

Assessing Effect of High Intensity of Continuous Traffic Noise on Mental Performance

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Abstract

Noise is an unwanted sound depending upon time and place. In fact, noise is both-a psychological and a physical construct. While measuring the impact of noise, amplitude of the sound, intensity, temperature and humidity of the environment must be taken in consideration, at the same time the personality traits, mental status of the perceiver must not be ignored. Sensitivity to noise is a prime factor while assessing impact of noise on human being. Considering this fact in mind, it was decided to study impact of high intensity of continuous traffic noise on mental performance. For this, 100 university students were selected randomly. Subjects were divided into two groups by applying Noise Sensitivity Scale developed by Weinstein and adopted in Hindi by Bhatia, Malhotra and Mohar. On these two groups, the experiment was done in two conditions- 'with noise condition' and 'without noise condition'. In without noise condition, subjects were given cancellation sheets on which they have to cross the desired alphabets written on the top of these sheets. In with noise condition, they were exposed to 90dB continuous traffic noise and have to cross the desired alphabets on cancellation sheets. Error committed in crossing the alphabets was indicator of quantity of mental performance, while time taken was indicator of quality of mental performance. On such parameter, the data were procured in both conditions and analyzed with the help of M,SD and t-ratio. It was found that there was significant difference in errors in both conditions. It means high intensity of continuous traffic noise decreases mental performance. Furthermore, it was found that there was significant difference in time taken in both conditions. It means high intensity of continuous traffic noise deteriorates quality of performance. Then the performance of noise sensitive and non-noise sensitivity groups were compared and found that sensitivity to noise decreases the quantity and quality of mental performance.

Keywords: Continuous Traffic Noise; Sensitivity to Noise; Mental Performance

Introduction

Prominently and progressively more exposure to road traffic noise is a feature of urban environment [1]. An increasing number of vehicles, difficulty in controlling of emitted noise and high number of persons exposed to noise intensity, undesirable transportation are making the situation more dangerous. In European Union, 40% of the inhabitants are exposed to equivalent noise levels exceeding 55dBA in day

times and more than 30% in night times [2]. Transportation noise contributes to the development of cardiovascular risk of coronary artery disease, arterial hypertension, stroke and heart failure [3]. Noise is an unwanted sound. Its unwantedness is dependent upon several factors. That is why, [4] defined, 'noise is a wrong sound in wrong place at the wrong time'. The concept of noise implies both a significant psychological component (i.e. unwantedness) as well as a physical component (intensity, etc). It must be perceived by

ear and higher brain [5]. Noise as a psychological concept may be defined as unwanted, unpleasant, bothersome for the listener which creates interference in their activities. It is considered psychologically harmful [6]. It creates unpleasant reactions in listeners. It may cause avoidance because it disturbs sleep or relaxation; it startles and interferes the conversation [7].

If beauty is in the eyes of the beholder, then noise is in the ears to listener. Wantedness of noise depends upon human judgment. A particular sound may be noise for one, while same sound may not be noise for another. The reason for disliking noise is that it is intrinsically unpleasant, because it interferes with some wanted sound like speech, music [8] reported that even at very low level, there could be some individuals who are intensely annoyed by noise and although this proportion increases with the level of noise at the highest level of exposure, a few individual remain unperturbed. It is observed that people who are highly sensitive to noise may have receptors that are more sensitive to noise than other. Noise may interferes with performance [9]. Have found noise exposure can cause other non-auditory effects like annoyance, changes of behavior and deterioration in performance. Generally human performance can be divided into three parts-mental, physical and physio-mental. High intensity of noise affects all kinds of performance, especially mental performance. Traffic noise is highly correlated with cognitive abilities like working memory and sustained attention [10].

Reviews of literature

Pervious works have demonstrated the adverse effects of continuous noise on vigilance [11,12], attention [13,14], reading deficits and skill [15,16], employee concentration [17] and cognitive processing [18-21] investigated three types of high intensity noise-intense, intermittent and unpredictable noise on 59 subjects whose age varied from 18 to 49 years. Subjects were given arithmetic task. The galvanic skin response (GSR) and heart rate were measured and their personality traits-neuroticism and introversion-extroversion were measured through Eysenck Personality Questionnaire. The performance of low noise sensitive subjects deteriorated due to increase in activation level. Performance of noise sensitive subjects deteriorated due to neuroticism, noise susceptibility and masking effect of noise [22].

Conducted a research work on ten year old children to measure the impact of noise on learning, reading and multiplication work under three conditions-no noise, continuous noise and intermittent noise. He found no relation between noise and personality traits. He found that intelligent subjects solved more items on a multiplication task in noisy condition than no noise condition. Reading ability of less

intelligent subjects deteriorated. Johanson interpreted this result in terms of arousal theory [23]. Examined the impact of airport noise on residents near Los-Angeles International Airport and found that active and passive communication is affected. In addition, it was also found that it produced slight disturbance on some people. In addition, few persons made a formal complaint about it and there was a limited awareness of noise abatement by community residents. [24] Conducted a study on the residents of 32 storied apartments near a highway in New York City. The noise level in the building was high on ground floor. The investigators assessed the reading ability and auditory discrimination of children who were living in the apartment since four years and it was found that the children living in ground floor where noise level was high had lower mental functioning than those children living in the upper storey of the apartment where noise level was low. It was also found that prolonged exposure to noise adversely affected hearing and reading. The children near the ground floor apparently adapted themselves to the highway noise by developing filtering mechanism suggested by the researchers. But the ability to filter out sounds made them less sensitive to auditory cues and impaired their reading ability. On the basis of their research, [25] opined that age, gender and education are independent of noise. [26] Found that intermittent noise is distracting when people are continuously distracted. It is difficult for them to concentrate on the task at hand. [27] Investigated the traffic noise in residential area and found that the highest annoyance class included the greatest proportion of those individual with headaches, insomnia and nervousness. Acute irritability showed a clear cut relationship with noise and annoyance.

It was found that people living in such area where aircraft noise was high committed more errors (i.e. attention failure, loss of memory and action)in comparison with people living in low noise area [28,29]. Found in his research that children in noisy area develop delayed impaired mental performance including incidental learning and visual search [30] found that noise impairs reading achievement. This was the result with puzzle solving [31].

Self-report of everyday errors, failure of attention, memory and action given by people in an area of high aircraft noise and those of a similar group who lived in an area with a low level of noise, the high noise group reported a greater frequency of every day errors [28].

Found in cross-sectional study carried out on 413 residents in the centre of Belgred [31]. The results showed the significant behavioural effect of road traffic noise (Leq 65 dBA) in terms of more frequent intention to change the place of living, shortening a daily period of open window and worse interpersonal relationship between dwellers [32]. Personality variables are important factors which Influence

mental performance in noisy environment [33]. Considering above facts, it was observed that all researches had some strengths and limitations. Sensitivity to noise which plays pivotal role on determining impact was almost neglected. So, it was decided to measure the impact of high intensity of continuous traffic noise on mental performance, involving sensitivity to noise.

Aims

Following was the main/aims of this work.

- To measure the sensitivity to noise of the sample.
- To assess the impact of high intensity of traffic noise on mental performance.
- To measure quality of performance due the joint effect of noise intensity and sensitivity.
- To assess quality of performance due to joint effect of noise intensity and sensitivity to noise.

Material and Methods

Sample

100 Post graduate students were selected as sample.

Sample Area

Sample area was Postgraduate Department of Vinoba Bhave University, Hazaribag, Jharkhand state of India.

Inclusion Criteria

- All subjects were male.
- All subjects were students of post graduate departments.
- All subjects were unmarried.
- Their age varied from 18-26 years.
- All subjects were physically and psychologically normal.

Exclusion Criteria

- The subjects with ontological problems were excluded.
- The subjects with high blood pressure, diabetes, and heart problems were excluded.
- Handicapped subjects were excluded.

Age of the sample

Age of the sample is given in Table 1.

Sl No.	Age of sample	No of subjects
1	18-20	11
2	21-23	55
3	24-26	34

Table 1: Considering above table no1, it is observed that maximum no of sample was between 21-23 years of age.

Sample Design

Sensitivity	Without noise	With noise
High	50	50
Low	50	50

Table 2: Within subject design was used.

Tools used

Following tools were used.

Personal Data Sheet

Personal Data sheet was used to acquire some demographic information like name, gender, institution, class, age, and department. This was prepared by the researcher himself.

Weinstein Noise Sensitivity Scale

This scale was used to measure the level of noise sensitivity. Originally this scale was developed by Dr. Neil D. Weinstein, Department of Human Ecology, Reuter University, U.S.A. This was adopted in Indian context by Prabha Bhatia, Sunita Malhotra and I.S Mohar, MD. University, Rohtak, Haryana, India. It is a likert type scale with positive and negative items. The reliability is .89 (test-retest method). It is in Hindi and published by Agra Psychological Corporation, Agra, India.

Cd Player

This instrument was used to play CD which ultimately exposed noise to the subjects. It was Samsung make. Its model no was DVP-Sr 320.

Cd

The CD used in CD player was Sony make 700 MBR CD. It contained continuous traffic noise.

Thermometer

The thermometer was used to measure the temperature of the room. It had very sensitive mercury level.

Hygrometer

This instrument was used to measure the humidity of the room environment. It had a digital thermohygro clock. It was Smextech make with model no. J412CTH.

Db Meter

This instrument was used to measure the intensity of sound emitted by the CD player. It was used constantly during experiment to ensure uniformity of the intensity of sound. It was a very sensitive sound level meter. The model no was SL 4012 from Max Tech company.

Stop Watch

The stop watch was used to measure time taken by the subjects. It was a super sensitive stopwatch which was able to

indicted 1/100th of the second. It was in fact, a sports timer which may indicate hours, minutes and second in addition. Its model no. was 963165.

Procedure

Since noise is related with humidity and temperature. It was measured on every day of experimental day. The scores are given in Table 3 and Table 4.

Sl. No	Humidity	Temperature (In Celsius)	Sl. No	Humidity	Temperature (In Celsius)
1	69	32.3	26	84	27.1
2	86	28.4	27	76	27.1
3	57	32.1	28	80	30.2
4	65	30.6	29	76	38.8
5	65	31.2	30	65	30.1
6	68	31	31	70	38.1
7	67	31.7	32	67	26.8
8	53	31.9	33	53	31.6
9	58	31.8	34	71	30.3
10	58	25	35	63	31.8
11	66	30.7	36	72	31.1
12	67	31.8	37	72	29.3
13	67	32	38	75	31.2
14	68	35	39	75	30.8
15	64	34.9	40	68	37.3
16	65	34.9	41	68	26.8
17	68	34.8	42	61	27.9
18	65	34.5	43	70	31.8
19	69	34.3	44	81	30.8
20	61	37.7	45	64	31.2
21	64	29.5	46	69	30.8
22	63	31.6	47	69	34.9
23	74	28.7	48	65	37.4
24	64	26.9	49	65	28.4
25	77	29.1	50	69	38.4

Table 3: Variation in temperature and humidity during mental performance of low noise sensitive subjects.

Sl No	Humidity	Temp (In Celsius)	Sl No	Humidity (In Celsius)	Temp
1	65	31.6	26	68	32.1
2	66	31.7	27	70	30.9
3	67	31.7	28	69	31.1
4	66	31.8	29	69	30
5	65	31	30	68	31.3
6	82	27.6	31	69	31
7	83	27.7	32	52	35.6

8	70	32.2	33	70	26.4
9	85	28.4	34	69	31.1
10	79	28.1	35	68	32.4
11	83	27.7	36	73	32.2
12	83	27.8	37	68	31.8
13	68	29.7	38	74	30
14	71	30.8	39	72	30.2
15	71	35.2	40	67	32.4
16	73	35	41	71	26.1
17	72	38.1	42	81	26.8
18	77	38.1	43	65	31
19	83	38.1	44	70	30.3
20	84	27	45	71	28.9
21	81	28.8	46	63	30.7
22	78	27.3	47	63	30.6
23	67	26.9	48	68	31
24	69	32.1	49	83	28.5
25	70	30.2	50	70	32.5

Table 4: Variation of temperature and humidity during mental performance of high noise sensitive subjects.

Noise Sensitivity Scale developed by Bhatia, Malhotra and Mohar was administered on 100 subjects. Data were collected and median was calculated to bifurcate them into high noise sensitive and low noise sensitive groups. In this way, 50 high sensitive subjects and 50 low noise sensitive subjects were selected. Then process of measuring mental performance was started. This experiment was done in two conditions- without noise condition and with noise condition. First of all, this experiment was performed with high noise sensitive subjects. It was conducted on each subjects separately. The subjects were brought to laboratory and each of them was given 10 cancellation sheets on which some alphabets were written on the top of each sheet and the subjects had to cross the desired alphabets. When the subjects cancelled all the given sheets, the stop watch was closed and time taken was recorded. In the mean time, the room temperature and humidity were noted and kept in record. Then 'with condition' was started. In this conditions, subjects were given 10 cancellation sheets and given prior instructions. 90dB traffic noise was exposed on them. Then, the subject was requested to cross the cancellation sheet. When all cancellation sheets were crossed, then time taken was noted, error was counted down. The distance between the subjects chair and the CD player was kept constant. The light arrangement of the room was kept constant by using CFL bulb of 100w. The curtain of door was maintained properly, to make illuminicity of the room constant. All possible arrangements were to maintain the environment uniform every day. The experiment was

done in two steps.

- **Step I**

In this step, the mental performance of high noise sensitive subjects was measured in two conditions- without noise condition and with noise condition.

- **Step II**

In this step the mental performance of low noise sensitive subjects was measured in two conditions without noise condition and with noise condition.

Result

Since this work was done to measure the impact of high intensity of noise on quantity and quality of mental performance. Quantity of mental performance was measured on the basis of errors committed by subjects in crossing the alphabets of cancellation sheet, while quality of mental performance was measured on the basis of time taken during the performance.

Effect of high intensity of noise on the quantity of mental performance

The impact of noise was measured separately on each groups- high sensitive to noise and low sensitive to noise. Following data were gathered and arranged in the Table 5.

Sl No	Sensitivity	without noise			with noise			t	∠P
		N	M	SD	N	M	SD		
1	High	50	436.42	223.77	50	615.12	252.84	3.68	.01*
2	Low	50	520.52	225.1	50	608.4	208.12	2.03	.05**

Table 5: N,M,SD and t-ratio of errors in without noise and with noise conditions.

*= Significant on .01 level.

**= Significant on .05 level.

From table 5, It also observed that the N, M and SD of high noise sensitive subjects in without noise condition are 50, 436.42 and 223.77 respectively, while N, M and SD of high noise sensitive (HNS) subjects in with noise condition are 50, 615.12 and 252.84 respectively. The t-ratio between these two conditions is 3.68 which is significant on 0.01 level. It means the errors committed in both conditions vary significantly. Subjects have committed more mistakes in with noise condition than without noise condition. Thus, it can be said that noise has deteriorated the mental performance of HNS subjects. Since error was the parameter of quantity, so can be said that the quantity of mental performance decreased in high intensity of traffic noise. Thus, it can be concluded that the quantity of mental performance of high sensitive to noise (HNS) decreases in high intensity of continuous traffic noise.

Considering second comparison, it is observed that N,M and SD of low noise sensitive (LNS) subjects in 'without noise condition' are 50, 520.52 and 225.10 respectively, while N,

M and SD of errors in 'with noise condition' are 50, 608.40 and 208.12 respectively. The t-ratio between these two conditions is 2.03 which is significant on 0.05 level. It means errors varied significantly in both conditions. The errors committed by subjects in 'with noise conditions' are higher than 'without noise condition'. It means noise affects the quantity of mental performance of the LNS subjects, because error committed by subjects was the parameter of quantity of performance. Hence, it can be concluded that high intensity of traffic noise decreases the quantity of mental performance of low noise sensitive subjects.

Effect of high intensity of noise on quality of mental performance

The experiment was done in two conditions-without noise condition and with noise condition. The parameter for measuring quality of mental performance was time taken in crossing the alphabets of cancellation sheets. Time taken in each condition was noted and tabulated in Table 6.

Sl No	sensitivity	without noise			With noise			t-ratio	∠P
		N	M	SD	N	M	SD		
1	High	50	3494.56	722.64	50	4091.1	907.56	3.63	.01*
2	Low	50	2854.86	911.83	50	3232.5	974.88	2	.05**

Table 6: N,M, SD and t-ratio of time taken in without and with noise conditions.

(Time taken was in seconds)

*= Significant on .01 level

**= Significant on .05 level

Pondering over first comparison, it is observed that N,M, SD and t-ratio of time taken in 'without noise condition' are 50, 3494.46 and 722.64 respectively, while the N, M and SD of time taken in 'with noise condition' are 50, 4091.10 and 907.56 respectively. The t-ratio is 3.63 which is significant on 0.01 level. It means there is significant difference in time taken by both conditions. The subjects took more time in 'with noise condition' than 'without noise condition'. It means the quality of performance in 'with noise condition' is inferior than 'without noise condition'. Thus, it can be said that noise decreases the quality of performance of HNS subjects.

The second comparison between time taken by LNS subjects in two conditions-without noise condition and with noise condition. The N,M, SD of time taken in without noise conditions are 50, 2854.86 and 911.83 respectively, while the N,M and SD of time taken in with noise condition are 50, 3232.46 and 974.88 respectively. The t-ratio between these two sub groups is 2.00 which is significant on 0.05 level. It means time taken varies significantly in both conditions. Low noise sensitive (LNS) subjects have taken much time in 'with noise condition' than 'without noise condition'. It means quality of mental performance of low noise sensitive subjects deteriorates due to high intensity of noise.

Sl No	Variables	High sensitive	Low sensitive	Difference
		M	M	
1	Errors	615.12	608.4	6.72
2	Time taken	4091.1	3232.46	858.64

Table 7: Mean difference of errors and time taken in mental performance by high and low sensitive subjects in with noise condition.

Considering table no 6, it is observed that the error committed by high sensitive noise group is 615.12 and the error committed by low sensitive to noise group is 608.40. The mean difference is 6.72. It means high sensitive to noise group has committed more mistakes in mental performance than low sensitive to noise group. It means the quality of mental performance of high sensitive to noise subjects deteriorated in high intensity of noise than low sensitive to noise subjects.

Pondering over the second comparison, it is observed that high noise sensitive (HNS) subjects has taken 4091.10 seconds in 'with noise condition', 'while low sensitive to noise subjects' have taken 3232.46 second in crossing the alphabets of cancellation sheets. The mean difference is 858.64 seconds. It means high sensitive to noise subjects have taken 858.64 seconds more time than low sensitive to noise groups. So, it is concluded that the quality of mental performance of high noise sensitive subjects is inferior to low sensitive to noise subjects.

Discussion

It was found that mental performance decreases due to high intensity of noise. It is agreement with several previous studies. [34] measured the reading ability of children in a New York school where trains passed frequently on one side, the other side was relatively quiet. The researcher found that the reading scores of children on the noisy side of the school were significantly lower. Found that noise hampered classroom performance [35]. When an individual is engaged in mental work, the noise produce much distraction. No significant evidence of deterioration in performance is noticeable under condition of noise which did not exceed 90-95 dB in intensity [36,37].

It has been also found that the quantity and quality of mental performance decrease by high intensity of noise. This has been confirmed by many previous findings [38]. Conducted an experiment on mathematics and reading achievement of third grades in an area of Los Angeles that experienced an over flight every 2.30 minutes of the schools day. Mental performance involves different stages-sensory process, short term memory, long term memory, and central and specific processers. Only some parts are identified, selected

and organized through perceptual and intentional process out of huge amount of information detected by sense organs during a cognitive task. In task with the highest mental load, thinking i.e. central processing of these data is required in order to select and execute the appropriate responses. In all stages, there are individual determined capacity and limitations which may lead to disturbance by some intrusive factors on processing [39]. Brain imaging studies revealed that brain areas responsible for attention process which indicate the extent of information processing is responsible for cognitive process. High intensity of noise reduces information processing. Noisy environment disturbs brain activity processing of mental task and also tribulation and conversation. Noise exposure also because other non-auditory effects such as annoyance, change of behavior and deterioration in performance. But there are some studies which do not confirm this result. Found in their research that there is a direct and significant association between the level of sound and the length of performance. Found in their research that traffic noise improves the attention and concentration rather than quite condition. This finding is probable relevant to enhancing the arousibility level of the participants.

Conclusion

High Intensity of Noise Deteriorates Mental Performance

- The quantity of mental performance of high noise sensitive subjects decreases in high intensity of noise.
- The quantity of mental performance of low noise sensitive subjects decreases in high intensity of continuous traffic noise.
- The quality of mental performance of high sensitivity to noise subjects decreases in high intensity of continuous traffic noise.
- The quality of mental performance of low sensitivity to noise subjects decreases in high intensity of continuous noise.

Sensitivity to Noise Decreases Mental Performance

- The quantity of mental performance of high sensitivity to noise subjects decreases than low sensitivity to noise subjects in high intensity of continuous traffic noise

- The quality of mental performance of high sensitivity to noise subjects decreases in high intensity of noise than low sensitivity to noise subjects.

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