International Research Journal of Applied and Basic Sciences
© 2014 Available online at www.irjabs.com
ISSN 2251-838X / Vol, 8 (7): 933-939
Science Explorer Publications

Assessment of the effects of different noise levels on mental performance of individual doing mathematical calculation

Parvin Nasiri[1], Mohammadreza Monazzam[1], Farough Mohammadian[1*], Seyed Abolfazl Zakerian[1], Kamal Azam[2]

1. Department of Occupational Health, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran
2. Department of Epidemiology and Biostatistics, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran

Corresponding Author email: F.Mohammadian1986@gmail.com

ABSTRACT: Noise is one of the most important adverse working conditions that experience in most workplaces. Effect of noise on job performance is a controversial topic among researchers. Noise is an environmental stressor, caused inaccuracy in brain activity, lack of coordination in intellectual task, enhancing in mental disorders and influence on efficiency. The sounds were required to be prepared and approved**.** The numbers of cases involving male students were determined. A checklist was used for entrance into the study. The study was performed using standard methods to control and limit confounding factors**.** The subjects were exposed to three sound level of 35 dB (sound-based), 75 and 85 dB**.** Simultaneously, samples were doing the mathematical calculations. Results showed that there was a significant correlation between different levels of noise and increased reaction time, depth of both middle and deep mental process (reduction of computational efficiency and precision). There is no significant relationship between different levels of noise and mental processes at shallow level. With rising the noise levels, reaction time increased and precision and efficiency calculations reduced.
Keywords**:** Sound level, Mental performance, Mathematical calculations

INTRODUCTION

Noise is the one of the most important adverse working conditions that there is in most workplaces. Effect of noise on job performance is a controversial topic among researchers (Loeb and Loeb, 1986, Broadbent, 1978). Sound has different known effect on human, including damage to the auditory system, interference with communication, physiological effects and psychological effects such as disturbance and reduces the welfare (Loeb and Loeb, 1986). Concentration performances are influenced by several factors including environmental conditions that can be caused distraction and the need to extra focus on the jobs. One of the important environmental factors is noise (Trimmel and Poelzl, 2006). Environments with high noise is caused disturbance in brain activity, Inconsistencies in intellectual work, impaired conversation and the ability to convey information. Overall, sound can be cause loss of precision at the brain activities and lack of coordination in intellectual work. National Institutes of Occupational Safety and Health America estimated 30 million American workers are exposed to hazardous noise (Franks et al., 1996). People with activities that need to process high volumes of data at a higher level 90 dB both continuous and intermittent sound were greatly reduced Concentration performances. When exposed to high noise, people should do more efforts to reduce noise effects. Moreover, the noise and the effect of this on human performances were considerable. Noise is an environmental stressor, Caused inaccuracy in brain activity, lack of coordination in intellectual work, enhancing in mental disorders and influence on efficiency (Trimmel and Poelzl, 2006). World Health Organization States incident is one of the indicators of reduce performance caused by noise. Noise is known as a direct cause of mental disorders, but it is assumed that as an Enhancing factor. Among the factors that may interfere with the effect of noise on the performance is quality of job. The effect of noise on performance depends on the work environment, nature of work (hard or easy), and mental or physical work being. In general it can be said that the impact of noise on difficult and complex tasks that require a lot of Skills and expertise, for more than it affects simple works. Because hard work requires a lot of care and maintenance is involved with numerous physical and mental activities. The noise has disturbing aspects on the cognitive tasks than physical tasks. So far, studies have been done on the effect of noise on mental performance, for example in a study conducted in

2013 by Habibi et al was observed that increasing the sound pressure level would be reduced the efficiency and precision (Habibi et al., 2013). Belojevic and et al in 2001 conducted a study to was evaluated the mental functionality in terms of silent and noise, The results of the study showed that there is no significant effect on the precision of fulfilling of intellectual work the, silent and noise conditions (Belojevic et al., 2001) .Many jobs to do the work of processing information and special care is needed. In such jobs correct mental performance has a specific role and noise can have the greatest effect on this (Kazempour et al., 2011). Despite the many studies regarding the impact of noise on mental performance and job skills is done, the results obtained are different and yet the results have not been proven definitive and same results (Jafari et al., 2008, Smith and Jones, 1992) . These differences may be the result of different individual sensitivity to noise assumed (Waye et al., 2003) .Therefore, the present study examined the effects of noise in different levels on the mental performance when people are paid to do the math.

METHODS AND SUBJECTS

Study subjects and sample collection

This cross - sectional study was conducted in 2013 among male graduate students of Tehran University of Medical Sciences and samples were selected randomly. Entrance criteria for this study was perfect hearing health, lack of visual disorders, and nonsmoking and lack of sleep disorders in the past 24 hours that the information was obtained through questionnaires.

Samples size

Using the results of previous similar studies, standard deviation of noise were obtained S = 2.07. at the significant level α = .05 , power β= 80% and with considering D = 1.35 (D = Effect Size), sample size obtained 18 .Due to the loss of the samples considered to be 15 percent more than the number of samples, thus the sample size was 20 people.

$$N = \frac{S^2(Z_{1-\alpha/2} + Z_{1-\beta)}}{D^2} = 18$$

Mathematical Calculations Test (Mental Arithmetic)

All eligible samples were participated in the math test. Samples were doing the math when exposed to background noise (35 dB), then they did the test in the face of variable and low-frequency noise at two levels 75 and 85 dB .This test included Division of 15 two-digit numbers to two decimal places of the numbers 6, 7, 8 and 9. Deep mental process can be expressed in terms of the number of digits correctly calculated. Response time and number of correct responses as a measure of mental performance, Time for this test, as an expression of people's reaction time and the correct figure is indicative of the surface level of mental operations, The first digit after the decimal is the indicator of mental functions in middle and the second digit after the decimal is the mental operation at a deep level. Precision are achieved in this experiment according to the number of errors.

The equipment used in this study

According to the reviewed studies and noise characteristics, needed noise sources are determined. Arj Company was selected to recording noise with using the pulse device. Industrial noise had on height hearing workers and the same distance from the sound source. The noise was recorded with respect to the relevant variables. The device includes a system that collects, analyzes and indicator of recorded noise. For noise play were used a computer and two speakers. In this study, two speakers were placed at a distance of one meter and a height of one meter from the surface of the desk study. In this step, examining frequency analysis of recorded sound that played in industry and the laboratory was detected. There was a high correlation between the frequencies of Analysis in that two ambient. The quality of played sound in the laboratory was reached to the sound quality of the recording industry with using of Software Gold wave. Using this software, was varying sound was provided. Using this software, sound editing, creating the required duration and level of noise was done. This software has the capability to produce different sounds. In this study, the B & K Model 2236 device to match a desired frequency analysis and measurement periods were used. The desired levels in this study, were 75, 85 dBs'. Using Gold Wave software to adjust sound levels to reach the desired levels. Stopwatch was used to determine the duration of the test. Before the start of test, Participants were filled informed consent forms, demographic questionnaires and, hearing and visual health check lists. Eligible persons were given adequate training on how to perform the test. In between each stage of the test was given 15 minutes rest in the individual. After the test is performed, dates of this study were analyzed with using of the SPSS statistical software, statistical test one way ANOVA and Pearson correlation coefficients.

RESULTS

Participants in this study were male graduate students in the field of health sciences with an average age of26.60± 1.16. Data distribution is considered normal according to the dependent variable histograms which are close to normal. In this test, the dependent variable consisted of response time (the test time), at the surface level of mental operations (integer number of divisions), intermediate (first decimal digit), deep (second decimal digit or fully accurate), in other words, the accuracy and computation efficiency is detected.in the table 1 The results of the effect of different levels of noise on the mean reaction times of subjects was showed. The mean reaction time for different levels of noise was used by the test One Way AONOVA. Results show that the lowest average reaction time is the state of background noise (35db) and the highest average reaction time is the noise level of 85 db. This means that there is a significant relationship between noise levels and the average reaction time. So that with increasing the reaction time of the average noise level has increased (P<0.001).

Table1. Cooperation of average reaction time with different levels of noise.

Sound Levels (dB)	Mean	Std. Deviation	P Value
35	339.90	6.51	
75	379.10	8.48	<0.001
85	391.11	7.57	

To compare the effects of different levels of noise on reaction time were used the Schaffer multiple comparisons (Table 2). The results showed that there is a significant difference between applied of noise levels and the average reaction time (P <0.001). But between 75 and 85 dB levels there is no statistically significant difference (p = .522). The results indicated that sound levels relative to silent mode caused increased their reaction time, but between75, 85dB levels there is no significant relationship.

Table 2. Corporation of average reaction time with different levels of noise

NOISE(db)	Mean Difference	Std. Error	P Value
35 * 75	-39.200		0.002
35 * 85	-51.43		<0.001
75 * 35	39.200	10.70	0.002
75 * 85	-12.23		0.522
85 * 35	51.43		<0.001
85 * 75	12.23		0.522

The reaction time of the different levels of noise has been shown in chart 1. The diagram shows an increased noise level, their reaction time is increased.

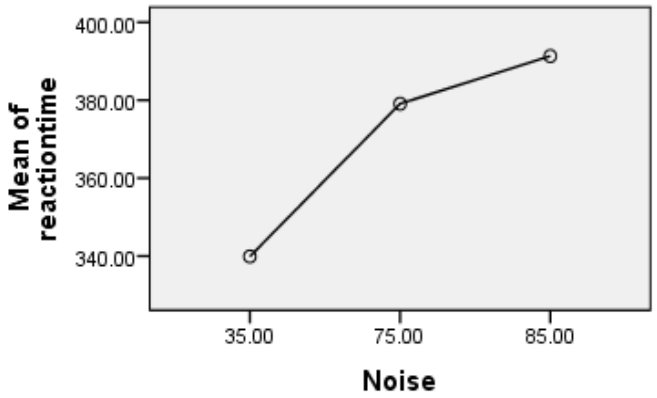

Figure1. The average response time for different levels of noise

The effect of noise on factor of mental operations in superficial level

The results of the effect of different levels of noise on the mental operations in superficial level that reflect the correct digits in math division Data were statistically analyzed using the ON Way ONOVA,

The showed There is no correlation between the noise levels on the mental operations in superficial level (p=.105). To compare the effects of different levels of noise on the mental operations in superficial level were used the Schaffer. The results showed that the noise level imposed on each of the mental operations mean in surface level (correct figure), was not statistically significant difference. In Chart 2 of mental operations

in superficial level (calculations precision) at various levels of noise was given and the graph shows with increased noise level was reduced the number of correct digits.

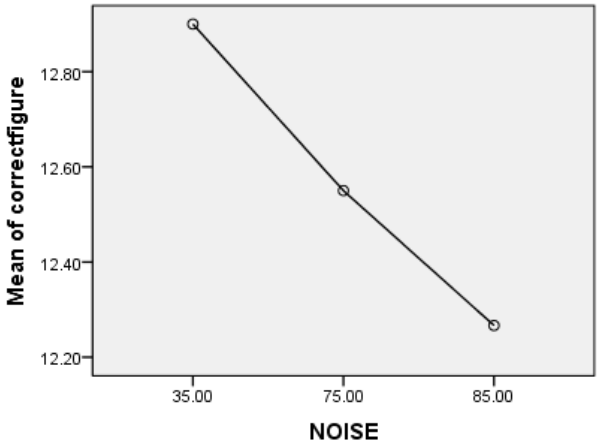

Figure2. Mean of correct figure in different noise levels

Effect of different levels of noise on the mental operations in middle level (first decimal digit)

The mean mental operations in middle level for different levels of noise were used by the test One Way AONOVA. Results show that the highest number of correct responses decimal digit is the state of background noise (35dB) and the lowest correct responses decimal digit is the noise level of 85 db. This means that there is a significant relationship between noise levels and the average correct responses decimal digit.So that the increase in noise level reduced the number of correct answer at the first decimal digit which represents subjective process in the middle level(P<0.001). To compare the effects of different levels of mean mental operations in middle level (first decimal digit) were used the Schaffer multiple comparisons (Table 2). The results showed that there is a significant difference between applied of noise levels and the average mental operations in middle level (P <0.001). But between 75 and 85 dB levels there is no statistically significant difference (p =0 .522). The results indicated that sound levels relative to silent mode caused increased their reaction time, but between75, 85dB levels there is no significant relationship.

Table 3. Comparison of average mental operations in middle level (first decimal digit) at the different levels of noise.

NOISE(dB)	Mean Difference	Std. Error	P Value
35 * 75	2.43		0.002
35 * 85	3.06		< 0.001
75 * 35	-2.43	0.66	0.002
75 * 85	.63		0.63
85 * 35	-3.06		< 0.001
85 * 75	-.63		0.63

In Chart 3 average number of correct answer (mental operations in middle level) at various levels of noise was given and the graph shows with increased noise level was reduced the number of correct answer at the first decimal digits.

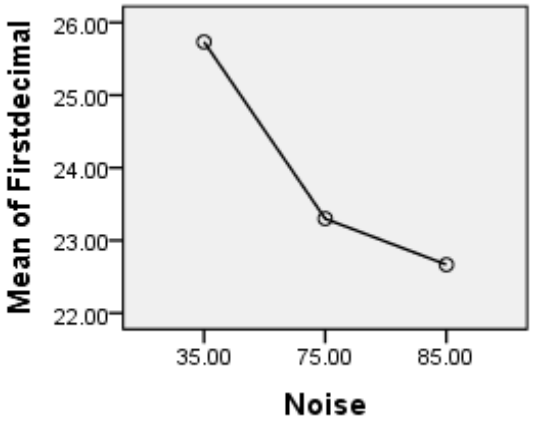

Figure3. Mean of first decimal digits in different noise levels

Effect of different levels of noise on the mental operations in deep level (second decimal digit)

The mean mental operations in deep level for different levels of noise were used by the test One Way AONOVA. Results showed that the highest number of correct responses decimal digit is the state of background noise (35db) and the lowest correct responses decimal digit is the noise level of 85 db. This means that there is a significant relationship between noise levels and the average correct responses decimal digit so that the increase in noise level reduced the number of correct answer at the second decimal digit which represents subjective process in the deep level (P<0.001). To compare the effects of different levels of mean mental operations in deep level **(second decimal digit)** were used the Schaffer multiple comparisons (Table 3). The results showed that there is a significant difference between applied of noise levels and the average mental operations in deep **level** (P <0.001). But between 75 and 85 dB levels there is no statistically significant difference (p = 0.522). The results indicated that sound levels relative to silent mode caused increased their reaction time, but between75, 85dB levels there is no significant relationship.

Table 4. Comparison of average mental operations in deep level (second decimal digit) at the different levels of noise

NOISE(db)	Mean Difference	Std. Error	P Value
35 * 75	6.35		< 0.001
35 * 85	7.90		< 0.001
75 * 35	-6.35	1.37	< 0.001
75 * 85	1.55		0.53
85 * 35	-7.90		< 0.001
85 * 75	-1.50		0.53

In Chart 4 average number of correct answer (mental operations in deep level) at various levels of noise was given and the graph shows with increased noise level was reduced the number of correct answer at the second decimal digits.

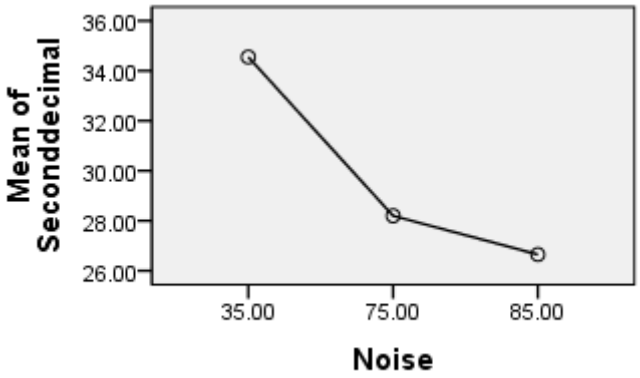

Figure4. Mean of second decimal digits in different noise levels

Pearson correlation coefficients was used to examine the relationship between different levels of noise and test time, number of correct responses and precision computational on the math test. The results showed that with increasing noise level increased reaction time and Computational efficiency and precision has declined.

Table 5. Correlation between different noise levels and reaction time, Number of correct mathematical division and Computational precision.

Dependent variable	NOISE(db)	
	P	R
Test time	< 0.001	0.353
correct digits	0.04	-0.153
first decimal digit	<0.001	-0.342
second decimal digit	<0.001	-0.417

DISCUSSION AND CONCLUSION

Results of previous studies concerning the effect of noise on mental performance when performing mathematical calculations have been inconsistent and do not show a Logical relationship. Given Baker et al and Krytr et al Opinions noise in the range of 50 to 110 dB can be cause loss of mental function (BAKER et al., 1984, Kryter and Poza, 1980). But Gawron Opinion noise has no effect on the mental performance (Gawron, 1984). Meanwhile, O'Malley and hockey believed that the noise caused improves speed and

precision Income test is related to mental processing (O'MALLEY and Poplawsky, 1971, Hockey, 1970), This is also a Park and Pine founded that mental performance is not affected by the noise associated with math tests at levels 60 to 95 dB, But Wei et al reported that the this ranging levels of the mental performance decreases (Park Jr and Payne Jr, 1963, Wu et al., 1988) . The results of this study showed that increasing the noise level increases reaction time (test Doing speed) are individuals. This result is consistent with a study Belojevic et al in 1992 that stated at the Playing noise at the sensitive individual the noise caused increase the time required to resolve a math division (Belojević et al., 1992). Of course, this study is in contradiction to investigate Ms. KazemPour et al. Their study states that high noise reduces the computation time. This problem has intensified in the case of low frequency noise, in this study it also increases the noise levels on the mental operations in middle and deep level has a significant effect and was caused reduce correct case at the Math Calculations, This result there is consistent with a study in 2011 by Ms. KazemPour et al found a significant correlation between sensitivity to low frequency noise and deep mental process. Low-frequency noise of 65 dB relative to the same reference noise level reduces the computational precision and the quality efficiency of the profound memory (Kazempour et al., 2011). This study is also consistent with the study of Barker et al stated that the noise in the range of 50 to 110 dB can cause loss the mental performance (BAKER et al., 1984). But the increase in noise level no significantly related to mental operations in superficial level, Words cannot infer that the noise is reduced or increased the number of correct, Also all noise levels relative to silent mode (background noise) was affected on reaction time and the correct mathematical divisions But the no correlation between levels 75 and 85 dB with the dependent variable in this study , This result is consistent with a study Park and Pine that found mental performance associated with mathematics test from 60 to 95dB of noise levels is not affected (Park Jr and Payne Jr, 1963). In a study was conducted in 2013 by Habibi et al, found that increasing the noise pressure level would be decreased the efficiency and precision that is consistent with the present study (Habibi et al., 2013). Tajik and Ghomri in the study in 2009 showed that the noise affects information processing and increase errors and reduce precision, in our study also increases the noise level increases reaction time and decreases the efficiency and precision computational. Belojevic et al in 2001 conducted a study to evaluate the mental functionality in silent and noise conditions, the results of the studies showed no significant effect was observed between the precision in the Intellectual work in silent and noise condition. The results of the study are consistent with present studies was stated that there is no significant relationship between the noise and mental operations in superficial level (Belojevic et al., 2001). Lusczyniska Pawlaczyk et al in 2005 was examined the effects of low frequency noise on human mental functioning, The results was indicated that the average level of low frequency noise (50dBA) can be effected on the eyes and focus performance, especially in people who are sensitive to noise (Pawlaczyk-Łuszczyńska et al., 2005) .Albery et al in 1989 was examined a study on the effect of noise on the workload of operators, according to result that study when the noise increased, significantly association with both workload and reaction time increased (Albery, 1989). Jafari et al in 2008, a study showed that low frequency noise reduction performance and the response speed (Jafari et al., 2008). Finkelman and Fisher stated that the presence of loud noise (65 dB) compared to the relatively quiet (45 dB), Although the speed of reaction becomes more, But the number of incorrect responses increases ,This is due to the defense response that people want more quickly dropping his noise to an uncomfortable condition (Fisher, 1983, Finkelman et al., 1977). The difference in results between studies may be due to the sensitivity of the population under study to the noise in different studies, dispute the results may be influenced by education level or differences in dominant system on the populations studied.

REFERENCES

Albery W. 1989. The effect of sustained acceleration and noise on workload in human operators. Aviation, space, and environmental medicine, 60**,** 943-948.

Baker MA, Holding DH, Loeb M. 1984. Noise, sex and time of day effects in a mathematics task. Ergonomics, 27**,** 67-80.

Belojević G, Öhrström E, Rylander R. 1992. Effects of noise on mental performance with regard to subjective noise sensitivity. International Archives of Occupational and Environmental Health, 64**,** 293-301.

Belojevic G, Slepcevic V, Jakovljevic B. 2001. Mental performance in noise: The role of introversion. Journal of environmental Psychology, 21**,** 209-213.

Broadbent DE. 1978. The current state of noise research: Reply to Poulton.

Finkelman JM, Zeitlin LR, Filippi JA, Friend MA. 1977. Noise and driver performance. Journal of Applied Psychology, 62**,** 713.

Fisher S. 1983. " Pessimistic noise effects": The perception of reaction times in noise. Canadian Journal of Psychology/Revue canadienne de psychologie, 37**,** 258.

Franks JR, Stephenson M, Merry CJ. 1996. Preventing occupational hearing loss: a practical guide, US Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Division of Biomedical and Behavioral Science, Physical Agents Effects Branch.

Gawron VJ. 1984. Noise: effect and aftereffect. Ergonomics, 27**,** 5-18.

Habibi E, Dehghan H, Dehkordy SE, Maracy MR. 2013. Evaluation of the Effect of Noise on the Rate of Errors and Speed of Work by the Ergonomic Test of Two-Hand Co-Ordination. International journal of preventive medicine, 4**,** 538.

Hockey G. 1970. Signal probability and spatial location as possible bases for increased selectivity in noise. The Quarterly Journal of Experimental Psychology, 22**,** 37-42.

Jafari M, Kazempour M, Alimohammadi I, Mehrabi Y, Hatami J. 2008. The Influences of Low Frequency Noise on Mental Performance. Journal of Mazandaran University of Medical Sciences (JMUMS), 18.

Kazempour M, Jafari M, Mehrabi Y, Alimohammadi I, Hatami J. 2011. The Impact of Low Frequency Noise on Mental Performance during Math Calculations. Iran Occupational Health, 8**,** 16-0.
Kryter KD, Poza F. 1980. Autonomic system activity and performance on a psychomotor task in noise. The Journal of the Acoustical Society of America, 67**,** 2096-2098.
Loeb M. 1986. Noise and human efficiency, Wiley Chichester, United Kingdom:.
O'malley JJ, Poplawsky A. 1971. Noise-induced arousal and breadth of attention. Perceptual and motor skills, 33**,** 887-890.
Park Jr JF, Payne Jr MC. 1963. Effects of noise level and difficulty of task in performing division. Journal of Applied Psychology, 47**,** 367.
Pawlaczyk-Łuszczyńska M, Dudarewicz A, Waszkowska M, Szymczak W, Śliwińska-Kowalska M. 2005. The impact of low frequency noise on human mental performance. Inter J Occup Med Environ Health, 18**,** 185-98.
Smith AP, Jones DM. 1992. Noise and performance.
Trimmel M, Poelzl G. 2006. Impact of background noise on reaction time and brain DC potential changes of VDT-based spatial attention. Ergonomics, 49**,** 202-208.
Waye KP, Clow A, Edwards S, Hucklebridge F, Rylander R. 2003. Effects of nighttime low frequency noise on the cortisol response to awakening and subjective sleep quality. Life sciences, 72**,** 863-875.
Wu TN, Huang JT, Chou PF, Chang PY. 1988. Effects of noise exposure and task demand on cardiovascular function. International archives of occupational and environmental health, 60**,** 99-105.