

# Relationship Between Psychomotor Efficiency and Sensation Seeking of People Exposed to Noise and Low Frequency Vibration Stimuli

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**Abstract.** At the workplace of the machine operator, low frequency whole body and hand- arm vibrations are observed. They occur together with noise. Whole body vibration in the range of 3-25 Hz are detrimental to the human body due to the location of the resonant frequency of large organs of the human body in this range. It can be assumed that for this reason people working every day in such conditions can have reduced working efficiency. The influence of low frequency vibration and noise on the human body leads to both physiological and functional changes. The result of the impact of noise and vibration stimuli depends largely on the specific characteristics of the objects, which include among other personality traits, temperament and emotional factor. The pilot study conducted in the laboratory was attended by 30 young men. The aim of the study was to look for correlations between the need for stimulation of the objects and their psychomotor efficiency in case of vibration exposure and vibration together with noise exposure in variable conditions task. The need for stimulation of the objects as defined in the study is based on theoretical assumptions of one dimensional model of temperament developed by Marvin Zuckerman. This theory defines the need for stimulation as the search for different, new, complex and intense sensations, as well as the willingness to take risks. The aim of research was to verify if from four factors such as: the search for adventure and horror, sensation seeking, disinhibition and susceptibility to boredom, we can choose the ones that in conjunction with varying operating conditions, may significantly determine the efficiency of the task situation. The objects performed the test evaluation of their motor skills which consisted in keeping the cursor controlled by a joystick through the path. The number of exceeds of the cursor beyond the path and its maximum deviation was recorded. The collected data were used to determine the correlation between the working efficiency and the need for stimulation of the objects under the influence of vibroacoustic factors. The analysis of the results allowed to define a set of criteria that make up the arduous working conditions. The obtained results indicate the need for the continuation of the research.

## 1. Introduction

The working environment has a direct impact on the accuracy and safety. Vibration and noise are physical factors, which are present in the working environment of the machine operator and cause



undesirable reactions of the body, such as physiological and functional changes. [1]. In extreme cases, it causes permanent health damage diagnosed as occupational diseases [2]. For this reason, the impact of noise and vibration risks on the physiological parameters of the human body has been evaluated. As a result of these activities, limits for vibration and noise at the workplace in standard approaches has been determined, however the relationship between whole body and hand-arm low frequency vibration parameters, noise and human temperament e.g. level of experience searching is still not fully recognized.

One of the fundamental individual differences that determine human behaviour is temperament. This concept defines an innate tendency of individuals to engage in a certain style of behaviour [3]. It is not surprising; the temperament became the subject of many studies and experiments. It is believed that temperament exerts a stronger influence on individual behaviour than personality traits. This determines what people do, think as well as how they work, think and feel (Buss, 1995, based on: Kosslyn, Rosenberg, 2006 [3]). Initially, the subject of a study to determine the temperament were psychometric properties. Abilities such as perception, memory, attention or correctness and precision of motor movements were able to extract such categories of temperament dimensions which will later allow to predict and evaluate human behaviour in a given situation. Later, however, the mechanisms responsible for the quality of these capacities were noticed. This is about the properties of the nervous system [4]. The research of the nervous system was directed to explain the differences in the behaviour of humans and in particular, their temperament and ability. On this basis, Zuckerman [5] has identified the feature of temperament called 'the search experience', which is defined as a search for different, new, complex, and intense sensations and experiences, and willingness to take the physical, social, legal, and financial risk in order to provide them with this type of experience. The search of sensations is not, in terms of the theory of Zuckerman, a homogeneous feature. It consists of four factors:

- searching for thrill and adventure (TAS) – passion for outdoor activities and activities physically risky.
- searching for experience (ES) – nonconformist lifestyle that involves the mind and the senses.
- disinhibition (Dis) – tendency to discharge and searching for relaxation in risky behaviour. This feature is the most biologically conditioned.
- susceptibility to boredom (BS) – aversion to repeat the experience, routine work. Need for constant, new external stimuli, such as social interaction or activities.

In 1979, Zuckerman [5], [6] proposed a questionnaire to measure this feature exactly – Sensation Seeking Scale Form V. Because this feature is part of the temperament of human being, and this in turn largely determines human behaviour, there seems to be an important question whether the need for stimulation can influence the work and whether there are such working conditions, which, combined with the need for stimulation of a subject can positively or negatively influence its results. Research of Zheng Sheng, Xu and Zhang [7] focused on recording the potentials of ERPs (event-related potentials) of the subjects in the performance of their duties of Eriksen flanker effect. The study showed little relationship between the search for sensations and activity ERN (error-related negativity). However, this relationship appeared in females.

Nevertheless, it was pointed out that the persons who receive higher scores on the scale of sensation seeking were inclined to make mistakes in the task which proved, their neglect and less sense of guilt for improperly performed tasks. In the experiment on glancing off the track for drivers during the additional steps shown, that drivers that acquire higher scores on the sensations searching scale significantly longer focused their eyes off the road while driving, while carrying out additional tasks [8]. It can therefore be assumed that the high level of searching for sensation will influence the way to work and will have a negative character that will result in a higher degree of negligence during feeling less risk in the course of their work incorrectly.

## 2. Purpose and methodology of research

The conducted pilot studies aimed to determine whether searching for sensations as the overall score obtained on the scale of the SSS-V and changing of working conditions as a vibration and noise can influence the accuracy and correctness of work. On a specially designed and built simulator, whole body and hand arm vibration of previously selected parameters were excited. For research the following frequencies of the chair (ff): 0 Hz, 2 Hz, 5 Hz, 8 Hz and 12 Hz and the corresponding amplitudes (Af): 0 mm, 8.5 mm, 4.6 mm, 2.9 mm, 1.9 mm were selected. The choice of these values depended on the technical possibilities of the inductor. For control panel the following frequencies (fp): 0 Hz, 2 Hz and 16 Hz and amplitudes (Ap): 0 mm, 5 mm and 5 mm were chosen. Working conditions will be a combination of the described above frequency values of the chair and control panel, which were arranged in pairs (ff, fp). Each of the objects performed the basic task of the experiment in two cycles. In the first cycle the main stimuli were vibration, and in the second cycle - vibration together with noise. Both cycles lasted 60 minutes. The sequence of stimuli was random for each participant. The subjects were young, healthy men, who after passing a cycle of medical and psychological tests, and after signing an informed consent to participate in the measurements were subjected to vibration and vibration including noise. During exposure, the person was performing a dedicated test examining the accuracy of the work. The test consists of driving the cursor on a moving track. To evaluate the accuracy of the work, two parameters were used – number of exits of the cursor from the track (LWK) and value of maximum distance of this exit (MOK).

## 3. Results and discussions

The obtained results of working accuracy, according to the LWK and MOK criterion, allow for unambiguous assessment of the impact of vibration and vibration including noise on this accuracy. In figure 1 and figure 2, the change of the number of exits of the cursor and the maximum deviation of the cursor is shown. It is shown that for chair frequency of 2 Hz and 12 Hz and for immovable chair, the results are similar to each other. In the case of vibration for frequency of 5 Hz, the results are significantly different – the accuracy, with taking into account both assessment criteria, is the worst. For ff = 18 Hz the results are also bad. Taking into account the results of the measured working accuracy for the frequency of desktop, it should be summarized that for immovable desktop and for frequency of 2 Hz for both criteria the obtained accuracy is similar. The significant differences are for fp = 16 Hz. The measured working accuracy deteriorated significantly.

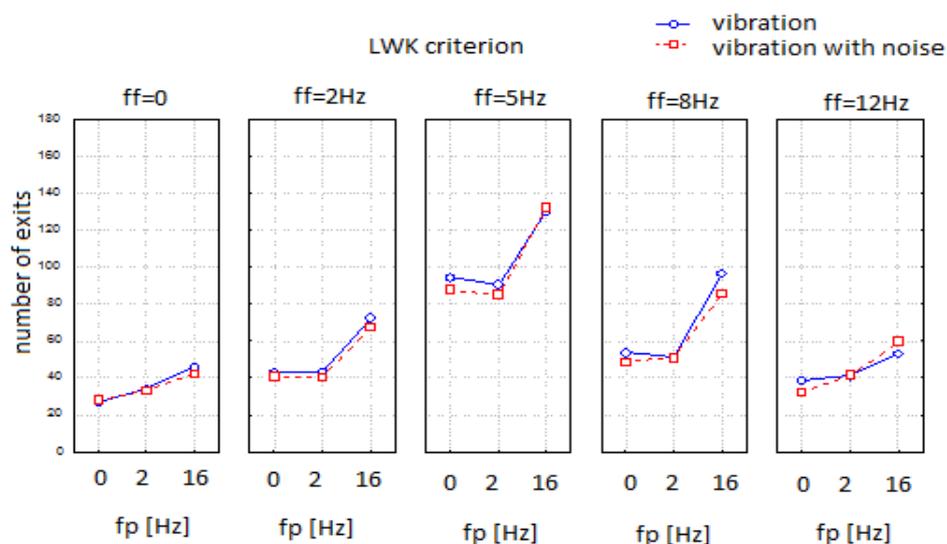


Figure 1. LWK criterion for vibration and for vibration with noise

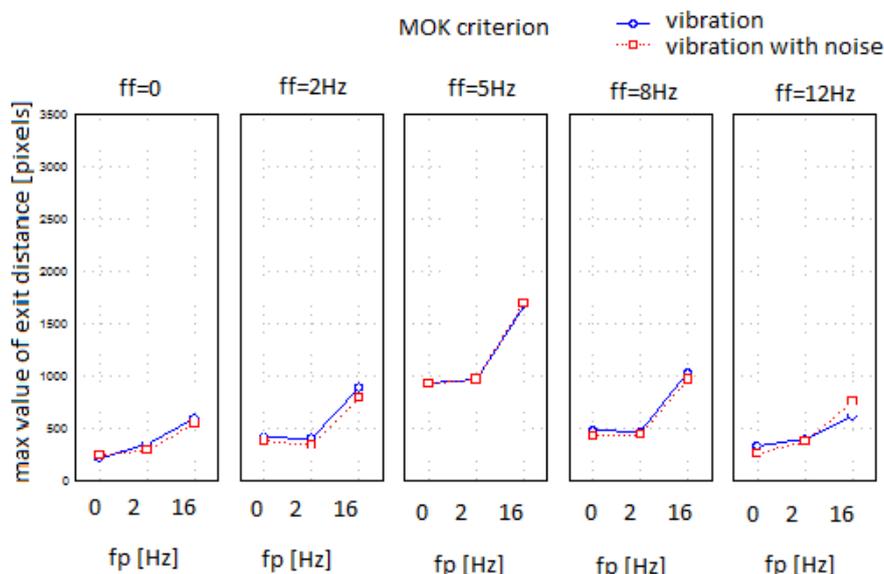


Figure 2. MOK criterion for vibration and for vibration with noise

For both types of the applied stimulus - vibration or vibration with noise, the results were similar. The collected results allowed to carry out an analysis based on the Spearman rank correlation coefficient. All the obtained correlations have a positive character. This therefore means that a higher score on the scale of the SSS-V was positively correlated both with the number of errors made by subjects, as well as with a maximum deviation of the cursor from the track. The detailed analysis of the 4-dimensional scale SSS-V and the overall score for all possible working conditions, i.e. for all possible variants of vibration of a chair and desktop (total of 16) with additional occurrence or non-occurrence of noise were conducted. The correlation of the results of the general scale of the SSS-V and the errors is asymmetric, which means that among the collected results, it is not possible to create a direction of changes. It is worth noting on the results of the correlation in the individual scales of the test. So, the greatest positive correlation with the number of errors and the maximum deflection is shown on the scale of disinhibition (Dis) (Table 1).

A high score on this scale means that the tested person is looking for relaxation by taking behaviour inappropriate and risky. One interpretation of these results may be that the subjects deliberately made mistakes in order to increase the stimulation. Unfortunately, in order to confirm this hypothesis, it will be necessary to conduct further studies. Because of the fact that the element of temperament which is searching for experience has a physiologically conditioned [9], specific frequencies of vibration, as a stimulus, may influence the occurrence of negative behaviours as an error, inaccuracies or negligence of working. In this case, the additional tests should be carried out as well. Most relationships between all the dimensions of the scale SSS-V have been observed in the measurement of a maximum value of exit distance with noise occurrence. The dimension of SSS-V scale, which showed the least correlation with the motor skills test was the size of searching for experience (ES). The only relationship for this dimension appeared, however, exactly in the measurement of a maximum value of exit from the track with noise occurrence.

**Table 1.** Correlations of test conditions with the results of the efficiency test for disinhibition scale (Dis) SSS-V.

Research conditions	Errors without noise	Errors with noise	Max value of exit distance from the track without noise	Exit from the track with noise
ff=0/fp=0	r = 0.55 / p = 0.002	r = 0.44 / p = 0.014	r = 0.53 / p = 0.003	r = 0.47 / p = 0.008
ff=2/fp=0			r = 0.37 / p = 0.046	
ff=2/fp=2		r = 0.35 / p = 0.055		r = 0.36 / p = 0.050
ff=8/fp=16			r = 0.41 / p = 0.022	
ff=12/fp=0			r = 0.38 / p = 0.038	r = 0.42 / p = 0.019
ff=12/fp=2			r = 0.41 / p = 0.023	
ff=12/fp=16				r = 0.38 / p = 0.039
ff=0/fp=2		r = 0.45 / p = 0.011		r = 0.46 / p = 0.011
ff=0/fp=16				r = 0.37 / p = 0.045
ff=0/fp=0	r = 0.47 / p = 0.009	r = 0.46 / p = 0.011	r = 0.39 / p = 0.033	r = 0.45 / p = 0.011

#### 4. Conclusions

On the basis of the analysis of the results, it could be observed that vibration and vibration together with noise has a significant influence on the measured working accuracy. The chair frequency equal of 5 Hz and 8 Hz seemed to have a bad influence on this accuracy. In turn, in the case of desktop for frequency 16 Hz (for both LWK and MOK criteria), the worst working accuracy has been observed. The type of stimuli – vibration or vibration together with noise – was insignificant. The obtained results in these cases were similar.

The obtained results fit in to the generally accepted by the scientific community concept of assuming that temperament as a forming part of the individual differences is a complex dimension. The need for experience searching may be the one, but not the only factor determining human cognitive functioning. Although in this and other studies, it can be observed a trend of a negative impact of the results of searching for experience on working results, it should be remembered that this is not a universal phenomenon. In the study [10] it has been shown that the person characterized by higher scores on the scale of experience searching has a higher level of attention in tasks requiring selective attention. Moreover, these persons committed fewer errors in tasks of dichotomous listening. These results suggest that people with higher levels of experience searching have a higher level of selectivity of attention and thus the ability to ignore irrelevant stimuli. The conducted pilot research does not give a clear answer to the question whether expressed on the SSS-V scale the need of experience searching can in a certain way, in conjunction with specific working conditions, determine the efficiency of the human in a task situation. However, the obtained results are an indication to continue research in this direction.

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