TEMPERAMENT THEORY AND STATISTICAL ANALYSIS OF TEMPERAMENTAL DEPENDENCE ON OTHER FACTORS – EMPIRICAL STUDY

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Abstract. The aim of this article is an empirical study of a person's temperamental dependence on other factors. Belov's temperament test and Eysenck's lability and stability test were used for research. A questionnaire survey was conducted at the University of Hradec Králové using first and third year students. A correlation analysis and $\chi^2 -$ test of independence in a PivotTable will be used to show independency of temperament on other factors; and both tests between themselves. Results will be discussed and questions for further results will be formulated.

Key words: Belov's temperament test, Eysenck's lability and stability test, correlation analysis, $\chi^2 -$ test of independence

Mathematics Subject Classification: Primary 62J02, 62J05; Secondary 62B15

1   Introduction

In the first half of the twentieth century, E. Krečmer expanded somatotyping to three basic types according to body structure - pyknic, leptos, athletics. "Pyknics are usually cooperative and cheerful, an occasional transition to depression, and have a cycling temperament. In the case of leptosomes, we usually find a schismatic temperament: they are usually closed, either hypersensitive ("romantic") or cold without a lively expression of emotions. Athletes have a viscous temperament (corresponding approximately to phlegmatic), characterized by indifference, inertia, and which sometimes alternates with explosiveness " [Čáp, Mareš, 2001].

People have always responded differently to certain stimuli. The attempts have been made to seal the individual into a certain type. The best known is the typology based on the teachings of Hippocrates and Galena. It distinguishes four basic types and defines their characteristics [Poláková, 2007]:

Sanguine - cheerful, optimistically tuned. Their experiences are rather shallow and short. They respond weakly to strong stimuli. They are dominated by a "straw fire" reaction. This name was invented by J. Strelau and marks a quick dying experience and a rapid change of focus. This type of person adapts quickly and is emotionally balanced. In motion, the course is unbalanced, and the

duration is short, the speed component is fast and strong. We will classify them as emotionally stable extroverts.

Phlegmatic - on the outside, has a quiet and lazy impression. They appear calm or cold or apathetic. Only exciting stimuli are excited. They choose friends and only have a deep relationship with them. They are rather passive, without great ambitions and demands. The motion response method is level, slow and weak. Emotionally we classify them as stable introverts.

Melancholic - a melancholic man approaching life is usually pessimistic with fear, and fear of the future. They love peace, their own well-being, and are characterized by profound experiences. They hate rage, noise and new people. They do not show their feelings outward, but live more internally. The relationships they establish are permanent and deep. The movement has a regular course; the duration is permanent. Emotionally labile introvert.

Choleric - often impulsive, irritable, impatient and overwhelming. They are prone to explosions of anger. Coexistence with them is difficult, they are often single minded. They are easily affected by emotions. Outwardly, they respond quickly, strongly, often without hindrance. Emotionally labile extrovert.

2 Data and methodology

The 2 tests of temperaments from Belov (1972) and from Eysenck (1960) were used for research. A questionnaire survey was conducted at the University of Hradec Králové for the first and third year students of the Faculty of Informatics and Management. The aim was to get at least 600 completed questionnaires from both University students, and other respondents over the age of 18.

The questionnaire was distributed to students in person throughout September 2016. During the submission of the questionnaires, students were trained to complete and disseminate the questionnaires. The data collection period ran from October to December 2016. In the following months January to May 2017, an evaluation of the questionnaires was carried out. In total, 650 questionnaires were distributed, of which 571 questionnaires were returned. 38 of them were poorly or incompletely filled. Altogether, 533 questionnaires were used for research. Returnability was 82%. Such a high return on the questionnaire was due to the fact that 315 questionnaires were distributed to students during class at the University of Hradec Králové, and the remaining 335 questionnaires were distributed outside the University.

The first three questions of the questionnaire concerned the input characteristics of the respondents. The following question dealt with net income for employees or monthly financial requirements for students (this area is planned for future research).

This is a case study of exploratory character. As a method, we chose quantitative research that uses random selections, experiments, and highly structured data collection using tests, questionnaires, or observations. Quantitative research uses experiment, observation, or polls to capture data. Structured, standardized questionnaires were selected for our research. Eysenck's Temperament Questionnaire [Eysenck, 1960] and temperament test by Belov [Čáp, 2001] were used. The Eysenck's Temperament questionnaire consists of 57 questions relating to behavior, behavior and feelings in different situations. For each of the questions, only YES or NO could be answered. [Bílý, Suss, 2006]

3 Temperament tests

The Belov's temperament test focuses on the characteristics, features and behavior of individuals. We use the test to determine the percentage of temperament components (sanguine, choleric, phlegmatic, melancholic). There are twenty questions for each type, for which the individual answers yes or no. Some questions are repeated in these four sections (A, B, C, D). The individual completing the questionnaire should respond spontaneously without long delay. Then an evaluation is made. [Poláková, 2007]

From each section the positive answers are added according to the formula:

$$V_{t1} = \frac{Ch_a * 100}{a} + \frac{S_a * 100}{a} + \frac{F_a * 100}{a} + \frac{M_a * 100}{a}$$

where: $a = Ch_a + S_a + F_a + M_a$

The second test from Eysenck determines the lability and stability, as we mentioned above. In other words, extrovert and neuroticism.

Sixty yes or no questions are asked. The evaluation is performed as follows: To determine positive lability we required a "yes" response to questions 2, 5, 7, 10, 13, 15, 18, 21, 23, 26, 29, 31, 34, 37, 39, 42, 45, 47, 50, 52 54, 56, 58, 60. A positive answer to questions 1, 3, 9, 11, 14, 17, 19, 22, 25, 27, 30, 35, 57 showed stability. In this case, we included questions 6, 33, 51, 55, 59, where the respondents should answer "no". Calculation:

$$V_{t2} = \frac{N_a * 100}{a} + \frac{E_a * 100}{a}$$

where: $a = N_a + E_a$

4 Correlation analysis and $\chi^2 -$ test of independence in a PivotTable

In the beginning of the first part a correlation analysis will be performed (correlation matrix will be composed). This will establish a correlation between both temperament tests, and age, and gender of respondents. [Hedvičáková, Pozdílková, 2015]

A Spearman correlation coefficient is an important characteristic in evaluating the validity of tests, because it determines how close together two related phenomena are captured. Thus, it allows quantitative determination of how far the two similar orders are created. For the calculation, it is necessary to have a table in which you can specify individual correlated pairs, which are compared to the individual components of the correlation, overall index and the basic form of vector analysis. The result is a dimensionless number, which indicates the degree of correlation between individual freedom and the steam created for each pair of correlation. [Marek, Svoboda, Brožek, 2016]

In the second part test of an independence in PivotTable will be used. If we examine the dependence of two variables X and Y, where variable X is not numeric, the ANOVA method is not appropriate to use. The better test is χ^2 – test of independence of two variables, which assumes that they are

detected

We arrange the data of the ordinal or nominal type into the PivotTables. [Hebák, 2006]

So we will test the hypothesis H: variables X and Y are independent, against the alternative hypothesis that they are dependent.

For independent phenomena A, B:
$$P(A \cap B) = P(A).P(B)$$

We will compare empirically established frequencies

$$n.\pi_{ij} = n.\pi_{i..}\pi_{.j}$$

Estimates of theoretical frequencies are

$$\hat{\pi}_{i.} = \frac{n_{i.}}{n}$$
$$\hat{\pi}_{.j} = \frac{n_{.j}}{n}$$

an estimate of the theoretical combined probability is

$$\hat{\pi}'_{ij} = \hat{\pi}_{i.}.\hat{\pi}_{.j} = \frac{n_{i.}}{n}\frac{n_{.j}}{n} = \frac{n_{i..}n_{.j}}{n^2}$$

Then an estimate of the theoretical frequency is

$$n'_{ij} = n.\hat{\pi}'_{ij} = n.\frac{n_{i..}n_{.j}}{n^2} = \frac{n_{i..}n_{.j}}{n}$$

For test H: variables X and Y are independent $\rightarrow$ A: variables X and Y are dependent we use test statistics

$$\chi^2 = \sum_{i=1}^{r}\sum_{j=1}^{s}\frac{\left(n_{ij} - n'_{ij}\right)^2}{n'_{ij}},$$

provided that the characters X and Y are independent for a sufficiently large n Pearson distribution $\chi^2(v)$ with $v = (r-1)(s-1)$ degrees of freedom.

The hypothesis on the independence of variables X and Y is denied if

$$\chi^2 \geq \chi^2_{1-\alpha}(v),$$

where $v = (r-1)(s-1)$.

5   Experiments and results

Using Spearman coefficient, it was proved, that Belov's temperament test and Eysenck's lability and stability test are independent of age and gender.

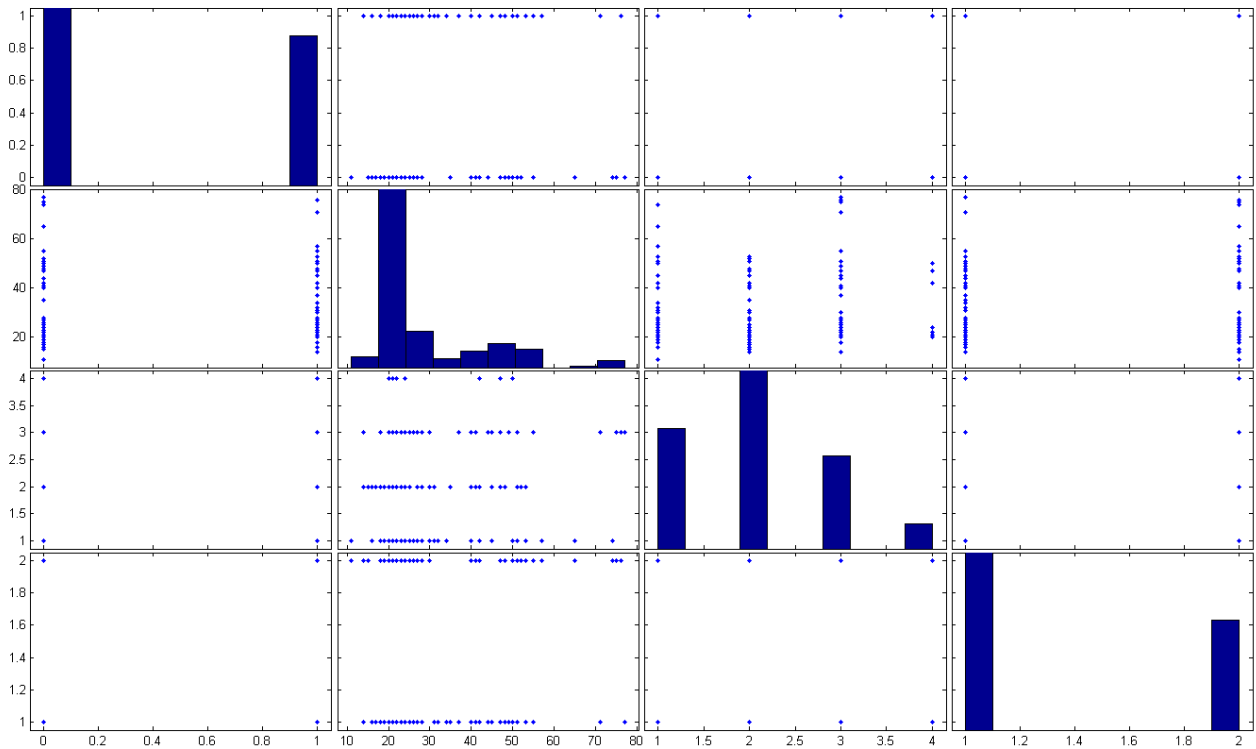The correlation matrix and independency is illustrated on the following graph:

Fig. 1. Independency of test results on variables age and gender

Due to the fact that the correlation of Belov's temperament test and Eysenck's lability and stability test is very low (between 0.2 and 0.3), the test of independence in PivotTable was realized to confirm this hypothesis.

Hypothesis H: tests are independent, was tested using the test of independence in the PivotTable. The resulting test statistic χ^2 was computed as 6,24. Comparison with $\chi^2(\nu)$ with $\nu = (r-1)(s-1)$ degrees of freedom, showed, that the hypothesis of independence cannot be dismissed.

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{s} \frac{\left(n_{ij} - n'_{ij}\right)^2}{n'_{ij}},$$
$$\chi^2 = 6{,}24 < 7{,}81 = \chi^2(3)$$

6 Discussion and conclusions

The results of the correlation analysis demonstrated the independence of both tests from other variables, such as age and gender, which is as expected. This result has also been confirmed by the test of independence in the PivotTable, which confirmed this hypothesis.

The reason for the small interdependence of both tests is the way they are evaluated. Belov's temperament test results for a given variant, are determined by the most questions answered in this variant. A better way would be to determine the standard of weights and evaluation with regard to all the answers. Alternatively, another option is to use fuzzy sets or graphical processing using 4 coordinates. This is the topic of our further research.

The other question in the discussion is whether the questionnaires are distorted because most of the respondents do not respond as they really feel, but rather as they would like to be seen. [Mummendey, 2006] Therefore, it is necessary to place emphasis on the truthfulness of the respondents and, if necessary, to supplement the questionnaire with further tests.

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