EVALUATION OF TEMPORAL RESOLUTION ABILITIES AND SPEECH PERCEPTION IN NOISE IN ABSTINENT ALCOHOLICS AND NON-ALCOHOLICS

KALAIYARASAN R

REGISTRATION NO.: 18AUD015

ALL INDIA INSTITUTE OF SPEECH AND HEARING

MANASAGANGOTHRI, MYSURU

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AUDIOLOGY

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CERTIFICATE

This is to certify that this dissertation entitled **“Evaluation of temporal resolution abilities and speech perception in noise in abstinent alcoholics and non-alcoholics”** is the bonafide work submitted in partfulfillment for the degree of Master of Science (Audiology) of the student Registration No.: 18AUD015. This has been carried out under the guidance of the faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru
July, 2020

Dr. M. Pushpavathi
Director
All India Institute of Speech and Hearing
Manasagangothri, Mysuru

CERTIFICATE

This is to certify that this dissertation entitled **"Evaluation of temporal resolution abilities and speech perception in noise in abstinent alcoholics and non-alcoholics"** has been prepared under my supervision and guidance. It is also being certified that this dissertation has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru
July, 2020

Dr. N. Devi
Guide
Reader in Audiology
Department of Audiology
All India Institute of Speech and Hearing
Manasagangothri, Mysuru

DECLARATION

This is to certify that this dissertation entitled **"Evaluation of temporal resolution abilities and speech perception in noise in abstinent alcoholics and non-alcoholics"** is the result of my own study under the guidance of Dr. Devi N, Reader in Audiology, Department of Audiology, All India Institute of Speech and Hearing, Mysuru, and it has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru
July, 2020

Registration No.: 18AUD015

என் தாயையும்

தமிழையும்

வணங்குகிறேன் !!!

Acknowledgement

உணர்வுகளைப் புரிந்துகொள்ள வார்த்தைள் தேவையில்லை!!! இருந்தும் விதைக்கிறேன்...என்றைக்கும் பேச்சு மற்றும் கேட்பியல் துறைக்கு முன்னோடியாய் விளங்கும் ***"AIISH"*** பல்வேறு சாதனைகளையும்..சாதனையாளர்களையும் உருவாக்கிய களஞ்சியம். அதில் ஓர் நினைவாய் இருக்க வேண்டும் என்பது எல்லோருக்கும் ஒரு கனவாய் இருக்கும்!? நானும் இருந்தேன்...அக்கனவுகளின் நினைவுகளை சுமந்தபடி... அந்த ஓர் நாள் வந்தது..! நானும் அக்கனவில் பயணிக்கத் தொடங்கினேன்... ஆச்சரியத்தோடும்!! குழப்பத்தோடும்? நிறைய சிந்தனை, குழப்பம், சிரிப்பு, அழுகை, வலி, வெற்றி என எண்ணில் அடங்கா நினைவுகள். முதன்முறையாக என் கூட்டைவிட்டுப் பிரிந்திருக்கக்கூடக் கற்றுக்கொடுத்தது!

பலரின் பெயர்களையும், அவர்களின் முகங்களையும் புத்தகங்களில் மட்டுமே பார்த்துவிட்டு.. திடீரென அவர்களை நேரில் பார்க்கும்போது பிரமிப்பாய் இருந்தது!!! மேலும் அவர்களே எனக்கு ஆசிரியர்களாய் ஆனபோது வியப்பின் உச்சத்தில் நின்றேன்!

என் முதல் வியப்பு..!!

Dr. Devi... இந்த பெயர் கேட்டால்...மொத்த கல்லூரியின் மாணவர்களும் சொல்லக்கூடிய ஒரே வார்த்தை **தெய்வம்**. ஆமா.. என்னோட **தெய்வமும், Guide'ம்** இவர் தான். எப்போதும் ***Cool*** ஆக இருப்பவர். அவரோட பிள்ளையாய் நினைத்து என்னோட உடல்நிலையிலையும் நிறைய அக்கறைக் காட்டுவார். இதுநாள் வரை ஒரு *Guide*-ஆ எங்களைத் திட்டினதோ... அதட்டியதோ இல்லை...எப்போதுமே தட்டிக்கொடுத்து வேலை செய்ய சொல்வார்... *Guide* ஆக மட்டுமில்லாமல் ஒரு ஆசிரியராகவும் இவரிடமிருந்து நிறைய கற்றுக்கொண்டிருக்கிறேன். வகுப்பில்.. எல்லா மாணவர்களின் கருத்துக்களையும் கேட்பது...அதுமட்டுமில்லாமல் அவர்களின் அறிவிற்குத் தீனி போடக்கூடிய வகையில் நிறைய கருத்துப்பரிமாற்றம் செய்ய சொல்வார்கள்.. ***Always, my guide is cool!!!***

Dr. Sandeep... பயம் கலந்த மரியாதை அவரிடம்.. என்னோட முதல் *presentation* அவரிடம் தான். அனைவரும் அவரைப் பற்றி சொன்ன கதையில் நான் உண்மையில் பயத்தில்

இருந்தேன். இருந்தும் ஒரு உத்வேகத்தோடு அந்த *presentation* முடித்து அவரிடம் நல்ல பெயர் வாங்கிய பிறகு, ஒரு அளப்பரிய மகிழ்ச்சி. நிறைய கற்றுக்கொண்டேன்..ஒரு ஆசிரியர் ஆவதற்கான முயற்சிப் பாதையை...

அடுத்து நான் இன்றும் வியந்து பார்க்கும் ஆசிரியர்கள்... இந்தியாவில் ***Vestibular Audiology'ல்*** நிறைய ஆராய்ச்சிகளில் ஈடுபட்டவர்களில் இவர்களும் அடக்கம்... ***Dr. Sujeet & Dr. Niraj.***

Dr. Sujeet – ஒரு நண்பன் போல் இருப்பார்...நான் எந்த ஆசிரியரிடம் அவ்வளவு பேசியது இல்லை ஆனால் இவரைத்தவிர.. இவரின் சுறுசுறுப்பு எனக்குள் மாற்றம் தந்தது. இவர் எடுத்த அந்த *Vestibular* வகுப்புகள் மறக்கமுடியாதவை. எனக்குத் தூக்கம் என்பது இவரது வகுப்பில் வந்ததே இல்லை... இவர் என்னிடம் பேசும் தமிழ் மறக்க முடியாத அனுபவம்.. **என்னடா கலையரசன்!!!** இவரால் தான் எனக்கு *Vestibular Audiology* மீது ஈர்ப்பு வந்தது.

Dr. Niraj – இவரைப் பார்த்தால் எல்லா மாணவர்களும் நடுங்குவார்கள்... நானும் தான். ஆனால் இவர் எனக்கு ஆசிரியராய் வரும் வரை தான் அந்த பயமெல்லாம் இருந்தது. ஒரு ஆசிரியராய் இருக்க.. புதுமையான சிந்தனையும்.. நிறைய நுணுக்கங்களும் தேவை. அதை இவரிடம் கற்றுக்கொண்டேன்... என்றென்றும் என் நினைவில் நீங்காமல் இருக்கும்... *RP* முடிந்து இவரிடம் பெற்ற பாராட்டு...

அடுத்து நான் பார்த்து, வியந்து, பயந்த ஆசிரியர் ***Dr. Asha Yathiraj***... இந்த பெயரைத் தெரியாத நபர்கள் நம் துறையில் இருக்க வாய்ப்பில்லை. அந்த அளவு பெயர் கொண்ட ஆசிரியரின் வகுப்பில் இருந்தது எனக்குக் கிடைத்த பெருமை. ***Speech perception***'ல் ஆர்வம் கொண்டு வந்தவர். இவர் வகுப்பில் இருப்பதற்கு அவ்வளவு பயமாக இருக்கும், ஏனென்றால், எந்த நேரத்தில் என்ன நடக்கும் என்று யாருக்கும் தெரியாது. ஆனால் நிறைய கற்றுக்கொண்டேன் – ஒரு மூத்த பேராசிரியரிடம் இருந்து... இவரிடமும் நல்ல பெயர் வாங்கியிருக்கிறேன் என்பது என் அழகான நினைவுகளில் ஒன்று...

என்னோட வாழ்க்கையையும் அழகாய் மாற்றிய, நிறைய நல்ல நினைவுகளில் இடம்பெறக்கூடிய மறக்க முடியாத.. ஒரு நல்ல மனசு... **நிவேதா**.. என்னோட சிரிப்பும் தெரியும் அழுகையும் தெரியும் அவளுக்கு... எப்போதும் எனக்குத் துணையாய் இருப்பவள். சிரிச்சுட்டே இரு!!!

அடுத்து என் உயிரு...**ஸ்ரீதர்**.. இவன் இல்லனா நிறைய நேரங்கள்'ல என்ன செஞ்சிருப்பேன்னு தெரியாது... நிறைய அரட்டைகள்..சண்டைகள்..சிரிப்பு..அழுகை'னு... இவன் என் வாழ்க்கையை நாசம் பண்ணாத நேரமே இல்ல...இன்னைக்கும் கூட என் மனசுக்கு என்ன பிடிக்கும்'னு இவனுக்குத் தெரியும்...

Hostel Life...எப்படி வாழ்க்கையை வாழணும்...எப்படி *adjust* பண்ணிக்கணும்-னு...இது கற்றுக்கொடுத்த பாடம் நிறைய...ஒவ்வொரு அறையிலையும் ஒவ்வொரு ஜந்து இருக்கும்... எப்போதும் இங்கேயே இருக்கணும்-னு நினைக்கவைக்கிற என்னோட அறை...அது எல்லாமே மகிழ்வான நினைவுகள்...மறக்க முடியாத தருணங்கள்...

Data collection செய்வதற்கு உறுதுணையாய் இருந்த *Rehabilitation centres* உரிமையாளர்களுக்கு மிகப்பெரிய நன்றி..

எப்போதும்...திறன் தேடலில்!!!

- உங்கள் நான் கலை

ABSTRACT

Conspicuous consumption of alcohol is one of the evident sources to show an effect of fine auditory structures, both anatomically and physiologically. Abusive use of alcohol also has shown its traces in the central nervous system. Serious effects of chronic alcoholism have been reported through electrophysiological measures. However, the psycoacoustical abilities of alcoholics; and its relation with abstinence are less explored. The present study aimed to evaluate the temporal resolution abilities: gap detection test (GDT), temporal modulation transfer function (TMTF), and speech perception in noise (SPIN) in abstinent alcoholic and non-alcoholics (groups). A total of 80 ears were included in this study. The results of this study indicate that there is a significant difference in temporal resolution abilities: GDT, TMTF; and SPIN between groups. A statistically significant positive correlation is seen between GDT and TMTF frequencies, also within TMTF frequencies, and a significant negative correlation is seen between SPIN and TMTF in abstinent alcoholic individuals. It can be concluded that chronic alcohol consumption leads to demyelination at most typical sites of auditory structures. Thus, alcohol addiction has shown its deleterious effect in audition and its finest temporal processing abilities even in abstinence.

Keywords: Abstinent alcoholics, GDT, TMTF, SPIN

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Chapter I

Introduction

Alcohol use disorder (AUD) is well-defined by a collection of behavioral and physical symptoms; it includes detachment, permissiveness, and craving. Perdurable alcohol consumption causes individuals with significant physical, social, psychological, or interpersonal problems (American Psychiatric Association [APA], 2013). Repeated large doses of alcohol affect nearly every organ system, especially the gastrointestinal tract, cardiovascular system, the central and peripheral nervous systems. Peripheral neuropathy possibly has proven by myasthenia, abnormal skin sensations (tickling, itching), and reduced peripheral sense. Tenacious central nervous system (CNS) effects include severe intellectual and memory deficits and deteriorating changes in the cerebellum, which is associated with immediate outcomes of alcohol, trauma, and vitamin deficiencies (especially Vitamin-B). Ravaging CNS effect is quite rare alcohol-induced prevailing amnesia or Wernicke-Korsakoff syndrome; it severely impairs the encoding ability for new memories (APA, 2013)

Alcohol is one of the two most widely used psychoactive substances (excluding caffeine, which is relatively unproblematic) with an estimated three billion consumers of alcoholic beverages. The deleterious use of alcohol is the contributing factor in over 200 diseases & injuries. Disability Adjusted Life Years (DALYs) quantified that overall, 5.1% of the global diseases and injuries were attributed to alcohol. Around 13.5% of overall fatalities were due to alcohol in the 20-39 years age group. On an overall population of India: Males – 39.1%; Females – 68.8%; both sexes – 53.5%

were reported as lifetime abstainers (15+ years) (World Health Organization [WHO], 2018).

The widespread use of alcohol has become a major public health concern for most countries all over the world. About 5.3% of all deaths happenings around the world (3 million) results from the abusive use of alcohol (WHO, 2018). Consumption of alcohol is ranked as the global third most causal factor for diseases and disability and as the greatest risk in the middle-income country (WHO, 2011). In India, 60 percent of the population lives in rural areas with the most fundamental level of education. A rural migrated population inhabits India's urban slums. Literature reports that the dependence of alcohol in this population is three times higher than in the rural population (Chavan, Arun, Bhargava & Singh, 2007).

Abstinence is defined as the number of drug-free days or weeks during the treatment regimen, and measures of the drug in urine are often used as objective indicators (Peele, 1995). Abstinence is the total avoidance of activity; it can also be used as a treatment-outcome measure, as an indicator of its effectiveness. Abstinence comprises three time periods: Acute detoxification (first two weeks of abstinence); Intermediate-term abstinence (after detoxification and extends to first two months of abstinence), and Long-term abstinence (extends from two months to five years of abstinence) (Fein, Bachman, Fisher & Davenport, 1990).

There is a significant proof in terms of mental health that cognitive impairment remains after alcohol withdrawal in individuals with long-standing and extreme use of alcohol (Eckardt, Stapleton, Rawlings, Davis & Gordon, 1995; Grant, 1987; Yohman, Parsons & Leber, 1985). Rational thinking, cognition flexibility and persistence, and inhibition of challenging responses often seem to be impaired after years of heavy alcohol consumption (Noel et al., 2001; Ratti, Giardini & Soragna, 2002). Hence, there is a need to study auditory processing deficits as a consequence of excessive alcohol use, which may facilitate an understanding of the effects of alcoholism and primary, secondary, or tertiary prevention accordingly.

Need for the study

Everyday communication involves the perception of speech in adverse listening situations like in noise or reverberation. It includes the extraction of key features of an auditory signal using several sensory processes. One such acoustic process which aids in speech perception is the temporal resolution ability, which codes the changes in the auditory signal occurring over time. The processes can affect speech perception in noise, discrimination of phonemes and duration, perception of rhythm, and prosody (Phillips, 2002; Chermak & Museik, 1997). Speech perception in noise is highly dependent on the temporal resolution ability of an individual, and their performance has shown a good correlation between speech and psychoacoustic tasks. As the SNR of the stimuli increases, better correlation with frequency modulation detection in both steady-state and modulated noise conditions were reported. Speech perception performance was deteriorated with increasing levels of distortion and reverberant speech stimuli. Authors have also stated that elderly listeners performed poorer in perceiving speech in the presence of noise (Papakonstantinou et al., 2011; Helfer & Vargo, 2009; Summers, Makashay, Theodoroff, & Leek, 2013; Walker et al., 2011; Elangovan & Stuart, 2008;

Fitzgibbons & Wightman, 1982; Moore, Galsberg, Donaldson, McPherson & Plack, 1989 and Gordon-Salant & Fitzgibbons, 1993).

Ahveninen et al. (1999) recorded middle latency response in 14 male alcoholics with 1-6 weeks of abstinence. Pa peak amplitude is larger in alcoholics, and a negative correlation between Pa amplitude and abstinence period was shown. Ehrensing, Stokes, Pick, Goldstone, and Lhamon (1970) assessed an intoxicated individual's capacity to create judgments on the duration of auditory signals. Participants made judgments in a prolonged period that equals to a second. Díaz, Cadaveira, and Grau (1990) recorded auditory evoked potentials in chronic alcoholics with abstinence of one month. In the brainstem auditory evoked potential, peak V was considerably delayed. Inter peak latencies (I-V, III-V) were prolonged. In contrast, Na and Pa latencies were significantly shortened. Significant amplitude reduction of auditory cortical potentials in humans and cats indicates attenuation for detecting auditory signals. The amplitude of cortical potentials revealed a decreasing trend for even a small quantity of alcohol intake (Grenell, 1959; Nakai, Sasa & Takaori, 1966; Hari, Sams & Jarvilehto, 1978; Chu & Squires, 1980; Teo & Ferguson, 1986).

Wolff and Gross (1968) reported that no damage to sensory end organs was found in the auditory system of chronic alcoholics. The physiological outcomes stated that alcohol could affect the Central nervous system, whereas more peripheral mechanisms are spared. Most studies have tested the effect of alcoholism on auditory processing, and few studies reported the effect of abstinence in alcoholism on sensory processing using electrophysiological measures. Since chronic alcoholism affects central auditory processing, it is vital to evaluate the impact of abstinence in alcoholics through the perception of speech in noise and temporal resolution abilities.

Aim of the study

To evaluate the temporal resolution abilities using gap detection test (GDT), temporal modulation transfer function (TMTF) and speech perception in noise (SPIN) in abstinent alcoholics and non-alcoholics

Objectives

1. To study the effect of alcohol abuse in temporal resolution abilities of abstinent alcoholics using gap detection test (GDT) and temporal modulation transfer function (TMTF)
2. To study the effect of alcohol abuse in the perception of speech in noise for alcoholics in abstinence
3. To correlate the temporal resolution and speech perception in noise in abstinent alcoholics with non- alcoholic individuals.

Null hypothesis

The null hypothesis is framed for each main objectives of the study. They are:

- There is no significant effect of alcohol abuse in temporal resolution abilities of abstinent alcoholics
- There is no significant effect of alcohol abuse in the perception of speech in noise for abstinent alcoholics

- There is no significant correlation in temporal resolution abilities and perception of speech in noise between abstinent alcoholics and non-alcoholics

Chapter II

Review of literature

Temporal processing

The perception of an acoustic stimulus or its alterations within the controlled period is well-defined as Temporal processing ability. This ability is a primary element for most of the auditory processing abilities, and this is more evident at the auditory pathway hierarchy. This prominence in physiological activities ranges from the instant neuronal responses to the effects of time and accelerates to higher-level processing sensory cortical areas to process complex speech stimuli. Temporal processing ability was grouped into four major types to process the acoustic stimulus and all the classes of this processing ability, which is more important for auditory processing. Those four significant types of temporal processing abilities are: ordering (or) sequencing, resolution (or) discrimination, integration (or) summation, and masking (Shinn, 2003).

One of the temporal processing abilities is the discrimination (or) resolution; it is an ability of an individual to detect the brief change and discriminate the acoustic signals that have been presented within a short period. Generally, it will be around 2-3 msec. The threshold for this type of temporal processing is termed as temporal auditory acuity (or) minimum integration time (Green, 1973). Gap detection threshold (GDT) and Temporal modulation transfer function (TMTF) were mostly used to compute an individual's temporal resolution ability. The temporal modulation transfer function is used to evaluate an individual's ability to identify amplitude variations in an acoustic stimulus, and the Gap detection test is used to assess the ability of an individual to detect the presence of a small gap within an acoustic stimulus (Shinn, 2003).

2.1 Temporal resolution

The human auditory system is capable of following the brief, rapid change in an acoustic signal within a short time known as temporal resolution. It can be measured in several ways: gap detection, detection of temporal modulation, duration discrimination, and gap duration discrimination. Researchers have also stated that if there is any presence of temporal resolution impairment in an individual, which insists extreme effort to understand speech signal at adverse listening conditions (Rawool, 2006).

2.1.1. Temporal resolution abilities in temporal modulation transfer function (TMTF)

Modulations in the amplitude of an acoustic signal are one of the primary factors seen in all environmental sounds; it also includes most of the communicating signals. Even human vocal cords periodically vibrate and produce amplitude modulated speech waveform; it is due to the vocal tract features. Primary information to perceive speech signals solely depends upon the temporal envelope (Drullman, 1995).

Bacon and Viemeister (1985) studied TMTF in normal-hearing and hearing-impaired listeners. Four normal hearing and 6 hearing-impaired subjects with the age range from 20-31 years were considered for the study. Sensitivity to modulation remains constant up to 10Hz, reduced by 3 dB at 50Hz, above 50Hz sensitivity decreases by 4-5 dB/octave. In hearing-impaired subject's TMTF changed extremely as the function of level decreased from 30 dB. Authors have suggested that peripheral cochlear filtering mechanisms did not limit normal-hearing individuals, making it more parsimonious to adopt for hearing-impaired individuals. Also, the apical area of the cochlea has a narrower bandwidth that had a more significant effect on the high modulation frequency. Its sensitivity decreased rapidly at higher modulation frequency relative to the lower modulation frequency.

Temporal processing ability was assessed in normal-hearing and hearing-impaired individuals using TMTF. Carrier frequencies were 1 kHz, 2 kHz & 5 kHz, and modulation over the rates ranged 10–640 Hz/octave. For testing healthy hearing individuals, the presentation level was maintained at 30 & 80 dB SPL. The thresholds to detect the modulations slightly varied till 80 Hz of the modulation rate at higher presentation levels, and it reduced above this rate. But for low presentation levels, thresholds were modified slightly for all carrier frequencies. This study concluded that temporal resolution ability is analogous for both NH and HI individuals (Moore & Glassberg, 2001).

2.1.2. Temporal resolution abilities in gap detection

Gap detection skill is one of the finest abilities of a human auditory system, and it assesses the individual's temporal resolution ability. A rapid, brief interval between an acoustic signal will be given in the gap detection task. Healthy normal hearing individuals can detect the gap between acoustic signals, mostly within 2-20 msec (Owens, Campbell, Liddell, DePlacido, & Wolters, 2007).

Lister and Roberts (2005) reported the age effect and hearing loss severity effects on gap detection tasks and precedence effect. An Individual's impairment in temporal resolution ability affects the performance in speech tasks (Rawool, 2006). The main aim of this study is to evaluate whether temporal resolution abilities are related to temporal fusion. Monotic, diotic, and dichotic gap detection tasks were given within and between the ears, respectively. Temporal fusion ability was assessed by using lag burst under 3 different listening conditions. GDT and threshold of lag burst were evaluated by using noise bursts. The study included young adults with normal hearing, older adults with normal hearing and hearing impaired. The study concluded with better temporal resolution abilities were seen within ear condition than between ear condition. Also, the age effect and hearing loss severity effect depends upon the conditions used to assess the temporal processing abilities.

Samelli and Schochat (2008) studied temporal resolution ability in 100 normal-hearing adults (50 males and 50 females). And this study reported that the average GDT was 4.19 ms. A psychometric graph was created for gap duration task, and it showed maximum accuracy of above 96% with GDT of 5 ms; 60-70% with GDT of 4 ms; 10-30% with GDT of 3 ms; only less than 5% of accuracy seen with GDT of 2 ms.

2.1.3. Temporal resolution abilities in duration discrimination for complex tone

Kumar, Sanju, and Nikhil (2016) evaluated vocal musicians' temporal processing abilities. Authors have concluded that a better threshold obtained by musicians for temporal discrimination task, which shows an improved temporal discrimination ability when compared with non-musicians. Temporal resolution and active auditory discrimination skills in vocal musicians. Guclu, Sevinc, and Canbeyli (2011) conducted a study to assess the temporal resolution ability of individuals who trained in music and non-trained. The results of this study revealed that trained musicians performed better than non-trained individuals. Better performance was seen with trained musicians (adults and children) than non-trained musicians. (Sangamanatha, Fernandes, Bhat, Srivastava, & Udupa, 2012)

2.2 Effects of alcoholism in brain volume

Demirakca et al. (2011) reported that consumption of alcohol has harmful effects on the brain's function, area, metabolism, and density. Extending the period of abstinence helps in reversing some of these adverse effects to a certain extent. Consuming alcohol affects both genders, but the severity of impact differs. An equal proportion of increment in cerebrospinal fluid volume and decrement in neuronal density in both sexes. Mainly, neuronal grey matter density loss was more for male patients; that includes significant areas of the brain, which helps for audition and cognition. Parietal lobe degeneration was more than the temporal lobe (Cardenas, Studholme, Gazdzinski, Durazzo & Meyerhoff, 2007).

Brain's volume was enormously reduced due to alcohol consumption. A similar effect was also seen for individuals who abstinent alcoholics. The decrement in cerebral volume found in both hemispheres which involved vital areas of the brain; all the four lobes were involved in degeneration, and even it extends to subcortical regions of the brain (Gazdzinski, Durazzo & Meyerhoff, 2005). Cadaveric studies in animals have shown a similar conclusion about the human brain with decreased cerebral cortex thickness. 3 significant brain lobes: Frontal, temporal, and parietal were the most susceptible areas that are affected by long-standing alcohol consumption (Santucci et al., 2004).

2.3 Chronic alcoholics and hearing loss:

2.3.1. Peripheral auditory effects

Duchon and Bauer (1960) demonstrated the effects of consuming alcohol and hearing impairment. Alcohol consumption affects the vital structure of the sensory system. Patients involved in this study were seen with the presence of hearing loss; sensory-neural in nature after 2 days of alcohol consumption without showing any traces of tinnitus. During the subjective hearing evaluation, it resulted in a saucer patterned audiogram for all study group populations. Then the participants' hearing level improved after they got involved in vitamin therapy enriched with Vit-B for about 96 hours. Even after some sort of management given to enhance their hearing level, a small notch at 4000 Hz in the audiogram was reported. Authors have stated that it might be due to the effects of noise exposure and concluded with a hypothesis that the presence of reversible mild hearing impairment is due to the intoxication of alcohol.

Nordahl (1964) has done a study of alcohol-consuming male individuals' hearing status. A total of eighty-three participants were included with a random age group and history of consuming alcohol, and this study also had an inclusion criterion of exposure to noise. Out of a total of eighty-three individuals, fourteen of them had different patterned audiograms; in that eleven of them had a history of noise exposure. All the participants in this study were subjected to specialized audiometric testing to rule out retro cochlear pathology (RCP). Tone decay test (TDT) was done to rule out RCP, and it resulted in negative findings for all the participants, & further testing to rule out RCP was done. Thereby, this study fails to confirm the auditory, vestibular nerve degeneration. Authors have concluded that a general presence of hearing loss in these types of alcohol-consuming individuals is more common; its leading root cause is exposure to noisy environments instead of intoxication of alcohol.

Upile et al. (2007) reported the status of the hearing system in long-standing alcohol individuals. A total of thirty healthy hearing individuals were recruited for this study. All of the participants were subjected to consume a proposed level of alcohol before they were involved in hearing evaluation. Audiograms were plotted before and after alcohol consumption—hearing status from these audiograms gave all the critical speech frequencies information. Second, audiogram testing was done to the individuals who had achieved a criterion of minimum respiration alcohol threshold. A prominent high positive correlation was the resulted between respiration alcohol threshold and increasing severity of hearing level at critical speech frequencies. Consuming alcohol mostly affects speech frequencies that help to discriminate the speech signal in adverse listening conditions. Authors have concluded most crucial frequencies to perceive speech signal was affected more in alcoholic consumers than non-consuming individuals.

2.3.2. Auditory-vestibular dysfunction

Bellé, Sartori, and Rossi (2007) studied the deleterious effects of balance and hearing in individuals consuming alcohol. The study included 74 individuals of anonymous alcoholics and control groups; these two groups were equally divided with age and gender-matched. Results have shown that 67.57% of individuals from the anonymous alcoholics' group shown abnormality in audiometry, and 24.32% shown abnormality in vecto-electronystagmography. In the control group, 27.03% of the individuals shown abnormality in audiometry, and 10.81% had abnormal computerized vecto-electronystagmography. The study concludes that alcohol interferes with an individual's hearing and balance, which causes deleterious effects on the cochlea-vestibular system.

2.3.3. Central auditory effects

2.3.3.1. Early evoked potentials

Rosenhamer and Silfverskiold (1980) examined individuals consuming alcohol and neurological deficit patients. A total of thirteen individuals with neurological deficits (tremors) were involved; out of thirteen individuals, eleven were alcohol-consuming individuals. Significantly delayed signal transmission time was noted at the brainstem level that was seen with ten individuals of the study group population. Authors have hypothesized that delay in signal transmission might be due to cerebral lesion, using the evidence from this study's results.

Begleiter, Porjesz, and Chou (1981) had done a study on chronic alcohol consumers using auditory brainstem responses and compared the obtained values with the control group population. All the alcoholic community had a varying history of alcohol consumption. They were instructed not to consume alcohol for about 21 days and subjected to a controlled environment before hearing assessment. In objective evaluation, individuals' auditory brainstem responses were delayed prominently, which is a key factor to explain the hypothesis that time taken to transmit signals through the auditory pathway was prolonged. Authors have concluded with a notion that this study results might explain the process of reducing myelination in important sensory structures.

Zhelyazkova and Benchev (2002) studied auditory evoked potentials in alcoholics. In this study, 80 chronic alcohol-intoxicated patients were included. Audiological evaluation was performed by using pure tone audiometry and ABR. Results have shown that 2 audiogram patterns obtained in these chronic alcohol-intoxicated patients. 46 patients had a flat type of audiogram with normal morphology of ABR and exhibited responses at normal absolute latencies and interpeak latencies. 34 patients had a sloping pattern of audiogram, sensory-neural hearing loss with greater loss in higher frequencies, and ABR has shown prolongation of absolute latency of peak V and its interpeak latencies. It was concluded that patients who were suffering from chronic alcoholism explained impairment of auditory system caused by the toxic agent. The cochlear and sensory-neural type of hearing loss gradually increases at higher frequency regions, and it also involves the higher auditory pathways.

Singh, Walia, Sharma, Kaur, and Kaur (2016) investigated how alcohol consumption affects the human audition system by using objective measures. The study involved fifty-two male participants and equally divided into two groups of alcohol consumers and non-consumers. It had an inclusion criterion for alcohol consumers with a history of alcohol intake for about 8 years. Objective measures were done on this study and control group by tapping out the brainstem response; evaluation resulted in significant prolongation in latency of the fifth positive peak and inter-peak latencies. Authors have concluded that too much alcohol consumption can affect the pathway that yields auditory structures. Intake level and consuming time were the main reasons beyond this deleterious effect of hearing level in these individuals.

Piramanayagam, Thenmozhi, and Banu (2017) compared brainstem evoked potentials between chronic alcoholics and non- alcoholics. The study included 120 participants (study and control groups). The study group consists of 60 participants who were persistent alcoholic men consuming alcohol more than 21units per week (1 unit – 10 grams), and the control group includes 60 participants who were non-alcoholics. Study results have shown a very high significant increase in mean latencies of third and fifth positive peaks, and average interpeak latencies in the study group were similar to the control group population. Begleiter et al. (1981) stated that chronic alcohol consumption was detected with central pontine myelinoisis; pathological changes usually involve the core region of mid to the basal areas of the pons. The presence was assured by these areas of abundant supporting cells; it is evident with relatively intact pressure by surrounding anatomical structures. A significant increment in transmission delay of acoustic signals at the brainstem level in alcohol-consuming individuals is due to the demyelination of pathways for auditory areas and major pontis regions.

2.3.3.2. Cortical evoked potentials

Cognitive event-related potentials were recorded in alcoholic consuming individuals, and it always resulted in a prominent decrement in P3b amplitude. (Patterson, Williams, McLean, Smith & Schaeffer, 1987; Pfefferbaum, Ford, White & Mathalon, 1991). Many researches evidences have also reported with latency prolongation in P3b peak in alcohol-consuming individuals (Pfefferbaum et al., 1979, 1991). Also, a prolonged second negative peak precedes the third positive peak in event-related potentials (Sandman, Gerner, O'Halloran & Isenhart, 1987; Cadaveira, Grau, Roso & Sanchez-Turet, 1991).

Costa et al. (2000) investigated P300 event-related potentials (ERPs) in alcohol-addicted and psychiatric patients. This study had a large number of case samples, and event-related potentials were recorded for alcohol addicts and non-alcoholics adults. Participants were further grouped based upon their mental status and age. Prominent P3 amplitude reduction was seen in the alcohol addicts group, too, when recording ERP at precedent sites. This study results data were better correlated within the advanced radiological evaluations. The authors of this study have concluded that P3 was found only at precedent electrode sites and hypothesized that ingenious physiological abnormality at the frontal cerebral cortex of alcohol-consuming individuals.

Maurage et al. (2007) studied the effects of alcohol drinkers using higher-order cortical potentials. Ten alcohol addicts were taken as a study group, and the control group consists of ten non-alcoholic individuals; all of them were age and gender-matched. The results of this study revealed that loss of P3 waveform; and better correlation with earlier peaks of higher cortical potentials, which explains the presence of cognitive impairment in alcohol drinkers. Authors have hypothesized that loss of ERP might be a connection for early visuospatial impairment instead of definite impairment to P3.

2.4 Abstinent alcoholics and hearing loss

2.4.1. Peripheral auditory effects

Ribeiro et al. (2007) investigated the impact of alcohol consumption and exposure to noisy environments on the human auditory system. Seventy-five individuals included in the study and grouped into study and control groups. Subjective and objective hearing assessments were done using routine audiological testing. The results of this study have reported that alcohol-consuming participants shown more reduced performance with audiological evaluation. No evidence of synergic effect was seen with noise exposure and alcohol consumption in the auditory system, and authors have hypothesized that consuming alcohol for a long time may damage the inner ear and specific the outer hair cells.

Naik, Aseemsaifan, and Quadri (2018) reported moderate to severe sensory-neural hearing loss in subjective evaluation & absence of transient evoked otoacoustic emission in both ears chronic alcoholic patients who had a history of consuming alcohol for past 8-10 years and abstinence for 4 months. Conclude with sensory-neural hearing loss is uncommon in alcoholic peripheral neuropathy. Antonopoulos et al. (2012) reported with bilateral symmetrical moderate sensory-neural hearing loss in chronic alcoholic individuals and also with no measurable otoacoustic emissions.

2.4.2 Auditory vestibular dysfunction

Verma, Panda, Basu, and Raghunathan (2006) examined eighth nerve physiology in alcohol addicts, and their significant functional variations were compared with occasional drinkers and abstinent alcoholic drinkers. Twenty individuals with a history of abundant alcohol consumption were included in this study. All of the participants were assessed with subjective and objective measures of hearing and balance. For individual measures, the study reported a decrement in the hearing threshold level mostly at higher frequencies; objective measures have shown that significant delay in prominent peak latencies and inter-peak latencies. In corresponding to the balancing evaluation, a caloric test was done for all the study participants and reported with varying abnormal electro-nystagmography responses only for alcohol addicts with other associated symptoms (vertigo). Authors have concluded that only reported abnormality in alcohol-dependent individuals is the elevated hearing thresholds at higher frequencies and also with the presence of associated symptoms that might have a link with abnormal electro-nystagmography.

2.4.3. Central auditory effects

2.4.3.1. Early evoked potentials

Smith and Riechelmann (2004) evaluated the hearing status of 38 male patients who consumed alcohol in their life for a long time using objective audiological measures. Out of 38, 19 patients had the head, and neck tumor & another 19 were plastic surgery patients. All the participants of this study were subjected to a period of three days of abstinence. The duration of alcohol consumption was assessed using a standard self-assessing questionnaire. This study resulted that all the participants had normal hearing sensitivity, and it is quite analogous with the first positive peak of brainstem auditory responses for both groups, but even some level of variations were seen in waveform latencies of head and neck tumor group. These results have explained that persistent alcoholic individuals affect the eighth cranial nerve and core areas in the auditory route; prolongation in latency is explained via the absence of myelination in those anatomical sites (Begleiter et al., 1981; Kril, Halliday, Svoboda, & Cartwright, 1997).

2.4.3.2. Cortical evoked potentials

Pfefferbaum et al. (1979) evaluated 10 alcohol-consuming individuals, and they were included as participants with an inclusion criterion of not consuming alcohol (abstinence) for at least 2 weeks. All the participants were equally divided into study and control group and involved in electrophysiological testing (P300) that requires quite an active participation. They were all trained to press a button whenever they hear a different acoustic stimulus (500 Hz/2 kHz) and a standard acoustic stimulus of 1 kHz used. Latency and amplitude values of the first negative peak (N1) and the second positive peak (P2) were comparable with both the groups involved in the study whereas prominent positive peak P3 was significantly delayed in the study group and, to some extent, similar to non-alcoholic individuals. This study revealed that even individuals obtained responses within normal limits for earlier peaks in P300 had a prolonged P3 peak; this result with P300 event-related potentials was analogous to individuals with dementia.

Researchers studied event-related potentials using speech and non-speech stimuli in alcoholic individuals. This study has reported that even abnormal amplitude of event-related potential recovers as the period of the abstinence increases; also, a significant rise in N1-P2 amplitude was reported with abstinent alcoholics (Salamy, Wright, & Faillace, 1980)

Díaz, Cadaveira, and Grau (1990) studied abstinent alcoholics with short and middle latency auditory evoked potentials. 15 outpatients who are chronic alcoholics included as participants in this study. Participants should have a history of alcohol consumption at least 8 years, and before an assessment, they should have abstained for 25-35 days. ABR & MLR was done for alcoholic and non-alcoholic groups. Morphology of waveforms was normal, but more considerable variation was seen only in the alcoholic group. Results have shown that in ABR, significant prolongation of latency of peak V and its inter-peak latencies, and in MLR, the significantly smaller amplitude of Na and Pa for alcoholics is compared with non-alcoholics. This study information gives an idea that alcoholic abuse might bring anatomical and physiological variations at different levels of the pathway of the audition.

Grau, Polo, Yago, Gual, and Escera (2001) studied mismatch negativity in chronic alcoholics, involving 17 abstinent chronic alcoholics and 17 non-alcoholics. Participants were included in this study with the inclusion criteria of having a history of alcohol consumption for about four years. Results revealed similar mismatch negativity (MMN) for both alcoholics and control groups when the memory probe interval was 0.4 seconds. It was not detectable when the range increased to five seconds. This study results give a sign of cognitive deficit in abstinent alcoholic individuals.

Marco, Fuentemilla, and Grau (2005) studied ERP’s for alcohol drinkers to find the abnormality in cognitive ability. Seventeen participants were included in this study; had inclusion criteria of consumed alcohol for a minimum of four years. This study's results have shown a significant variation between the study group and the control group for eliciting ERP. Variations were reported with waveform amplitude and not related to latencies. Authors have concluded from the results that an impairment of acoustic sensory gating in abstinent alcoholic individuals can be viewed as impairment in the process of inhibition.

Literature has reported that consuming alcohol in the long term affects the auditory-vestibular functions. Effects of alcohol consumption are seen within peripheral sites and showed evidence at the central sites of the auditory pathway. Even abstinent alcoholics showed a structural and functional abnormality in the brain, bringing neurochemical alterations at the hierarchy of auditory pathways. Hence, it may affect the abilities of temporal processing and perceiving speech in adverse listening conditions; that put forth the need to study the effect of abstinence in alcoholic individuals.

Chapter III

Method

This research study was designed to evaluate the temporal resolution abilities using gap detection test (GDT), temporal modulation transfer function (TMTF), and speech perception in noise (SPIN) in abstinent alcoholics and non-alcoholics.

3.1. Participants:

Forty healthy normal hearing individuals within the age range of 20-40 years participated in this study. Based on the study inclusion criteria, these individuals were divided into two groups as abstinent alcoholics – group I (mean age = 31.0 years; SD = 6.9); non-alcoholics – group II (mean age = 21.15 years; SD = 1.8).

3.1.1. Inclusion criteria:

Abstinent alcoholics (Group I)

- Participants with a clinical diagnosis of alcohol use disorder according to DSM V criteria (APA, 2013) with abstinence of 21 days or more (Diaz et al., 1990).
- Individuals with normal hearing sensitivity. Hearing threshold: Air conduction hearing thresholds should be within -10 dBHL to 15 dBHL at octave frequencies between 250Hz to 8000Hz and Speech audiometry thresholds have to correlate with pure tone audiometry thresholds.
- No history/presence of any external or middle ear problem
- No history/presence of any neurological problem

- No history of diabetes mellitus and hypertension
- No history/presence of any medical-related problems
- No history of head injury
- No history of frequent use of opiate, inhalant or smoking
- No history of psychiatric disorders
- Abstinent alcoholic individuals, those who score greater than or equal to 24 points in Mini-Mental State Examination (MMSE) (Folstein, Folstein & McHugh, 1975)

Non-alcoholics (Group II)

- Non-alcoholic individuals who are willing to participate in this study will be interviewed for any substance abuse and exclusionary medical conditions.
- Individuals with normal hearing sensitivity. Hearing threshold: Air conduction hearing thresholds should be within -10 dBHL to 15 dBHL at octave frequencies between 250Hz to 8000Hz and Speech audiometry thresholds have to correlate with pure tone audiometry thresholds.
- No history of major depression, untreated sleep apnea, polypharmacy
- No history of severe head injury, stroke
- No history of any chronic neurological condition (Alzheimer’s or Parkinson’s disease), chronic psychosis or schizophrenia

3.2. Equipment:

The following equipment was used in the study.

- To measure pure tone and speech thresholds, a standard calibrated:
    - 2 channel diagnostic audiometer GSI-61 coupled with acoustically matched TDH 39 headphones housed in MX-41/AR and
    - Radio ear B-71 bone vibrator
- A standard calibrated, GSI tympstar 2 - middle ear analyzer
- A Lenovo laptop with AMD PRO, loaded with the MATLAB software (version 7.12.0 (R2011a))

3.3. Testing environment:

All audiological tests were carried out in an acoustically treated double room where the ambient noise levels maintained within permissible limits (American National Standard Institute [ANSI], 2013).

3.4. Stimuli & Procedure:

A consent form was taken from all the participants who were voluntarily participated in this study.

1. Detailed case history

A detailed case history was taken as a structured interview on the clinical symptoms of auditory and vestibular disorders, the presence of tinnitus, ototoxic drugs, and general health conditions.

2. **Otoscopy**

Before the testing, otoscopy was carried out to visually inspect the status of the external ear canal and tympanic membrane.

3. **Obtaining thresholds**

For each test ear, the hearing thresholds were established for air and bone conduction at octave frequencies using Modified Hughson and Westlake (Carhart & Jerger, 1959). To obtain Speech thresholds: speech recognition threshold (SRT) and word recognition scores (WRS) were obtained by utilizing the spondee word list developed by Samuel (1979) & PB word list by Mahima (2017) respectively. The phonemically balanced words were presented at the level of 40 dB above SRT, the uncomfortable loudness level (UCL) was obtained for running speech.

4. **Acoustic immittance audiometry**

Tympanometry (226 Hz probe tone) and reflexometry were done to rule out middle ear pathology (if any) and to obtain acoustic reflex thresholds for octave frequencies ranging from 0.5 kHz to 4 kHz respectively.

5. **Assessment of speech perception in the presence of noise and temporal resolution abilities**

Temporal resolution was assessed using the maximum likelihood procedure toolbox in MATLAB (Soranzo & Grassi, 2014). The entire test was done by using the 'mlp' toolbox. The 'mlp' implements a maximum likelihood procedure for threshold estimation in MATLAB platform Grassi and Soranzo (2009). It is useful to measure diverse individual's psychometric functions. For every trial, this procedure helps to assess the individual's performance for the presented stimuli.

Further, the psychometric function that gives the highest possibility is used to decide the stimulus to be presented in the next trial. It is reported that this procedure usually meets the relatively reliable approximation of the highest probable psychometric function within twelve trials, which can be utilized to approximate thresholds (Grassi & Soranzo 2009; Green, 1990, 1993). This procedure has been widely used to assess psychophysical abilities and found to have good reliability and validity (Kumar & Sangamanatha, 2011).

The test that was done and the procedure are as follows:

1. Gap detection test (GDT)

GDT test was done with the temporal center gapped band of Gaussian noise (750ms), varied across the listener's performance. 0.5ms cosine ramps were introduced at the onset & offset of the noise. Participants were presented with 3 alternate forced-choice (3AFC) tasks. The standard was always 750 ms BBN (broadband noise) with no gap & a gap presented in the variable. This test assesses the individual's temporal resolution ability.

2. Temporal modulation transfer function (TMTF)

TMTF is a noise discrimination task consists of sinusoidal amplitude modulation. Gaussian noise of 500ms is amplitude modulated sinusoidally at a rate of 8, 20, 60 & 200 Hz. Modulation depth (MD) is expressed at 20 log (m), where 'm' is the index for modulation. It ranges from 'No' to 'Full' modulation (0.0 to 1.0). The participants had to identify modulated noise intervals. A two 10ms cosine ramps were there at onset and offset of noises. MD is the threshold (in dB). This test assesses the individual's ability to detect the temporal resolution of the envelope.

3. Speech perception in noise (SPIN)

Phonemically balanced (PB) Tamil word list (Mahima, 2017) was used for the SPIN assessment. The stimuli were played on a laptop and routed through the audiometer. The presentation level was 40 dB SL or at an individual's comfortable hearing level. Monosyllabic words and the speech noise were presented monaurally at 0 dB SNR. 25 bisyllabic words were presented for each trial. The subjects' task was to perceive the bisyllabic presented in the presence of noise and repeat them back. Each correct word was given with a score of 4%. The number of correctly identified words at 0dB SNR was noted down to find the SPIN score.

3.5. Statistical analysis

The data obtained from the study was subjected to statistical analysis using the statistical package for the social science. Descriptive statistics was carried out to estimate the mean and standard deviation for all the parameters. Following this test of normality and other assumptions of non parametric tests like Wilcoxon signed rank test for within group comparisons of right and left ear scores; and Mann whitney U test for between group comparisons of scores were carried out.

Chapter IV

Results

The present study was aimed to evaluate the temporal resolution abilities using gap detection test (GDT), temporal modulation transfer function (TMTF) and speech perception in noise (SPIN) in abstinent alcoholics (group I) and non-alcoholics (group II). In each group, 20 participants (40 ears) were included in this study. For both the groups, temporal resolution abilities were assessed using the 'mlp' toolbox, which implements a maximum likelihood procedure in MATLAB 7.12.0 (R2011a). Perception of speech in the presence of noise was assessed by using the PB word list at 0 dB SNR, which was presented through a laptop. Each ear was presented with 25 words, and each correct response was given with a score of 4%. All the collected data were statistically analyzed in SPSS software.

The results of this study were explained under the following headings:

4.1 Comparison of gap detection ability between abstinent alcoholic and non-alcoholic individuals

4.2 Comparison of the temporal modulation transfer function between abstinent alcoholic and non-alcoholic individuals

4.3 Comparison of speech perception in the presence of noise between abstinent alcoholic and non-alcoholic individuals

4.4 Correlation of gap detection, temporal modulation transfer function, speech perception in the presence of noise in abstinent alcoholic and non-alcoholic individuals

Shapiro-Wilk's test of normality was done to check whether the data is normally distributed, and this study's data were found to be non-normally distributed ($p < 0.05$). Hence, non-parametric inferential statistics were done.

4.1 Comparison of gap detection ability between abstinent alcoholic and non-alcoholic individuals

The data were collected separately for the right ear (RE) and left ear (LE). Wilcoxon signed-rank test was carried out to see if there is a significant difference for gap detection ability in between the ear. The results of the Wilcoxon signed-rank test by comparing the right and left ear GDT scores are depicted in Table 4.1.

Table 4.1.

Results of Wilcoxon signed-rank test by comparing right and left ear GDT scores for both groups I and II

GDT	Group I	Group II
	Z values ('p' value of significance)	**Z values ('p' value of significance)**
RE vs LE	-1.242 ($p > 0.05$)	-.484 ($p > 0.05$)

Results from Table 4.1. reveals no significant differences between RE and LE's GDT scores for both abstinent alcoholics and non-alcoholic individuals. Hence for further analyses, the data of the right ear and left ear were combined. Descriptive statistical analysis was done with the combined data to find the mean, median, and standard deviation (SD) of GDT scores for both groups I and II were depicted in Table 4.2.

Table 4.2.

Mean, Median and Standard deviation (SD) for GDT scores of abstinent and non-alcoholic individuals

Group	**Mean in ms (SD)**	**Median in ms**
Abstinent alcoholics	4.1 (± 1.7)	3.7
Non-alcoholics	2.5 (± 0.9)	2.8

Results from Table 4.2 shows that there is a difference between the groups, which indicates that lesser mean scores obtained by non-alcoholics when compared to abstinent alcoholics. Gap detection test scores were compared between abstinent and non-alcoholic individuals using a non-parametric Mann-Whitney U test were shown in Table 4.3.

Table 4.3.

Results of the Mann-Whitney U test for GDT between two groups

GDT	**Z values**	***'p'* values**
Group I vs II	-4.926	$p < 0.05$

Results from Table 4.3 shows a significant difference ($p < 0.05$) for gap detection ability between groups I and II.

4.2 Comparison of the temporal modulation transfer function between abstinent alcoholic and non-alcoholic individuals

The data were collected separately for the right ear and left ear. Wilcoxon signed-rank test was carried out to check if there is a significant difference between the ears. The Wilcoxon signed-rank test was done to compare the right and left ear TMTF scores across frequencies were depicted in Table 4.4.

Table 4.4.

Results of Wilcoxon signed-rank test by comparing right and left ear TMTF scores across frequencies for both the groups

TMTF Frequencies	**Group I Z values ('p' value of significance)**	**Group II Z values ('p' value of significance)**
8 Hz	-.158 ($p > 0.05$)	-.946 ($p > 0.05$)
20 Hz	-.450 ($p > 0.05$)	-2.641 ($p > 0.05$)
60 Hz	-.318 ($p > 0.05$)	-1.473 ($p > 0.05$)
200 Hz	-.020 ($p > 0.05$)	-.426 ($p > 0.05$)

Results from Table 4.4 shows that there is no significant difference between RE and LE, TMTF scores across frequencies for abstinent and non-alcoholic individuals. Hence for further analyses, the data of the right ear and left ear were combined. Descriptive analysis was done with the combined data to find the mean, median, and standard deviation (SD) of TMTF scores across frequencies for both the groups I and II were depicted in Table 4.5.

Table 4.5.

Mean, Median and Standard deviation (SD) of TMTF scores across frequencies for abstinent and non-alcoholic individuals

TMTF Frequencies	**Group**	**Mean in Hz (SD)**	**Median in Hz**
8 Hz	I	-31.7 (± 3.4)	-34.1
	II	-33.7 (± 1.3)	-34.3
20 Hz	I	-32.8 (± 5.6)	-33.3
	II	-36.8 (± 2.3)	-36.9
60 Hz	I	-29.7 (± 4.5)	-29.5
	II	-35.9 (± 2.4)	-35.9
200 Hz	I	-17.9 (± 5.8)	-18.9
	II	-26.4 (± 2.9)	-27.2

Table 4.5 shows the difference in TMTF scores between the two groups, which indicates that non-alcoholics obtained lesser mean scores than abstinent alcoholics. Mann-Whitney U test was done to compare the TMTF scores across frequencies for both groups I and II represented in Table 4.6.

Table 4.6.

Results of the Mann-Whitney U test for TMTF between two groups

TMTF Frequencies	**Z value**	**‘*p*’ value**
8 Hz	-3.001	$p < 0.05$
20 Hz	-3.241	$p < 0.05$
60 Hz	-5.915	$p < 0.05$
200 Hz	-6.343	$p < 0.05$

Results from Table 4.6. shows that there is a significant difference between the group I and II for TMTF scores across frequencies.

4.3 Comparison of speech perception in the presence of noise between abstinent alcoholic and non-alcoholic individuals

The data were collected separately for the right ear and left ear. Wilcoxon signed-rank test was carried out to check if there is a significant difference between the ears. The Wilcoxon signed-rank test results by comparing right and left ear SPIN scores at 0dB SNR for both the groups were depicted in Table 4.7.

Table 4.7.

The Wilcoxon signed-rank test results by comparing right and left ear SPIN scores at 0dB SNR for both the groups

SPIN	Group I Z values ('p' value of significance)	Group II Z values ('p' value of significance)
0 dB	-.121 ($p > 0.05$)	-.646 ($p > 0.05$)

Results from Table 4.7. reveals that there is no significant difference between RE and LE scores for SPIN at 0dB SNR in both the groups. Hence for further analyses, the data of the left ear and right ear were combined. Descriptive analysis was done with the combined data to find the mean, median, and standard deviation (SD) of SPIN scores at 0dB SNR for both groups I and II were depicted in Table 4.8.

Table 4.8.

Mean, Median and Standard deviation (SD) of SPIN scores at 0dB SNR for both the groups

SPIN	Group	Mean in dB (SD)	Median in dB
0 dB	I	18.7 (± 2.7)	19.0
	II	21.7 (± 1.1)	22.0

The data from Table 4.8. reveals the difference between the two groups, indicating that non-alcoholics obtain more mean scores than abstinent alcoholic individuals. Mann-Whitney U test was done to compare the speech perception in noise (SPIN) scores at 0dB SNR for both groups I and II have been represented in Table 4.9.

Table 4.9.

Results of Mann-Whitney U test for SPIN scores at 0 dB between two groups

SPIN	Z values	'p' values
0 dB	-5.364	$p < 0.05$

The results from Table 4.9. shows a significant difference between abstinent and non-alcoholic individuals for SPIN scores at 0dB SNR.

4.4 Correlation of gap detection, temporal modulation transfer function, speech perception in the presence of noise between abstinent alcoholic and non-alcoholic individuals

Spearman's rho coefficient correlation was used to assess GDT, TMTF, and SPIN scores in abstinent alcoholics and non-alcoholics. In abstinent alcoholic individuals group, results have shown a statistically significant strong positive correlation between GDT and TMTF at 60 Hz ($r_s = 0.446$, $p = 0.004$), GDT and TMTF at 200 Hz ($r_s = 0.473$, $p = 0.002$). A strong positive correlation with statistical significance was seen within TMTF frequencies: 8 Hz and 20 Hz ($r_s = 0.438$, $p = 0.005$); 8 Hz and 60 Hz ($r_s = 0.464$, $p = 0.003$); 8 Hz and 200 Hz ($r_s = 0.491$, $p = 0.001$); 20 Hz and 60 Hz ($r_s = 0.408$, $p = 0.009$); 20 Hz and 200 Hz ($r_s = 0.515$, $p = 0.001$); 60 Hz and 200 Hz ($r_s = 0.590$, $p = 0.000$). And a significant strong negative correlation was seen between SPIN at 0 dB SNR and TMTF at 20 Hz ($r_s = -0.414$, $p = 0.008$); SPIN and TMTF at 200 Hz ($r_s = -0.409$, $p = 0.009$). For non-alcoholic individuals, a strong positive correlation with statistical significance was seen only between TMTF at 20 Hz and 60 Hz. No other significant correlations were found between GDT, TMTF across frequencies and SPIN at 0 dB SNR.

Chapter V

Discussion

Several pieces of research were done in chronic alcoholic individuals to evaluate the effects of both peripheral and central-level hearing loss. But there is the dearth of research shreds of evidence to illustrate the central auditory processing abilities in abstinent alcoholic individuals. Henceforth, the current study was carried out to evaluate the temporal resolution abilities such as gap detection, temporal modulation transfer function; and speech perception in noise in abstinent alcoholic individuals. Detrimental effects on cerebral function, metabolism, and volume were reported by Demirakca et al. (2011) due to alcohol abuse. Especially, more damage to grey matter was precisely localized at insula, medial temporal lobe, and hypothalamus. Reduced whole-brain thickness was reported bilaterally in abstinent alcoholic individuals, mostly in susceptible areas such as frontal, temporal, and parietal cortex (Gazdzinski et al., 2005; Santucci et al., 2004). A significant increase in brainstem transmission time in chronic alcoholic individuals was reported by Begleiter et al. (1981) due to the demyelination of auditory tracts and major nuclei of the caudal and mid-pons adjacent to the basis pontis region. So, these research studies have given a basis that neural demyelination arises mostly at major auditory areas that might be the prime lead to affect the auditory processing abilities in alcohol-consuming individuals.

5.1. Comparison of temporal resolution abilities: GDT, TMTF between abstinent alcoholic and non-alcoholic individuals

Gap detection ability is a quite complex process that happens at either cortical or brainstem level. To assess the ability to detect the amplitude modulation in an acoustic signal, TMTF was used (Shinn, 2003); this temporal envelope carries relevant data pertinent for perceiving speech (Drullman, 1995). Typically, it remained around 2-20 ms for healthy hearing individuals (Owens et al., 2007); but Alessandra et al. (2003) stated that normal-hearing individuals detect the gap with the mean threshold of 4.19 ms. TMTF in normal-hearing individuals, sensitivity to modulation remained constant, but it varied extremely as the function of level decreased (Bacon and Viemeister, 1985). But none of the research studies have evidenced the temporal resolution abilities in alcoholic individuals. In this study, non-alcoholics reported significantly better performances than abstinent alcoholics. Hence, it reveals that alcohol abuse affects individuals' psychoacoustic abilities even in their abstinent period.

5.2. Comparison of speech perception ability in the presence of noise between abstinent alcoholic and non-alcoholic individuals

Deficits in temporal resolution abilities might lead to difficulty in perceiving speech in the presence of noise and reverberant listening conditions (Rawool, 2006). Temporal resolution ability plays a major role in understanding speech in the presence of noise. Both normal hearing & hearing-impaired individuals have shown good performance with speech tasks as the SNR of stimuli increases (Summers et al., 2013). Most often, hearing impaired demonstrated more reduced performance with both behavioral experiments such as frequency discrimination, speech reception, and also objective measures using peak V amplitude of ABR, which acts as an indicator for neural synchrony across frequencies (Papakonstantinou et al., 2011). Perceiving speech would deteriorate with older age groups and with growing levels of distorted speech stimuli (Gordon-Salant & Fitzgibbons, 1993). If the hearing impaired have lost their ability to process low frequency temporal fine structure information that might affect perceiving speech in the presence of noise. There is limited research evidence in this area for alcoholic individuals; thus, no experimental studies on SPIN were reported. But the current study reveals that non-alcoholic individuals were perceived the speech better even in the presence of noise when comparing abstinent alcoholic individuals. Several studies have reported that chronic alcohol consumption leads to demyelination across major nuclei of the auditory pathway. It might be one reason why abstinent alcoholic individuals performed poorer in SPIN tasks.

5.3. Correlation of gap detection, temporal modulation transfer function, speech perception ability in the presence of noise between abstinent alcoholic and non-alcoholic individuals

Helfer and Vargo (2009) reported a negative correlation between middle-aged female listeners between small amounts of high-frequency hearing loss and their speech task performance. Still, the gap in noise test scores showed a positive correlation with speech tasks. Both normal hearing and hearing-impaired individuals performed better with speech stimuli as the SNR increases; and also reported a better correlation between positive SNR's speech scores and modulated frequency detection for both steady-state and modulated noisy situations (Summers et al., 2013). And in this study, Spearman's rho correlation was done between temporal resolution abilities: GDT, TMTF; and speech perception in noise for abstinent and non-alcoholic individuals. This study revealed that a significant correlation was seen more in abstinent alcoholics when comparing non-alcoholic individuals. In the abstinent alcoholics' group, a significant positive correlation was found with GDT and across TMTF frequencies at 60 Hz and

200 Hz and within TMTF frequencies. A significant negative correlation was seen for SPIN at 0dB SNR with TMTF frequencies: 20 Hz and 200 Hz. However, for the non-alcoholics group, it has shown a significant positive correlation between TMTF frequencies at 20 Hz and 60 Hz. And further, there is no significant correlation between GDT, TMTF frequencies, and SPIN at 0dB SNR. Hence this study reported with better correlation for abstinent alcoholic individuals than non-alcoholics. It might be due to the reason that less number of population has been included in this study.

Chapter VI

Summary and Conclusion

Alcohol-consumption has a deleterious effect on individuals, mostly seen at vital anatomical structures and their physiological roles, which are responsible for processing simple acoustic and complex speech signals. Many kinds of research in alcohol dependents have clearly explained the impairment of peripheral and central auditory mechanisms through various subjective and objective measures. The anatomical evidence, mostly precedent sites of the cerebral cortex, showed a detrimental effect in terms of area, volume, and efficiency. Those precedent sites even include the most crucial site in the temporal cortex, which is responsible for the audition. It accurately gives the support, and it connects the abnormal or varying results in the audiological evaluation. Hence this study has revealed a clear understanding of some processes of central auditory abilities of abstinent alcoholic individuals. So, this study has aimed to explain the auditory processing abilities of abstinent alcoholics through the evaluation of temporal processing abilities: GDT, TMTF; and speech perception ability in the presence of noise. A total of 40 individuals (80 ears) were divided into two groups as abstinent alcoholics (group I) and non-alcoholics (group II) and they were included as participants in this study. Statistical data of this study have documented a significant poor performance for abstinent alcoholics when comparing non-alcoholics. Thus, it reveals that alcohol addiction has shown its deleterious effect in audition and its finest processing abilities even in abstinence.

6.1. Clinical implication

This study will provide information:

- Regarding the temporal resolution abilities such as gap detection and the temporal modulation transfer function of abstinent alcoholic individuals.
- Regarding the speech perception ability of abstinent alcoholics in the presence of noise
- To guide the clinicians during the assessment and testing of abstinent alcoholic individuals.
- To counsel regarding the auditory processing deficits of abstinent alcoholic individuals.
- To get a better understanding of the psychoacoustical abilities of abstinent alcoholic individuals.

6.2. Future directions

- To study the association of alcohol consumption with peripheral & central vestibular functioning
- To investigate the association of alcohol consumption and abstinence period with higher-level cognitive working memory abilities
- To analyze the influence of consuming alcohol on speech perception in noise at different SNR's
- To examine the relation between alcohol-consuming levels; effects of abstinence and their auditory processing abilities

- To study the quality of life of alcoholic individuals
- To explore the correlation effects between central auditory processing abilities and objective audiological measures
- This study can also be probed to examine the relationship between alcohol consumption and systemic diseases

6.3. Limitations

- This study was conducted for only less number of participants
- This study was not reported gender effect
- The age effect was also not explained

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