Master Thesis Summary

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Title

The study of the effect of mental and physical workload on the perceived noise annoyance caused by urban traffic in students (Based on Electroencephalography analysis)

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Abstract

Introduction: The typical approach to dealing with the complexity of tasks despite the advancement of technology is based on improving environmental conditions, which is provided by modulating underlying stressors such as sound and improving cognitive function and workload. The workload is a broad concept and a point in which any increase or decrease can harm the operator's level of performance. Physiological changes due to workload such as increased heart rate, psychosocial effects such as excitement, and behavioral effects such as an increased error in operators are among the issues and problems considered in relation to workload. The aim of this study was to investigate the impact of mental and physical workload on the perception of noise annoyance caused by urban traffic among students (based on brain wave analysis).

Materials and Methods: In this study, a one-step Astrand protocol was used to estimate the physical workload and the amount of load applied at two levels of 100 and 75 watts for men and women. The test lasted for 6-7 minutes, and at the end of each stage, heart rate (bpm) and blood pressure (mmHg) were recorded. Considering the volunteer's age, using the heart rate and Borg scale, the physical workload of the individual was determined. The N-back machine learning test was used in two levels of one-stage and two-stage measure mental workload, and the NASA-TLX questionnaire was used to determine the amount of workload. Electroencephalogram also examined three brain components (attention, stress, alertness) for the mental workload. The ISO15666 noise Annoyance Questionnaire was used to measure the perception of noise annoyance. All mental and physical tests were before and after exposure to urban road traffic noise, and the comparison between them was made by repeated measures test. It should be noted that the speakers were located at a distance of 1.5 meters from the hearing area of the subjects, and the sound recorded from urban traffic according to the analysis of the central band frequency had an average sound pressure level of 77 dB in the network A and by Cool Edit Pro software. .2.1 was broadcast.

Results: The results showed that increasing the perception of voice annoyance is directly related to mental and physical load. So that with increasing the amount of mental and physical load, the noise annoyance caused by the noise of urban traffic increases significantly (Sig = 0.000). Also, the number of people's errors had a significant positive relationship with increasing workload (Sig = 0.000) and increased workload (correlation 0.702 and t = -52.242). Brainwave studies showed that increasing workload in the face of traffic noise increases stress (Sig = 0.000 and t = 13.02) and decreases the amount of attention (Sig = 0.000 and t = 14.329). On the other hand, the results showed that the heart rate increases significantly (Sig = 0.000) due to urban traffic noise exposure.

Conclusion: The results showed that the amount of mental and physical load applied in the face of urban traffic noise is a more influential factor than urban traffic noise in understanding the amount of noise annoyance in people. Therefore, to improve people's cognitive and physical function and prevent noise annoyance caused by increasing mental and physical workload in the face of urban traffic noise, increasing stress, and reducing attention, especially in sensitive jobs and activities, exceptional attention to load classification and monitoring is necessary. Work-related work and ensure that you do not experience chronic annoying noises such as the sound of city traffic in high-workload jobs.

Keywords: Road traffic noise annoyance, Mental Workload, Physical Workload, Electroencephalogram, Neuroergonomics

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Introduction:

Research has shown that long-term exposure to moderate-pitched sounds, especially at low frequencies, can develop symptoms of stress, anxiety, and chronic psychological and physiological damage, which affects the central nervous and cardiovascular systems. Vision, hearing, and endocrinology reduce human perceptual and cognitive function. Noise annoyance is dissatisfaction with any factor or situation believed to affect an individual or group. Annoyance leads to some negative factors in the well-being and comfort of the person. Its effects may include physiological reactions, central nervous system reactions, and biochemical changes. Physiological responses to noise annoyance have increased heart rate and increased blood pressure, which may, among others, lead to high blood pressure.

The electroencephalogram (EEG) and the characteristics of brain activity also reflect the underlying neural dynamics. In addition to assessing the relationship between brain activity and the perception of mental distress, the EEG is used to determine a person's psychophysiological state in the face of sound. Echocardiography has also been used to assess the sound source as an underlying stressor and its effect on attention, sound processing performance in the cortex, and working memory. According to an exchange approach, the presence of a person in a work environment to perform a job task includes two aspects of the effect of the environment on the person (such as the effects of sound and task factors on stress) and the impact of the person on the ground (such as the effects of stress on performance). Considering the role of workload as the main influential factor in causing physical and psychological stress in workers and according to the above, this study is essential to determine the physical and mental workload and their impact on the perception of noise annoyance. The present study investigates noise annoyance at different levels of workload in the face of urban traffic noise. This study's primary purpose is to determine whether varying levels of physical and mental workload affect the perception of noise annoyance caused by traffic noise. Comparing the level of annoyance at different workload levels is one of the goals of this research project. Exerting a workload at the exposure of noise annoyance affects a person's physiological and psychological parameters. Evaluation of physiological parameters (blood pressure, heart rate, and SPO2) and psychological parameters (Alertness, Meditation, and attention) and consequently physical and mental workload under annoying noise conditions at different levels of workload is another objective of this study. By performing this study, individuals' physical and mental workload is measured, and its effect on the perception of voice annoyance in different situations is determined.

General Purpose:

Title: the study of the effect of mental and physical workload on the perceived noise annoyance caused by urban traffic in students (based on Electroencephalography analysis)

Applications of this research:

Noise annoyance can result from interference with daily activities, feelings, thoughts, sleep, or rest and may be accompanied by negative emotional responses, such as irritability, distress, exhaustion, a wish to escape the noise, and other stress-related symptoms [1,2]. Many people and occupations are exposed to substandard noise like road traffic noise,

Aircraft Noise Annoyance, etc., leading to noise annoyance. Most of these people are involved in mental and physical workload simultaneously, such as police officers, construction workers, drilling operations workers, taxi drivers, bus drivers, etc. Therefore, in my master thesis, we determined to what extent mental and physical workload is effective (negative or positive) in the perception of noise annoyance, what consequences it may cause, and what measures should be taken to prevent these consequences.

Method and materials:

This study was performed on students as an exposed group. The study population includes both men and women. According to similar studies in the past, whose statistical population was between 7 and 35 people, the statistical population studied was medical students in the occupational health department. The number of samples was calculated using Cochran's formula with a 95% confidence interval (5% error percentage) which was equal to 32 people. To increase the reliability, the number of samples was 60 (32 men and 28 women). Inclusion criteria included complete satisfaction to participate in the study. Individuals' personal information and medical history were obtained through a questionnaire of demographic characteristics and interviews with the participants. Since the age of onset of work is over 18 years, the human ears suffer from hearing loss after the age of 40. 25.83 with standard deviation = 1.80 and mean age of men = 26.67 with standard deviation = 2.62). It should be noted that through the questionnaire of demographic characteristics, variables such as age, height, weight, work experience, smoking, etc., were collected, and the history of the disease, especially cardiovascular, neurological and auditory problems, were examined. Participants with heart, neurological or auditory disorders were excluded from the study. Three volunteers (one male and two female) were excluded from the study due to drug use and heart problems in the week before the start of the study. Because the target population was students, and by default, the physical workload of this group was at the basic level (low activity) and light, and the mental workload of these people was moderate and heavy. The present study examines these levels. Participants were informed before taking the test to get enough sleep for 7 hours the night before the test and refrain from taking any caffeinated substances or painkillers.

Physical Workload:

The One-Step Astrand bicycle test was used to measure the physical workload. Heart rate and blood pressure were recorded using a pulse-oximeter and Blood Pressure meter, respectively. Finally, using the Borg scale, heart rate, and participant age, the physical workload was determined.

Fig1 – Ergometer bicycle

Fig2 – pulse-oximeter (PO30)

Fig 3 - Blood Pressure meter (GLAMOR)

Evaluate Noise annoyance under the physical workload

First, the noise annoyance caused by traffic noise was measured separately by the noise annoyance questionnaire; in the next step, Noise annoyance due to ergometer workload and traffic noise was measured simultaneously.

Mental workload:

In the next step, to evaluate the mental workload, two medium and heavy workload levels were determined using the difficulty of the N back task for the participants. Each workload level was performed in two stages, so that the second stage was with the intervention of noise annoyance caused by traffic noise.

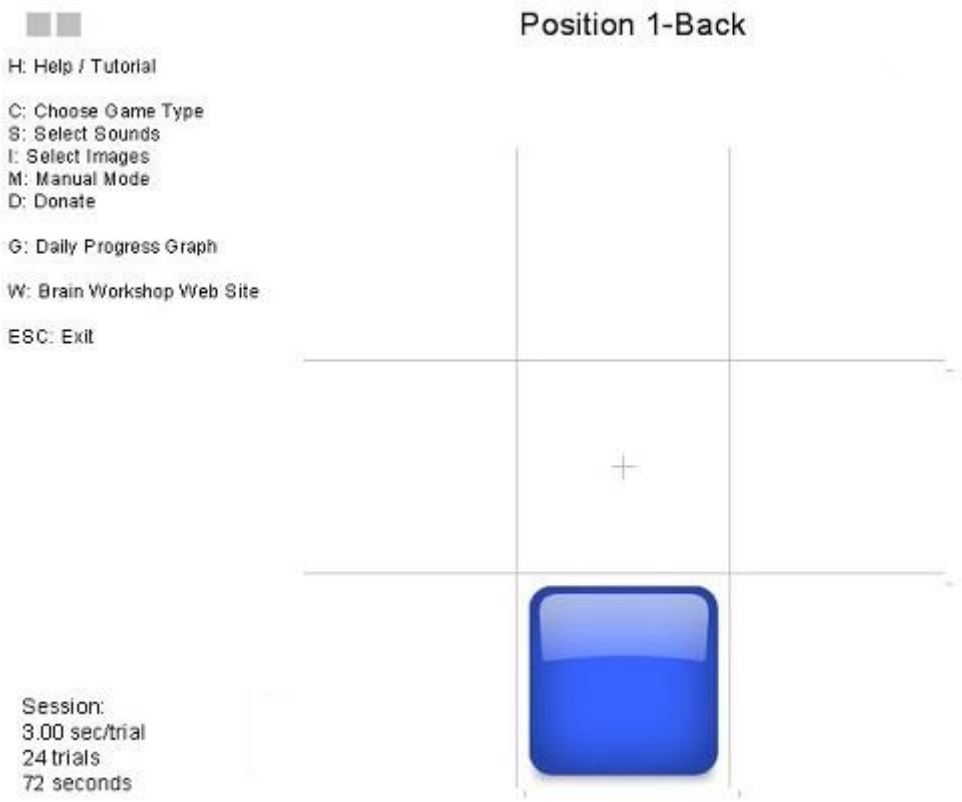

Fig 4 – N-back task platform

During the mental workload assessment, a portable Mind Wave (EEG) device in the form of a headset was placed on the participant's head (forehead and auricle) to record brain waves caused by mental workload accurately. The results were used to assess the level of alertness, stress, and attention in different conditions of mental workload and noise annoyance caused by traffic noise.

Fig 5 - Neurosky Mind wave EEG

Evaluate Noise annoyance under the mental workload:
At the end of each stage, a mental workload a noise annoyance questionnaire was given to the individual to be filled. The questionnaire used was ISO/TS 15666 and NASA-TLX, which was validated in former studies.

NASA-TLX:
NASA-TLX originally consisted of two parts: the total workload is divided into six subjective subscales that are represented on a single page, serving as one part of the questionnaire:

1- Mental Demand
2- Physical Demand
3- Temporal Demand
4- Performance
5- Effort
6- Frustration

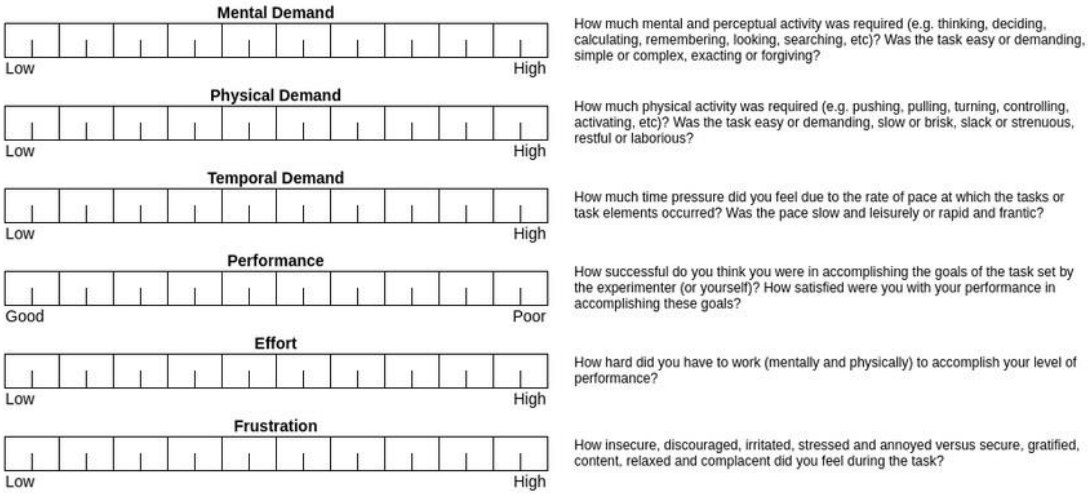

Fig5 – NASA Task Load Index (NASA-TLX)