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PERSONALITY DETERMINATION USING VIBRATING MOVEMENT PARAMETERS

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Abstract. *The human body responds to stimuli by organizing a response depending on purpose. How each person responds to external stress is determined by psychophysical reactions to these factors. But one key aspect that has not been studied enough so far, is the individual personality. This depends on a huge number of external (educational, cultural, social background characteristics, etc.), and internal factors (genetic, anatomical, etc.). Practically every man has his personality and, therefore, it is impossible to classify in this respect. To study this issue, we used Likert scale, which quantifies the degree of discomfort due to external stress. Depending upon how the subject chooses a certain level of the 5 of the Likert scale, we determined the personality of the subject. Several individuals underwent the same type of vibrations. To measure the whole-body vibrations transmitted by the vibrating platform, we used the multiple acquisition vibrations system NetdB. We fixed PCB Piezotronics 356A16 triaxial accelerometers on the subjects. We processed the data with the dBFA Suite-Software acquisition control and post-processing data; we have maintained constant parameters to study how different subjects perceive the same external stimulus. We assessed magnitude of the perception using Likert degree of discomfort scale: with values ranging from 1 (slight discomfort) to 5 (extreme discomfort). Furthermore, we used Rasch's model to calculate the θ coefficient, which indicates the type of personality for the studied subject.*

Key words: *vibrations, degree of discomfort, model for personality determination, Likert scale*

1. INTRODUCTION

The human body responds to stimuli by organizing a response depending on our purpose [(1), (4)]. How each person responds to external stress is determined by psychophysical reactions to these factors.

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But one key aspect that has not been studied enough so far is the individual personality. This depends on a huge number of external factors (educational, cultural, social background characteristics, etc.), and internal (genetic, anatomical, etc.). Practically every man has his own personality and therefore it is impossible to classify in this respect [5].

In this paper we studied how workers perceive the transmission of vibration from vibrating platforms through the whole body (WBV) [(3), (6), (8)].

Quantifying the perception of external stress is best represented by Likert Scale [2]. This is a psychometric scale based on Rasch's Model [7]. It is widely used in questionnaires and survey research, so the term is often used interchangeably with the scale of assessment, even though the two are not synonymous (Table 1). When responding to a Likert item, the subjects state whether they agree with the questions from the questionnaire and/or conducting an experiment.

All calculations that determine the degree of discomfort due to vibrations should take into consideration the subject's size. For this reason, we calculated the Body Mass Index ($BMI=m/h^2$) (Table 2) and Body Volume Index for each case (BVI refers to the relationship between mass and its distribution throughout the body, taking into account the chest circumference and chest/waist ratio). In all experiments, the subjects were in the normal range of BMI and BVI.

Depending on how the subject chooses a particular level from the 5 above, one can determine personality of the subject.

Table 1 Degree of discomfort scale

Degree of discomfort	Likert Scale
Not at all	0-1
A little	1-2
Moderate	2-3
Strong	3-4
Very strong	4-5

Table 2 Body Mass Index

Category	BMI [kg/m^2]
Very severely underweight	< 15
Severely underweight	15.0 - 16.0
Underweight	16.0 - 18.5
Normal (healthy weight)	18.5 - 25
Overweight	25 - 30
Obese Class I (Moderately obese)	30 - 35
Obese Class II (Severely obese)	35 - 40
Obese Class III (Very severely obese)	> 40

2. PROCEDURE

Several people were subject to the same type of vibrations. To measure the whole-body vibrations transmitted by the vibrating platform (Fig. 1) the vibrations multiple

acquisition system, NetdB, was used. The PCB Piezotronics 356A16 triaxial accelerometers were fixed on the subjects. The data were processed with the dBFA Suite-Software of data acquisition control and post-processing; the parameters were kept constant, to study how different subjects perceive the same external stimulus. The θ coefficient, which indicates the type of personality the studied subject has, was calculated based on Rasch's model.

Rasch's model is used for analyzing data from assessments, such as skills, attitudes and personality traits; it is increasingly used in other areas, the most important being occupational health. Mathematical theory underlying Rasch models is based on the theory of item response. For example, in the logistic model of the three parameters, the probability of correct answer for the i item is: $P_i=c_i+\frac{1-c_i}{1+e^{-a_i(\theta-b_i)}}$, where θ is the person's parameter (ability), and a_i, b_i, and c_i are the item's parameters.

Fig. 1 Subject on a vibrating platform

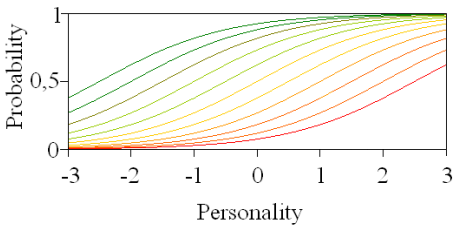

Fig. 2 Probability curves for a number of items

Table 3 Personality Scale

θ	Personality Type
0-0.5	Very Weak Personality
0.5-1	Weak Personality
1-1.5	Weak to Average Personality
1.5-2	Average to Strong Personality
2-2.5	Strong Personality
2.5-3	Very Strong Personality

Probability curves (Fig. 2) are colored to highlight the changes in probability of a correct answer depending on the location of personality (Table 3). The person is likely to respond correctly to the questions (left) and is unlikely to answer the questions correctly (right).

In this paper, the results obtained from determinations made on 58 subjects, ages between 19 and 54 years with a majority normal BMI, will be presented. Among these,

41 subjects are smokers and 6 subjects drink more than 2 glasses of wine per day. Also, 27 subjects are students, 26 are workers and the rest have university degree (desk jobs).

The subjects agreed to take part in the experiments. First, they answered multiple specialized questionnaires in order to determine each personality [9], [10], [11].

3. RESULTS AND DISCUSSIONS

Following the answers given by the subjects, 3 types of personalities were defined:

- class A: a weak to average personality
- class B: a very weak personality
- class C: a strong to very strong personality

Hereinafter are presented the mediate results for each class.

Class A

Vibration time was 1min, the measured r.m.s accelerations are: 0.85; 0.87; 0.91; 0.93 and 0.95m/s^2, at the frequencies: 4, 6, 8, 11 and 16Hz. Measure of Perception (MP) is presented in Fig. 3 and Fig. 4.

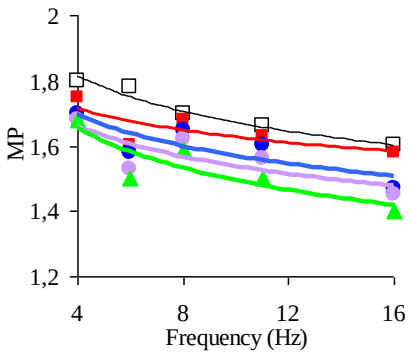

Fig. 3 Measure of Perception for vertical vibrations versus frequency
(□) – 0.85m/s^2; (■) – 0.87m/s^2; (●) – 0.91m/s^2; (●) – 0.93m/s^2; (▲) – 0.95m/s^2

Curves equations from Fig. 3 are (Eq. 1):

$$\begin{aligned}
&\text{For } a=0.85\text{m/s}^2 \Rightarrow MP=2.0569v^{-0.0896} \ (R^2=0.9618)\\
&\text{For } a=0.87\text{m/s}^2 \Rightarrow MP=1.8566v^{-0.0575} \ (R^2=0.8609)\\
&\text{For } a=0.91\text{m/s}^2 \Rightarrow MP=1.9073v^{-0.0848} \ (R^2=0.8889\ ) \qquad (1)\\
&\text{For } a=0.93\text{m/s}^2 \Rightarrow MP=1.8673v^{-0.0844} \ (R^2=0.8484)\\
&\text{For } a=0.95\text{m/s}^2 \Rightarrow MP=1{,}9297v^{-0{,}1109} \ (R^2=0.9457)
\end{aligned}$$

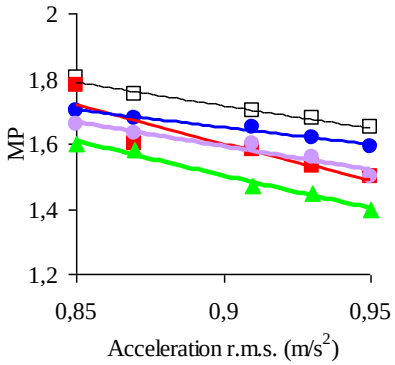

Fig. 4 Measure of Perception for vertical vibrations versus acceleration
(□) - 4Hz; (■) - 6Hz; (●) - 8Hz; (●) - 11Hz; (▲) - 16Hz

Curves equations from Fig. 4 are (Eq. 2):

For ν=4Hz $\Rightarrow$ MP=3.6043e$^{-0.8233a}$ (R^2=0.8795)
For ν=6Hz $\Rightarrow$ MP=5.914e$^{-1.4527a}$ (R^2=0.9025)
For ν=8Hz $\Rightarrow$ MP=2.9413e$^{-036425a}$ (R^2=0.9212) (2)
For ν=11Hz $\Rightarrow$ MP=3.6368e$^{-0.918a}$ (R^2=0.9504)
For ν=16Hz $\Rightarrow$ MP=5.1652e$^{-1.3723a}$ (R^2=0.9718)

We consider that the two estimates of the measure of perception (depending on the frequency and on acceleration) must be identical, and then we can obtain a relation between acceleration and frequency for each case. From Eq. (1) and Eq. (2) we get Eq. (3) for acceleration as a function of frequency, for each case (Fig. 5).

a_{4Hz} =0.6818+0.1088·lnν
a_{6Hz} =0.7974+0.0395·lnν
a_{8Hz} =0.6740+0.1319·lnν (3)
a_{11Hz} =0.7261+0.0919·lnν
a_{16Hz} =0.7174+0.0808·lnν

In Fig. 5, inside the area between the five lines is the line which represents the most probable relation between acceleration and frequency, for the studied cases; by extrapolation the dotted line was found, whose equation is given by:

a=0.72103+0.08858·lnν (R^2=0.9921) (4)

Next we calculated θ, which represents the subjects' personality quantification, using Rasch's theory, where items were noted:

- $a_i=\nu_i$ (Frequency)
- $b_i=MP_i$ (Measure of Perception)
- $c_i=a_i$ (Acceleration)

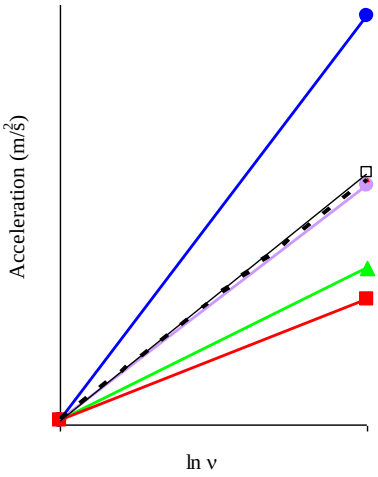

Fig. 5 Acceleration versus frequency (Subject A)
(□) - a_{4Hz}; (■) - $a_{6Hz;}$ (●) - a_{8Hz}; (●) - a_{11Hz}; (▲) - a_{16Hz};(- - - - -) - $a_{\text{the most probable}}$

This estimation is needed to see if the subject's personality is strong enough and whether the assessment by Likert scale is correct or not. We consider, for each case, that the probability of giving a correct answer equals the deviation ($P_i = R_i^2$). From Rasch's equation: $P_i=c_i+\frac{1-c_i}{1+e^{-a_i(\theta-b_i)}}$, by replacing the items we obtain: $R_i^2= a_i+\frac{1-a_i}{1+e^{-\nu_i(\theta-MP_i)}}$.

Replacing the values from Fig. 3 and 4 and from Eq. (2), results:

- Case 1: ν_1=4Hz; MP_1=1.8; a_1=0.85m/s^2; R_1^2=0.8795 $\Rightarrow$ θ_1=1.448185
- Case 2: ν_2=6Hz; MP_2=1.6; a_1=0.87m/s^2; R_2^2=0.9025 $\Rightarrow$ θ_2=1.416897
- Case 3: ν_3=8Hz; MP_3=1.65; a_3=0.91m/s^2; R_3^2=0.9212 $\Rightarrow$ θ_3=1.406125
- Case 4: ν_4=11Hz; MP_4=1.65; a_4=0.93m/s^2; R_4^2=0.9504 $\Rightarrow$ θ_4=1.569231
- Case 5: ν_5=16Hz; MP_5=1.4; a_5=0.95m/s^2; R_5^2=0.9718 $\Rightarrow$ θ_5=1.434877

After excluding θ_4=1.569231 (which is outside the field), we obtain the average θ_a=1.426521 (Fig. 6).

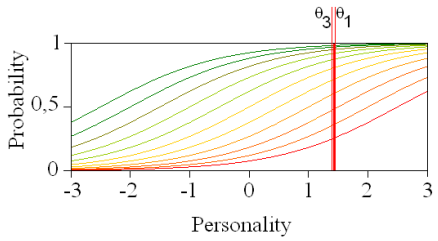

Fig. 6 The A subjects have a weak to average personality: $\theta \in (1.40\text{-}1.44)$

Class B

The experimental data are the same as in Class A. Measure of Perception is presented in Fig. 7 and Fig. 8.

For the same reasons as Class A, we can obtain relations between acceleration and frequency for each case. From Eq. (5) and Eq. (6) we get Eq. (7) for acceleration as a function of frequency, for each case (Fig. 9).

Curves equations from Fig. 7 are (Eq. 5):

$$\begin{aligned}
&\text{For } a=0.85\text{m/s}^2 \Rightarrow MP=0.8099\nu^{-0.3499} \ (R^2=0.9913)\\
&\text{For } a=0.87\text{m/s}^2 \Rightarrow MP=0.5396\nu^{-0.2708} \ (R^2=0.8238)\\
&\text{For } a=0.91\text{m/s}^2 \Rightarrow MP=0.5762\nu^{-0.3807} \ (R^2=0.7613)\\
&\text{For } a=0.93\text{m/s}^2 \Rightarrow MP=0.6569\nu^{-0.5178} \ (R^2=0.9767)\\
&\text{For } a=0.95\text{m/s}^2 \Rightarrow MP=0.5975\nu^{-0.5912} \ (R^2=0.8369)
\end{aligned} \tag{5}$$

Curves equations from Fig. 8 are (Eq. 6):

$$\begin{aligned}
&\text{For } \nu=4\text{Hz} \Rightarrow MP=77.363e^{-5.9888a} \ (R^2=0.8526)\\
&\text{For } \nu=6\text{Hz} \Rightarrow MP=108.96e^{-6.5904a} \ (R^2=0.8718)\\
&\text{For } \nu=8\text{Hz} \Rightarrow MP=98.405e^{-6.5378a} \ (R^2=0.9102)\\
&\text{For } \nu=11\text{Hz} \Rightarrow MP=91.09e^{-6.5821a} \ (R^2=0.9504)\\
&\text{For } \nu=16\text{Hz} \Rightarrow MP=105.1e^{-10.599a} \ (R^2=0.9503)
\end{aligned} \tag{6}$$

From Eq. (5) and Eq. (6) we get Eq. (7) for acceleration as a function of frequency, for each case (Fig. 9).

$$\begin{aligned}
a_{4Hz}&=0.7624+0.0584\cdot\ln\nu\\
a_{6Hz}&=0.8055+0.0411\cdot\ln\nu\\
a_{8Hz}&=0.7861+0.0582\cdot\ln\nu\\
a_{11Hz}&=0.7493+0.0786\cdot\ln\nu\\
a_{16Hz}&=0.7925+0.0557\cdot\ln\nu
\end{aligned} \tag{7}$$

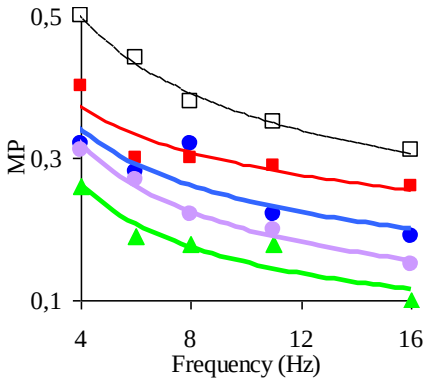

Fig. 7 Measure of Perception for vertical vibrations versus frequency
(□) – 0.85m/s^2; (■) – 0.87m/s^2; (●) – 0.91m/s^2; (●) – 0.93m/s^2; (▲) – 0.95m/s^2

In Fig. 9, inside the area between the five lines, is the line which represents the most probable relation between acceleration and frequency, for the studied cases; by extrapolation the dotted line was found, whose equation is given by:

$$a=0.852+0.941\cdot\ln\nu \quad (R^2=0.9874) \tag{8}$$

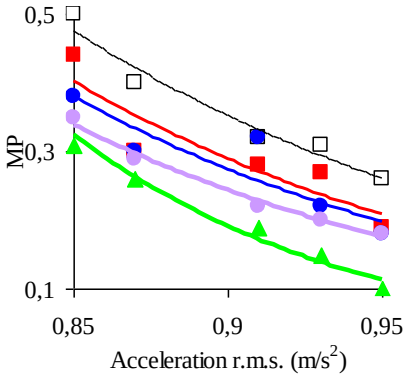

Fig. 8 Measure of Perception for vertical vibrations versus acceleration
(□) - 4Hz; (■) - 6Hz; (●) - 8Hz; (●) - 11Hz; (▲) - 16Hz

Next we calculated θ, which represents subjects' B personality quantification. Replacing with the values from Fig. 7 and Fig. 8 and from Eq. (6), we obtain:

- Case 1: ν_1=4Hz; MP_1=0.5; a_1=0.85m/s^2; R_1^2=0.8526 ⇒ θ_1=-0.509409
- Case 2: ν_2=6Hz; MP_2=0.3; a_1=0.87m/s^2; R_1^2=0.8718 ⇒ θ_2=-0.410967
- Case 3: ν_3=8Hz; MP_3=0.25; a_3=0.91m/s^2; R_3^2=0.9102 ⇒ θ_3=-0.513377
- Case 4: ν_4=11Hz; MP_4=0.2; a_4=0.93m/s^2; R_4^2=0.9504 ⇒ θ_4=-0.269005
- Case 5: ν_5=16Hz; MP_5=0.1; a_5=0.95m/s^2; R_5^2=0.9503 ⇒ θ_5=-0.219373

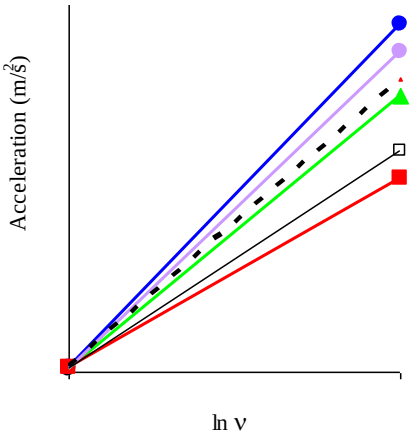

Fig. 9 Acceleration versus frequency (Subject B)
(□) - a_{4Hz}; (■) - $a_{6Hz;}$ (●) - a_{8Hz}; (●) - a_{11Hz}; (▲) - a_{16Hz};(- - - - -) - $a_{\text{the most probable}}$

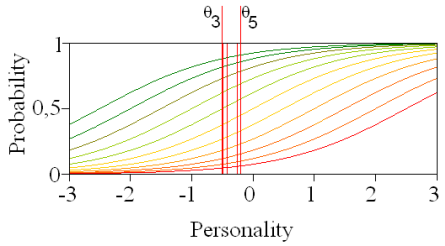

Fig. 10 The B subjects have a very weak personality:$\theta \in (-0.219 \div -0.513)$

The subjects always said that they did not feel anything. After insisting to quantify the magnitude of perception on the Likert Scale, the notes obtained from them are increasingly lower for MP. They showed negativity, even rebellion- refusal to cooperate.

By averaging results we obtain the average value θ_a=-0.384426. After excluding the last two values (which do not fall in the previous values range) we obtain the average value θ_a=-0.477917 which fits best the θ coefficients range (Fig. 10).

Class C

The experimental data are the same as were for Class A. Measure of Perception is presented in Fig. 11 and Fig. 12.

Curves equations from Fig. 11 are (Eq. 9):

For $a=0.85 m/s^2 \Rightarrow MP=1.514 \cdot \nu^{0.1205}$ (R^2=0.9692)
For $a=0.87 m/s^2 \Rightarrow MP=1.4719 \cdot \nu^{0.1893}$ (R^2=0.9645)
For $a=0.91 m/s^2 \Rightarrow MP=1.7461 \cdot \nu^{0.0858}$ (R^2=0.9760) (9)
For $a=0.93 m/s^2 \Rightarrow MP=2.6118 \cdot \nu^{0.0598}$ (R^2=0.9794)
For $a=0.95 m/s^2 \Rightarrow MP=2.5584 \cdot \nu^{0.1557}$ (R^2=0.9485)

Curves equations from Fig. 12 are (Eq. 10):

For $\nu=4Hz \Rightarrow MP=0.5259 \cdot e^{1.4397a}$ (R^2=0.9872)
For $\nu=6Hz \Rightarrow MP=0.7425 \cdot e^{1.1195a}$ (R^2=0.9931)
For $\nu=8Hz \Rightarrow MP=0.4692 \cdot e^{1.654a}$ (R^2=0.9935) (10)
For $\nu=11Hz \Rightarrow MP=0.2442 \cdot e^{2.6831a}$ (R^2=0.9910)
For $\nu=16Hz \Rightarrow MP=0.153 \cdot e^{3.4161a}$ (R^2=0.9507)

For the same reasons as Class A, we can obtain the relations between acceleration and frequency for each case. From Eq. (9) and Eq. (10) we get Eq. (11) for acceleration as a function of frequency, for each case (Fig. 13).

$a_{4Hz}=0.7344+0.0836 \cdot \ln\nu$
$a_{6Hz}=0.6112+0.1690 \cdot \ln\nu$
$a_{8Hz}=0.7945+0.0518 \cdot \ln\nu$ (11)
$a_{11Hz}=1.4327+0.0222 \cdot \ln\nu$
$a_{16Hz}=0.8245+0.0455 \cdot \ln\nu$

In Fig. 13, inside the area between the five lines is the line which represents the most probable relation between acceleration and frequency, for the studied cases; by extrapolation the dotted line was found, whose equation is given by:

$$a=0.8814+0.07511\cdot\ln\nu \quad (R^2=0.9902) \tag{12}$$

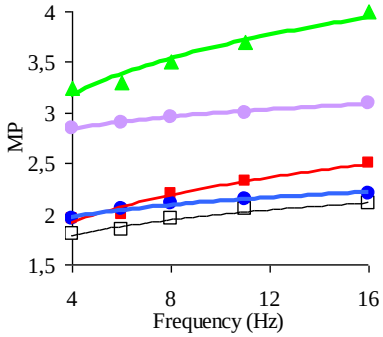

Fig. 11 Measure of Perception for vertical vibrations versus frequency
(□) – 0.85m/s^2; (■) – 0.87m/s^2; (●) – 0.91m/s^2;(●) – 0.93m/s^2; (▲) – 0.95m/s^2

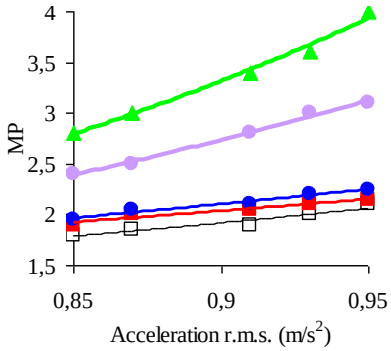

Fig. 12 Measure of Perception for vertical vibrations versus acceleration
(□) - 4Hz; (■) - 6Hz; (●) - 8Hz; (●) - 11Hz;(▲) - 16Hz

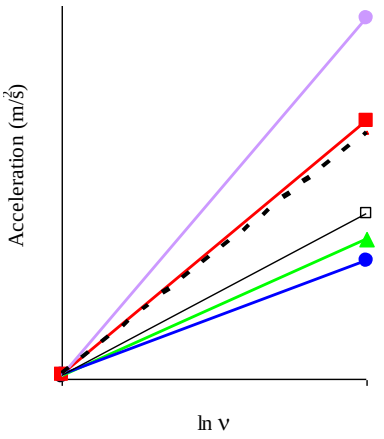

Fig. 13 Acceleration versus frequency (Subject A)
(□) - a_{4Hz}; (■) - $a_{6Hz;}$ (●) - a_{8Hz}; (●) - a_{11Hz}; (▲) - a_{16Hz};(- - - - -) - $a_{\text{the most probable}}$

Next we calculate θ, which represents subjects' C personality quantification. Replacing with the values from Fig. 11 and Fig. 12 and from Eq. (10), we obtain:

- Case 1: ν_1=4Hz; MP_1=1.8; a_1=0.85m/s^2; R_1^2=0.9872 $\Rightarrow \theta_1$=2.393856
- Case 2: ν_2=6Hz; MP_2=2; a_2=0.87m/s^2; R_2^2=0.9931 θ_2=2.480245
- Case 3: ν_3=8Hz; MP_3=2.1; a_3=0.91m/s^2; R_3^2=0.9935 $\Rightarrow \theta_3$=2.419130
- Case 4: ν_4=11Hz; MP_4=2.3; a_4=0.93m/s^2; R_4^2=0.9910 $\Rightarrow \theta_4$=2.473968
- Case 5: ν_5=16Hz; MP_5=2.4; a_5=0.95m/s^2; R_5^2=0.9507 $\Rightarrow \theta_5$=2.665912

By averaging results we obtain the average value θ_a=2.486622. After excluding the values θ_1 and θ_5 (which do not fall in the previous values range) we obtain the average value θ_a=2.457781 which fits best the θ coefficients range (Fig. 14).

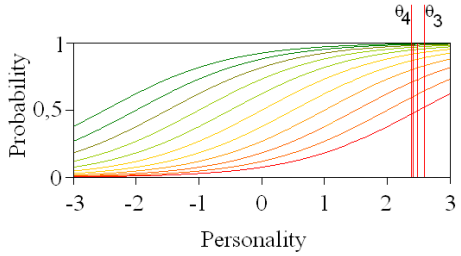

Fig. 14 The C subjects have a strong to very strong personality: θ∈(2.39-2.66)

4. CONCLUSION

For the A subjects, from the five values of θ, only one θ_4=1.57 is outside the very narrow range where the others are, θ∈(1.40-1.44); they have a weak to average personality and they are able to respond correctly to the most simple questions. This type of person might have been influenced by the fact that he had to participate in an experiment, by the presence of equipment, by the fact that he was subject to vibrations, etc., so there is a possibility that the evaluations made by the Likert Scale are not fully correct.

Table 4 Number of subjects – relative to the BMI and to the type of personality

BMI [kg/m^2]	Number of subjects	Class A	Class B	Class C
< 15	-	-	-	-
15.0 – 16.0	-	-	-	-
16.0 – 18.5	2	1	1	
18.5 – 25	37	31	1	5
25 – 30	16	11	5	-
30 – 35	2	1	-	1
35 – 40	1	-	1	-
> 40	-	-	-	-
Total	58	44	8	6

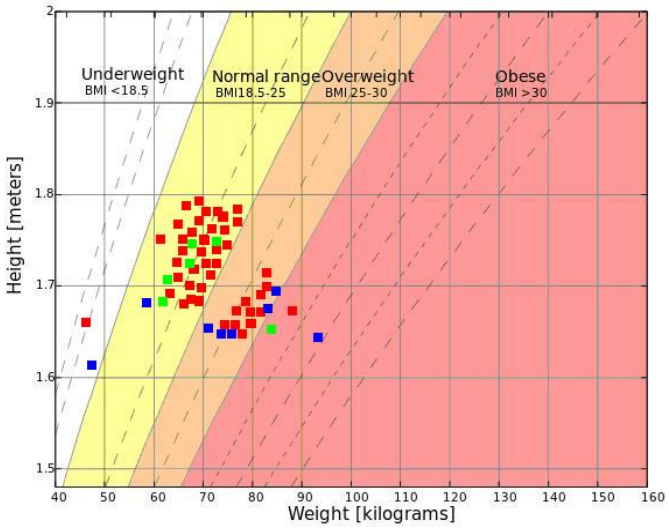

Fig. 15 Subjects' distribution – relative to the BMI and to the type of personality (■) – class A; (■) – class B; (■) – class C

For the B subjects, from the five values of θ, the last two were far from the average. This was the moment when the subjects lost interest and stop concentrating. We do not know if this is something that usually happens to them or if it is just hostility towards something new. The subjects totally refused to participate to the 2nd part of the experiment. They have a very weak personality and they try to hide it with bravery; they do not agree to even a single direction and they are not influenced by the presence of a professor. They are able to answer correctly but there is a very high possibility that their assessment with the Likert Scale is not correct.

For the C subjects, from the five values of θ, two are outside the very narrow range where thee other are, $\theta \in (2.41\text{-}2.48)$; they have a strong to very strong personality. Also it can be said that they can answer correct to questions. This type of person will never be influenced by the fact he has to take part in an experiment, by the presence of equipment or by the fact that he was subject to vibrations. For sure, his assessment by the Likert Scale was almost entirely correct.

The cumulative results are presented in Table 4 and Fig. 15.

It was observed that in all cases, the results obtained from the answers given at the questionnaires coincide with the results obtained from the vibrations experimental measurements.

In conclusion, from the measurements perceived magnitudes of vibrations ne can determine the type of personality. This determination is as precise as the classic questionnaires method, because it represents a result of practical experimental measurements.

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ODREĐIVANJE TIPA LIČNOSTI UZ POMOĆ PARAMETARA VIBRIRAJUĆIH POKRETA

Ljudsko telo reaguje na uticaje dajući određeni odgovor u zavisnosti od situacije. Način na koji svaka osoba reaguje na spoljni stres je određen psihofizičkim reakcijama na te faktore. Međutim, jedan ključni aspekt kome do sada nije posvećeno dovoljno pažnje je individualna ličnost. Na ličnost utiče veliki broj spoljnih (obrazovanje, kultura, socijalno poreklo, itd.) i unutrašnjih faktora (genetika, anatomija, itd.). Praktično svaki čovek ima svoju ličnost i, prema tome, nemoguće je klasifikovati tipove ličnosti u tom pogledu. Da bismo proučili ovaj problem, koristili smo Likertovu skalu, kojom se kvantifikuje stepen nelagodnosti koja je uzrokovana spoljnim stresom. Tip ličnost ispitanika smo određivali u zavisnosti od njihovih odgovora na petostepenoj Likertovoj skali. Nekoliko lica je imalo osećaj iste vrste vibracija. Za merenje vibracija koje se prenose na celo telo sa vibracione platforme, koristili smo višekanalni vibracioni sistem NetdB. Priključili smo troaksijalne akcelerometre PCB Piezotronics 356A16 na ispitanike. Obradili smo podatke uz pomoć dBFA Suite-Software za obradu podataka; uspeli smo da zadržimo konstantne parametre kako bismo ispitali na koji način ispitanici doživljavaju isti spoljašnji stimulans. Procenili smo jačinu percepcije koristeći Likert skalu za procenu nelagodnosti: sa vrednostima u rasponu od 1 (mala nelagodnost) do 5 (izuzetna nelagodost). Osim toga, koristili smo Rašov model za izračunavanje koeficijenta θ, kojim se definiše tip ličnosti ispitanika.

Ključne reči: *vibracije, stepen nelagodnosti, model za određivanje ličnosti, Likertova skala*