oddball procedures that had reference tones of 500 Hz in particular tasks while others had reference tones 2000 Hz with 500 ms durations. Adoption of differences in frequency between frequent and odd tones was dependent on how they were performing. Administration of tasks that were non-speech was through 60 trial interfaces that were friendly to listeners. The tests were utilized in determining if generalization could be seen in basic psychoacoustic tasks that were non-speech that had not been trained. The tasks of generalization were undertaken in every ARHL and NH participant in t1 and t2 times. The administration of the tasks was therefore before and after periods of training for the group in immediate training but after and before periods of control for the no training and delayed training groups.

Perceptual Learning in the Training-Phase

The study involved 41 out of the forty six participants that were trained from both ARHL and NH groups completing all 13 sessions of the program on auditory training and this showed high compliance levels without dropouts. There was therefore inclusion of data from 46 participants that were trained to the statistical analysis. For the purpose of making determinations on improvement of participants at training and if it relied on their status of hearing, estimations of linear curves were performed in group performance at every condition of training over the sessions. After analysis, it was found that there were fits that were good between the data and the linear curves with values of R-squares that were significant (R-squared > 0.43, $p < 0.01$) therefore suggesting that across sessions improvements that are linear lead to significant variance amounts in performance. To enable comparisons of the extent of changes induced by training between ARHL and NH groups, calculation of the individual learning curves linear slopes was performed for every participant in each condition of training. Mean slopes included;

i. Learning curves: thresholds of the Mean as functions of the blocks that were trained in the ARHL group band the NH group in (A) speech in noisy conditions (B) speech that was time compressed and (C) speech in condition of speakers competing. Ratios of the noise to signal mean thresholds for every block were utilized as the measures that were dependent in the competing speaker and speech in noise conditions while the ratio of compression was utilized in the speech in time compressed condition.

The standard deviations and means of learning slopes for the groups of ARHL that was trained as well as NH that was trained were obtained. Group p values as well as t values of speakers as well as confidence intervals of 95% of the groups' difference were obtained as well. In the speech in noisy conditions, significantly steep learning curves were found in the group with normal hearing compared to the group with ARHL [$t(44) = -2.05$, $p = 0.046$]. No differences that are significant were observed between ARHL and NH learning curve slopes in the speech in time compressed condition [$t(44) = 0.65$, $p = 0.52$] as well as the condition of competing speakers [$t(44) = -0.76$, $p = 0.45$]. After visually inspecting the data (Figure 3) it was suggested that the learning rates may have altered over the trainings duration with initial learning phases that were rapid which were followed by learning phases that were slower. It therefore led to the fitting of linear curves that were two-line for the data of the group and this was in separate for the first to sixth session and the seventh to thirteenth sessions for every condition. Fits that were good were shown for various groups and conditions. Calculations of individual slopes were therefore performed for conditions showing significant models in the groups while there was comparison of slopes between the groups. Similarities of results were found with those acquired through one-line models. The combined data suggests that learning on training phases occurred in both the ARHL and the normal hearing groups that had been trained. Both groups that had been trained displayed similar learning amounts over the training's duration in conditions of competing speakers and speech in time compressed. In the speech in noisy condition training, the group with normal hearing displayed higher improvements compared to the ARHL group.

Pre- to Post-Test Learning on the Trained Tasks

With the aim of determining if training caused increased changes pretest and posttest in those who were trained compared to those who were not, comparisons were conducted on performance before and after tests for every condition across the groups (Figure 4) through repeated ANOVA measures. As the learning section explains, tasks of training were performed right before the initial training and immediately after the final session of training and it corresponded with t1 and t2 times for the group in the delayed training (Figure 2). The analysis therefore incorporates data from 21 NH participants that were trained, 25 ARHL participants that were trained and 10 ARHL participants that were not trained.

Auditory Perceptual Learning in Age-Related Hearing Loss

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

Conclusion and Recommendations

Introduction

In this chapter, augmentations are made to the draw conclusions from the analysis of data as well as review of qualitative outcomes from previous chapters and this is in regard to the objectives of the research. The chapter is beneficial in aggregating of conclusions and the consequent recommendations from the work of the author in the topic of research. Since it is a field in medicine, acknowledgement is given to the challenge of emerging from a study of the same magnitude with guidelines that are easily implementable from the recommendations and conclusions. Nonetheless, denudating and covering large scope psychological, biomedical, medical engineering and therapy milestones with regard to auditory perceptual learning is still beneficial to policy and medical bodies as well as agencies of advocacy. In this study, there has been advancement and exposition of related conclusions and literature which the author expects will help in furthering this study area. This is in regard to the challenges, achievements and further investigation areas as well as improvements deciphered this far in the study of auditory perceptual learning.

Conclusion and Recommendations for Future Studies and Interventions

As posited in the study, many changes related to training happened at cognitive processes that are specific to tasks and are of higher levels and this evidenced by lack of generalization to hearing, reading and speaking tasks as well as duration and frequency discrimination tasks. Since the definition of differences between groups with ARHL and normal hearing has a basis on lower level perceptual and acoustic processing, the learning gains that are larger in the group with normal hearing shows there are interactions between top-down and bottom-up processes. Specifically, changes related to learning in high level cognitive processes that are task related are increased by perceptual representations that are of high quality in the group with normal hearing. Additionally, the generalization findings to pseudo words only in the group with ARHL points out that some changes related to learning also happen at levels of phonemic representation identification in this group. Undoubtedly, since the phonemic and perceptual representations in the group with ARHL were of low quality, the program of training affected representation levels in those with ARHL more than those in the group with normal hearing.

Empirically, it was found by the investigations of the author that the utilized auditory training was of benefit to individuals with hearing loss that moderate to mild. Future research needs to conduct measurements on processing strategies that are top-down to enable the enhancement of training effects understanding. Methods of training that may be more effective may be available to add to the programs of training and maybe this necessitates training that is more diverse in additional tasks or training that is more intensive over extended time periods or changes to be made to the feedback type utilized. Studying of regimens of training that produce more generalization are also required. The aggregated findings from the four studies that have been cited it can be seen that the present study has effectively tested home based training effects in situations of every day listening for older adults that suffer from hearing loss that is sensorineural and is moderate or mild and have experienced difficulties in hearing without the utilization of aids of hearing as well as listeners whose hearing is normal within age rages that are similar. Training outcomes on perception of speech have been compared between adults with ARHL and those with normal hearing. Training outcomes on generalization to non-speech and speech tasks were also examined. The focus of the study was adults that have moderate to mild hearing loss that is sensorineural and that experience difficulties in hearing without any interventions sought for their loss in hearing together with adults that have hearing that is normal.

a) Significant study conclusion includes:

i. Robust learning effects induced by training were observed and found to be both in the group with ARHL as well as the normal hearing individuals and for the tasks that were trained it was not confined to the materials of training.

ii. From all categories sampled for tests that were empirical, more learning was observed in the group with normal hearing compared to the ARHL group in conditions of speech in noise, and this validated the need for instrument and training interventions for adults that have or don't have ARHL.

iii. Generalization to pseudo word perceptions in noise was only evident in the group with ARHL.

iv. In noise sentence perceptions as well as frequency and duration discrimination showed no improvements in either of the groups that were trained. In combination the findings show that even though learning remains intact in older adults with ARHL and those with normal hearing, there is a limitation of generalization.

Previous Study Findings and Precedents: Previous studies that have been cited conducted evaluations on home based ecological training effects on ARHL participants Sweetow [7] as well as participants with hearing that is normal Anderson [14]. Discoveries were made that speech sound neural processing was altered by perceptual training and it also led to promotion of perceptual and cognitive skills. Improvements in both perceptual and physiological were also evident among participants in one of the studies Andersons [15]. Learning comparisons between adults with normal hearing and those with ARHL found significant changes that were induced by training in perception of speech in noisy conditions especially in the trained group whose hearing was impaired, but no changes were evident in the group with normal hearing Anderson [14].

For the expansion of future studies literature, other different publications have made the hypothesis that ecological tasks training with sentences that are whole where top down processes are accentuated will lead to generalizations that are wider compared to training that focuses on auditory capacities that are specific Sweetow [7]. The author of this study utilized the approach related to age since evidence from individuals with normal hearing as well as few studies on auditory rehabilitation points out that the accentuation of processes that are top-down at training has more generalization effectiveness compared to basic acoustic training Borg [19]. Listeners may be capable of cramming the utilization of semantic knowledge that they have stored with regard to the language or topic as well as verbal information that is presented visually for the facilitation of perception for auditory signals that are episodic.

Conclusions and Recommendations on Learning and Generalization

Learning on the Trained Tasks: In line with studies done previously Humes [20], there was observation of learning in the groups that were trained. Learning at the phases of training that was significant was seen in both ARHL and normal-hearing. Performance of participants was better at the training periods end compared to the beginning and this showed that speech understanding by participants improved over the training period in all conditions. Similar learning patterns were observed in both ARHL and normal hearing groups in conditions of speech that time compressed as well as speakers competing, and this was evidenced by learning curves that were overlapping. Additionally, in the condition of speech in noise, there were steeper learning curves in the group with hearing that was normal compared to those with ARHL, showing that influences of training were greater in the listeners with normal hearing compared to those with ARHL. The study is the first to conduct comparisons between outcomes of training for ARHL and normal hearing groups. The definition of the groups is in regard to their differences in sensory processes of the lower level. Despite the program of training being designed to focus on cognitive processes that are top down on higher levels, the learning differences show that perceptual representations that were of low quality in ARHL diminished benefits of this training type. Possibly, the utilization of hearing aids can result in improvements in representation quality and enhancement of training benefits [21-28].

Generalization: Even though trained condition learning was not specific to stimulus, amounts of transfers induced by training to other tasks were minimal. There was limitation of transfers to the task of pseudo words as well as the group with ARHL. Additionally, in the study there was no generalization of training to sentence tasks of speech in noise that was not trained. The task involved listeners judging sentences semantic plausibility with noise being embedded. There was a difference of the task to the trained ones where there was asking of questions with multiple choices. Therefore, despite the same bubble noise being used, task requirement changes were enough for generalization preclusion. Additionally, there were absences of transfers in both groups with regard to psychophysical abilities that were basic such as frequency and duration. The findings show that the training type utilized only enhanced cognitive processes that were task specific and of higher levels but not auditory processing that was of low level [29-37].

The minimal generalization effects seen in the group with ARHL have also been seen in other training studies that utilized training programs that were similar Sweetow [7]. It was reported by Sweetow et al., that there were only small generalization effects to outcomes of speech in ARHL adults. However, young adults with normal hearing displayed generalization to speech tasks that were untrained in similar programs showing that there was improvement of neural representation cues due to training Song et al., In combination, the results show that generalization was restricted in the current study due to old age that is responsible for degenerative changes of loss in hearing. Discrepancies between generalization and learning in the group with ARHL can be interpreted as meaning that even though the focus of listeners was on sentence content and not phonetic or acoustic stimuli characteristics, low signal qualities due to noise and auditory loss caused listeners to rely on sensory representations of lower levels that were not specific to sentences. Even though abilities of utilizing sensory representations of low levels may have been beneficial in deciding about pseudo words, they wouldn't be enough for demands of new semantics Banai et al.

In line with such interpretations, it is possible that sensory representations that er mid-level were utilized in training of the tasks involving pseudo words. Learning did attain the high sentence level representations as well as the low parameters of acoustics for duration and frequency. This can be associated with the feedback and tasks types utilized in training or may be due to general auditory training features as previous studies suggest. A different hypothesis is that perceptual speech level generalizations can be observed through other different outcomes which the current study does not utilize Amitay et al., like real words identification. Error patterns displayed by researchers in early trials are substantial. There is often an advancement of various learning curve plateaus by performance instead of learning growths that are multiple-exponential that can be predicted from temporary and discretely segregated learning types. In my opinion, challenges for future studies include incorporating likelihoods of early perceptual learning into experiment designs instead of going for early trial exclusions from being considered due to the ages of learners on auditory perceptions.

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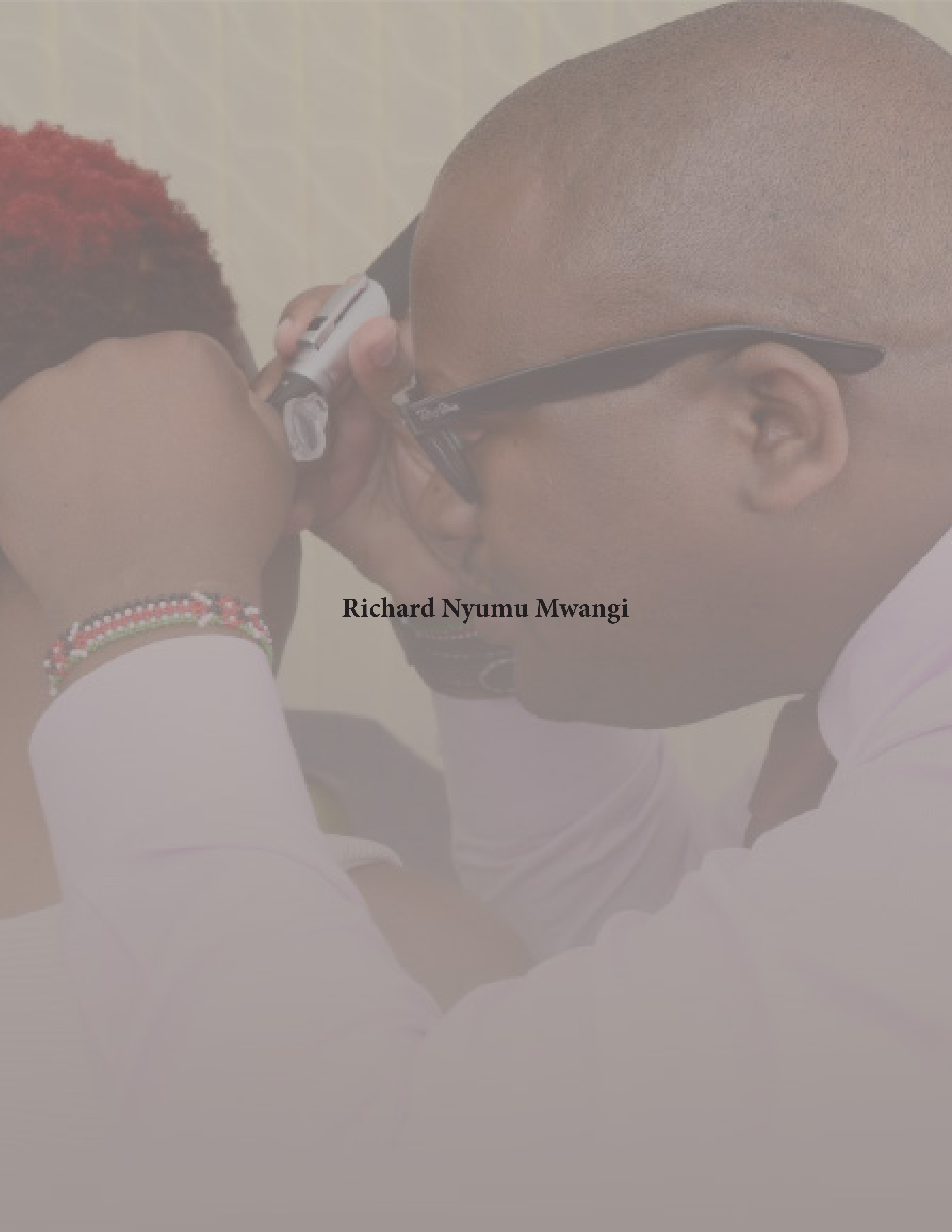
Richard Nyumu Mwangi