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Socionics aspects of the human factor in aviation

Aspectos sociónicos del factor humano en la aviación

ARINICHEVA, Olga V[1]
LEBEDEVA, Natalia A. [2]
MALISHEVSKII, Aleksei V. [3]

Abstract
The article substantiates the need to include psychological characteristics relevant to managing information flows into the list of professional qualities that are important to success in aviation. It describes and substantiates a method for finding a person's type of information metabolism. It proves that there is such a thing as the socionics portrait of a profession and discusses socionics characteristics which are most relevant to an ideal pilot.
Keywords: typology, information metabolism, psychological dichotomies, socionics, socionics portrait of a group

Resumen:
El artículo justifica la necesidad de incluir características psicológicas relevantes para gestionar los flujos de información en la lista de cualidades profesionales que son importantes para tener éxito en la aviación. Se describe y justifica un método para saber el tipo de metabolismo de información de una persona. Se demuestra que existe el retrato sociónico de una profesión y se analiza las características sociónicas que son más relevantes para un piloto ideal.
Palabras clave: tipología, metabolismo de la información, dicotomías psicológicas, sociónica, retrato sociónico de un grupo.

1. Introduction

Operations and tasks performed by such aviation specialists as the pilot and the air traffic controller (ATC) are associated with the continuous processing of large amounts of information at a forced pace. This imposes rather stringent psychological requirements on them regarding their mental qualities associated with information processing and exchange.

[1] Ph.D. of historical sciences, head of the department of Language Training, Saint Petersburg State University of Civil Aviation, 196210, 38 Pilotov st., Saint Petersburg, Russia. lebedevanatali@inbox.ru
[2] Ph.D. of engineering sciences, associate professor at the department of Flight Operations and Flight Safety in Civil Aviation, Saint Petersburg State University of Civil Aviation, 196210, 38 Pilotov st., Saint Petersburg, Russia. 2067535@mail.ru
[3] Ph.D. of engineering sciences, associate professor at the department of Flight Operations and Flight Safety in Civil Aviation, Saint Petersburg State University of Civil Aviation, 196210, 38 Pilotov st., Saint Petersburg, Russia. 9909395@bk.ru

In the previous century, the famous Polish psychologist Antoni Kępiński introduced the concept of information metabolism (IM) as a process of constant exchange of information in its broadest sense between a person and the surrounding environment. The Lithuanian researcher Aušra Augustinavičiūtė, a follower of the Swiss psychiatrist Carl Gustav Jung, combined Jung's theory of psychological types (Jung, 1971) with Kępiński's theory of information metabolism (Kępiński, 2014) and created a theory of socionics (Augustinavičiūtė, 2016; Bukalov, 2009).

It should be noted that socionics is an independent research area which differs significantly from studies carried out in the USA and Western Europe based on Jung' theory and works by Katharine Cook Briggs, Isabel Briggs Myers (Myers & McCaulley, 1985; Myers & Myers, 1995, and David Keirsey 1998), American psychologists who are the most prominent representatives of this research area. K. Briggs and I. Myers developed the Myers-Briggs Type Indicator (MBTI, The Myers-Briggs Company, 2020), which is the main psychodiagnostic tool used in typology. Similarities and differences between socionics and typology are examined in detail in papers (Leichenko et al., 2006); Bukalov, (2003). R. Blutner and E. Hochnadel (2010) give a concise description of these differences in their article: "Socionics was developed in the 1970s and 1980s mainly by the Lithuanian researcher Aušra Augustinavičiūtė. The name 'socionics' is derived from the word 'society', since Augustinavičiūtė believed that each personality type has a distinct purpose in society, which can be described and explained by socionics. The system of socionics is in several respects similar to the MBTI; however, whereas the latter is dominantly used in the USA and Western Europe, the former is mainly used in Russia and Eastern Europe. Despite of several similarities there are also important differences. For instance, the MBTI is based on questionnaires with so-called forced-choice questions. Forced-choice means that the individual has to choose only one of two possible answers to each question. Obviously, such tests are self-referential. That means they are based on judgments of persons about themselves. Socionics rejects the use of such questionnaires and is based on interviews and direct observation of certain aspects of human behavior instead. However, if personality tests are well constructed and their questions are answered properly, we expect results that often make sense. For that reason, we do not reject test questions principally, but we have to take into account their self-referential character. Another difference relates to the fact that socionics tries to understand the Jung's intuitive system and to provide a deeper explanation for it, mainly in terms of informational metabolism (Kępiński, 1972). Further, socionics is not so much a theory of personalities per se, but much more a theory of type relations providing an analysis of the relationships that arise as a consequence of the interaction of people with different personalities" (p. 247).

It should be noted that, as is the case with any growing research area, socionics covers several schools of thought with significant differences between them which cause debates among researchers (Leichenko et al., ł 2006; Arinicheva & Malishevskii, (2017); Bukalov, (2017). The authors of this article belong to the school which is called aviation socionics, since its views are primarily developed at the University of Civil Aviation (St. Petersburg, Russia) (Mukhtarov et al., (1999; Lejchenko et al.,–, (2002; Leichenko et al., ł2006=; Arinicheva *et al*., 2008; Malishevskii et al., ł2015); Arinicheva & Malishevskii,(2019b); Malishevskii & Arinicheva, (2019), National Aviation University (Kiev, Ukraine) (Leichenko et al., ł2006); Samkov *et al*., 2011a; Samkov *et al*., 2011b; Kharchenko *et al*., 2012), and Milli Aviasiya Akademiyası (Baku, Azerbaijan) (Paşayev *et al*., 2005).

The authors of this article, while representing the school of aviation socionics, turn to works by typology experts from the USA and Western Europe when it is necessary, at least tentatively, to compare the results with similar studies conducted in other countries. Since the authors are interested in analyzing the issues of interaction efficiency and conflicts between aircraft crew members, which we studied in many works (for example Arinicheva *et al*., 2008; Arinicheva & Malishevskii, 2019b; Leichenko et al., (2006); Malishevskii & Arinicheva, (2019), we compared our results with data from (Woosley, 2001; Percival et al., – (1992). Table 1 shows an approximate correspondence between types of information metabolism (TIMs) in socionics and psychological types in the typology developed by K. Briggs and I. Myers.

Table 1
A rough correspondence between the types of information metabolism in socionics andthe personality types according to K. Briggs and I. Myers

Types of information metabolism in socionics		Personality types according to K. Briggs and I. Myers
Intuitive Logical Extravert	ILE	ENTP
Sensory Ethical Introvert	SEI	ISFP
Ethical Sensory Extravert	ESE	ESFJ
Logical Intuitive Introvert	LII	INTJ
Ethical Intuitive Extravert	EIE	ENFJ
Logical Sensory Introvert	LSI	ISTJ
Sensory Logical Extravert	SLE	ESTP
Intuitive Ethical Introvert	IEI	INFP
Logical Intuitive Extravert	LIE	ENTJ
Ethical Sensory Introvert	ESI	ISFJ
Sensory Ethical Extravert	SEE	ESFP
Intuitive Logical Introvert	ILI	INTP
Logical Sensory Extravert	LSE	ESTJ
Ethical Intuitive Introvert	EII	INFJ
Intuitive Ethical Extravert	IEE	ENFP
Sensory Logical Introvert	SLI	ISTP

The TIM is the way a person perceives processes and transmits information in its broadest sense. At the level of ordinary common sense, it is clear that the TIM that an aviation professional (in particular, a pilot or an air traffic controller) has cannot but affect their professional success, i.e. the TIM should be considered as qualities which are important in the aviation industry.

In this regard, a study that was carried out among flight school cadets and members of flight crews is of some interest (Ivanov & Ivanov, 1996). 117 flight cadets were studied. Based on the results of psychological screening which was carried out upon their entering the flight school, the cadets were divided into 3 groups:

● the group who got an excellent score (7 to 9 points on a 9-point scale) – 34 cadets;

● the group who got a good score (4 to 6 points) – 61 cadets;

● the group who got a satisfactory score (2 to 3 points) – 22 cadets.

The results of the study showed that in the first group, 42% of the cadets were classified as LSE (Logical Sensory Extravert), 33% were classified as LIE (Logical Intuitive Extravert), and 17% were classified as SLE (Sensory Logical Extravert). LSE cadets from the first group demonstrated fairly good indicators regarding attention distribution and switching, short-term memory, thinking speed, skill development and reinforcement regardless of disturbances, adaptive skills, emotional stability, motor reaction, coordination, and tension. The next stage of research involved the use of flight simulators. The cadets were divided into two groups depending on what level of flight skills they demonstrated in the simulators. The first group included 78 cadets whose motion amplitudes did not affect flight dynamics as negatively as those of the 39 cadets in the second group where there were

significant deviations from the given altitude and speed parameters. The predominant socionics types in the first group were LSE, LIE, and SLE, with EII, SEI, and IEI types being predominant in the second group.

It was established that pilots who do not differ from each other in their credentials, health, physical condition, and sensorimotor skills behave differently in the same situations. This is why the authors conducted experiments not only under normal conditions but also imitated emergencies (such as engine failure or fire) (Ivanov & Ivanov, 1996). While cadets with the LSE type demonstrated the best results in ordinary situations, cadets with the SLE type were better at timely decision-making and problem elimination, i.e. were better at dealing with emergencies even though their results had not been so good at the initial stage of the study. In general, the first group (cadets with SLE, LIE, and LSE types) demonstrated positive results in the experiments simulating emergencies. In addition to measuring flight dynamics parameters, physiological indicators such as heart rate and the volume of inhaled air were also measured and showed that representatives of the first group (SLE and LSE cadets) were better at adapting to emergencies. SLE cadets had positive indicators regarding their voice exchange with the instructor pilot in emergencies. They demonstrated confidence, emotional restraint, brevity, and adequacy. In the second group, cadets' remarks were aimed at obtaining information and reflected doubts whether the instrument readings were correct. The authors make the following conclusion (Ivanov & Ivanov, 1996): "The results of our research suggest that SLE, LIE, and LSE socionics types satisfy pilot requirements the best" (p. 49).

Similar data confirming that people with SLE, LIE, and LSE socionics types make the best pilots were obtained by the authors of (Ivanov & Ivanov, 1996) based on the results of both introductory flights and 16 PF tests. As the authors argue (Ivanov & Ivanov, 1996), "socionics test results not only correspond with flight characteristics and conclusions made by instructors but are also a look-ahead tool which gives important information on flight cadets and aviation staff" (p. 49).

Even though it is impossible to cover all aspects of this issue within one article, the points discussed by the authors seem to be quite important.

2. Methodology

Unlike it is done in "traditional" socionics, the authors of this article, as well as personality type experts from the U.S. and Western Europe, use a personality inventory. However, the methodology which we use is quite different from the MBTI.

In "traditional" socionics (Augustinavičiūtė, (2016); Bukalov, (2009), it is generally accepted that each person has a particular type of information metabolism. The authors of this article suggest (Leichenko et al.,(2006; Arinicheva & Malishevskii, 2017) going back to the principles based on Jung's theory which state that if we consider extraversion and introversion, then "every human being possesses both mechanisms as an expression of his natural life-rhythm" (Jung, 1971), and the same is true for other psychological functions (PF), but one is "usually predominant" (Jung, 1971) while the others are "less differentiated" (Jung, 1971). This means that each person uses all 16 possible options for exchanging information with the environment.

However, there is a possibility of using some information metabolism options rather than others. We would like to stress the word *possibility*, which is not *probability*. Probability theory operates on random variables, whereas psychological phenomena are not random; they are always caused by something even though we might not always be aware of the reasons. However, human psychology is so complex that information metabolism processes are not rigidly determined. There are several *possible* ways how they may develop. Moreover, information metabolism processes are inherently *fuzzy*. It is enough to say that the decision-making process is inevitably associated with thinking, which has been proved to have a direct connection with speech, and,

consequently, is associated with *verbalization* and the use of *linguistic variables*. The fact that information is *fuzzy* as a substrate gives rise to the possibility of using different information metabolism options. This is why it seems that such mathematical tools as fuzzy set theory and possibility theory (Zadeh, 1978; Kaufmann, 1975) suit the needs of socionics best.

In view of this, A. V. Malishevsky and N. F. Mikhailik developed a socionics test called MM-1 (Malishevskij & Mikhajlik (comp.), 2000). The biggest difference between the MM-1 test and standard socionics tests is the fact that it is based on fuzzy set theory. The test has been patented (Mukhtarov et al., (1999; Lejchenko et al., (2002; Paşayev *et al*., 2005). Instead of simply finding the subject's socionics type, which, of course, is also done, the MM-1 test (Leichenko et al.,(2006; Malishevskij & Mikhajlik (comp.), (2000) focuses on finding the membership function for each of Jung's dichotomies (Zadeh, 1978; Kaufmann, 1975). This results in a comprehensive characterization of a socionics type, and, by analyzing the membership function, makes it possible to assess the validity of the test for each of Jung's dichotomies.

In order to show the difference between the approach proposed by the authors of this article and other approaches, let us look at how traditional personality inventory tests are designed. It is obvious that the structure of the test is an important factor. In all the traditional tests, the "yes/no" dichotomy is present, which means that there may be one of the following options.

Let *A* be a certain vector or an ordered set of questions necessary to find out whether a person has a particular property, i.e., $A = (a_1, a_2, \dots, a_n)$, where a_i is the i-th question of the test which aims to identify whether the desired property is present or absent. In this case, the answer vector has the form $X = (x_1, x_2, \dots, x_n),\ x_i = 0 \vee 1$, where 0 is the absence of the desired property, and 1 is its presence. It may happen that two answer options which are opposite in meaning are given; then there will be either one answer vector with the form of $X = (x_1, x_2, \dots, x_n),\ x_i = -1 \vee 1$, or two answer vectors which will indicate the presence or absence of any of the desired properties and, accordingly, that of the opposite property, i.e. $X_j = (x_{1j}, x_{2j}, \dots, x_{nj}),\ j = \overline{1,2},\ x_{ij} = 0 \vee 1,\ x_{i1} \neq x_{i2}$ due to the fact that there are dichotomies in psychology, the absence of one quality implies the presence of another (e.g. if a person is not an extravert, then he or she is an introvert).

Moreover, there are tests in which the person answering the a_i question is given not only the choice between answers x_{i1} and x_{i2} but also such options as $(x_{i1} \wedge x_{i2})$"both this and that" or $\neg(x_{i1} \wedge x_{i2})$"neither this not that". This makes it easier for the person to complete the test, but if there are a lot of neutral answers, the informational value of the results will be close to zero. The answer vector in this case may have the form $X = (x_1, x_2, \dots, x_n),\ x_i = -1 \vee 0 \vee 1$, where 1 indicates the presence of the desired property, -1 indicates the presence of the opposite property, and 0 indicates that the person's position is uncertain.

As it is extremely difficult to formulate vector A in such a way that all of its components (test questions) are of the same significance, it is possible to assign a weighting factor to each component. In this case, the answer vector has the form $X = (x_1, x_2, \dots, x_n),\ x_i \in [0,1]$. Despite the apparent attractiveness, this approach bears the imprint of inevitable voluntarism due to the procedure of assigning weighting factors.

When developing the MM-1 test, an answer vector with the form of $X = (x_1, x_2, \dots, x_t)$ was used instead of the ordinary vector, where x_i is the share expressing the ratio of the desired properties according to the i-th question

of the test. As is the case for each dichotomy, the vector $X_1 = (x_{11}, x_{12}, \dots, x_{1t})$ characterizing the share of a certain property in this dichotomy means that there is a second answer vector $X_2 = (x_{21}, x_{22}, \dots, x_{2t})$ that describes the share of the opposite property, with

$$(x_{1i} \in [0,1]) \wedge (x_{2i} \in [0,1]) \wedge (x_{1i} = 1 - x_{2i})$$

However, it is possible to use a completely different approach based on possibility theory and the use of fuzzy sets (Zadeh, 1978; Kaufmann, 1975). Let there be question *A*, a positive answer to which clearly indicates that the person taking the test has property *S*. As a rule, this positive answer is formulated as statement *B*.

Usually, the person needs to decide if statement *B* is true or false. However, it is obvious that it can be difficult for the person to give a clear-cut answer to such a question because he or she may act differently depending on the situation. This is why instead of giving only one answer option *B*, a set of answers $\{x_1, x_2, \dots, x_t\}$ to question *A* is given, where answer x_1 indicates the presence of property *S* exclusively, answer x_t indicates the presence of the opposite property (-*S*), and answer $x_{t/2}$ indicates complete uncertainty regarding property *S*.

The person being tested is also given a scale with the form of $M = (m_1, m_2, \dots, m_n)$ where m_1 indicates the case when property *S* always (x_i), never (m_n), or in 50% of cases ($m_{n/2}$) manifests itself in the person. The person has to make a correlation between each x_i option and a certain value on the m_j, with $x_{i1} \neq x_{i2}$ applicable for $m_{j1} = m_{j2}$.

This operation means creating a membership function (Zadeh, 1978; Kaufmann, 1975) for property *S*. The membership function is more accurate in terms not only finding if some property is present but also finding the degree of its intensity.

A very important issue in any testing procedure is the construct validity of the test. Construct validity is one of the main types of validity; it reflects the degree of representation of the psychological construct being studied in the test results. In other words, construct validity determines the area of the theoretical structure of psychological phenomena being measured by the test.

The $\{x_1, x_2, \dots, x_t\}$ set represents collectively exhaustive events. However, as we are in the realm of possibility theory rather than probability theory, when $\mu(x) \in [0,1]$, area δ_x under the $\mu(x) = X(S)$ graph does not have to be equal to 1. This is why the condition $\delta_x = 1$ cannot serve as a criterion of construct validity. However, such a criterion (in this case, an internal consistency criterion) can be found in the fact that the graph is not multimodal $\mu(x) = X(S)$ in accordance with the axiom given in (Leichenko, Malishevskii & Mikhailik, 2006), which says that if $A, B \in a$ and $A \subseteq B$, then $g(A) \leq g(B)$ (inclusion monotonicity, where g is the fuzzy measure (Zadeh, 1978; Kaufmann, 1975)).

So, the testing algorithm for finding a person's information metabolism type will be as follows:

1. Out of the set of questions $\{A_1, A_2, A_3\}$ where A_i is a subset of questions, an a_{ij} question is randomly selected and given to the person in order to find out where he or she stands on the three scales (extraversion / introversion (E/I); logic / ethics (L/E), and sensing / intuition (S/I)).

2. The person assigns an m_{ijk} value out of set M to each x_{ijk} answer from the B_{ij} set of answers; by making pairs (m, x), a membership function is created which describes property S_i. (If the question is inverted and helps to find if property $-S_i$ is present, then the m_{ijk} values in the pairs will also be inverted).

3. For each value of i, at least ξ questions from set A_i are given, i.e. $\xi \leq card(A_i)$

4. A summation is made, which results in finding the values of the membership function for each S_i property

$$m_{ik} = \sum_{j=1}^{N} m_{ijk}$$

5. If the i_{th} membership function is not multimodal, that is,

$$\{i \mid (i_1 > i_2 > i_3) \wedge ((x_{i1} > x_{i2}) \wedge (x_{i3} > x_{i2}))\} = \emptyset \quad (1)$$

then no more questions are given for the i_{th} membership function. Otherwise, questions are given either until this condition is met or until $j > card(A_i)$ In the latter case, the test results are invalid.

6. When condition (1) is met for $\forall i = \overline{1,3}$, the membership function is normalized, i.e. the m_{ik} values found in the course of the test are proportionally reduced or increased until the condition $\delta_{xi} = 1$ is met.

The novelty of this approach lies in:

● using fuzzy set theory to replace the dichotomous approach with the membership function as a tool which is more relevant.

● using the criterion of lack of multimodality as a construct validity (internal consistency) criterion of the test.

● using a flexible survey method, in which the number of questions in the test, rather than being rigid, varies due to the presence of feedback based on the internal consistency criterion.

Naturally, the MM-1 test is far from being perfect. Its original (0-th) version was examined in order to check the validity of individual test questions. The results of the studies devoted to individual test questions can be found in (Leichenko et al., 2006; Arinicheva & Malishevskii, 2014). It should be noted that the parameters characterizing the quality of individual test questions changed only a little while statistical data was being accumulated.

As a result, the authors of (Leichenko, et al. 2006) developed the third modification of the test (the first two modifications had not been used much), in which the questionnaire was left unchanged but the test results were processed differently. A similar approach was used for the fourth (Arinicheva, 2008) and fifth (Arinicheva & Malishevskii, 2014) modifications of the MM-1 test.

Weighting factors (c_j) proportional to the sum of the deviations from the center point were introduced, as well as the magnitude of the shift for the center point (d_j) which depends on the general vector of the answers (Arinicheva & Malishevskii, 2014).

Based on the above, the third modification of the MM-1 test proposed by S. D. Leichenko et al (2006), the fourth modification of the MM-1 test proposed by O.V. Arinicheva (2008), and the fifth modification of the MM-1 test, which is the latest development by A. V. Malishevsky (Arinicheva & Malishevskii, 2014), contain λ1, λ2, λ3, π1, π2 and π3 which take the following form:

$$\begin{cases} \lambda_1 = \sum_{j=1}^{10} (\lambda_j + d_j)c_j; & \pi_1 = 1 - \lambda_1; \\ \lambda_2 = \sum_{j=11}^{20} (\lambda_j + d_j)c_j; & \pi_2 = 1 - \lambda_2; \\ \lambda_3 = \sum_{j=21}^{30} (\lambda_j + d_j)c_j; & \pi_3 = 1 - \lambda_3, \end{cases}$$

where j is the number of the corresponding question in the MM-1 test; c_j is the weighting factor which reflects the significance of the j-th question; d_j is the magnitude of the shift for the central point for the j-th question;

$\lambda_i, i = \overline{1,3}$ is the area under the left side of the graph of the membership function plotted for the j-th question;

$\pi_i, i = \overline{1,3}$ is the area under the right side of the graph of the membership function plotted for the j-th question.

The values of λ_4 and π_4 in all of the above modifications are found using the following expressions:

$$\begin{cases} \lambda_4 = 0.5 + \text{sign}(|0.5 - \lambda_2| - |0.5 - \lambda_3|)\sqrt{(|0.5 - \lambda_2| - |0.5 - \lambda_3|)}, \\ \pi_4 = 1 - \lambda_4. \end{cases}$$

(In the 0-th modification, c_j was equal to 1, d_j was equal to 0, and the value of λ_4 was found from the expression

$$\lambda_4 = 0.5 + |0.5 - \lambda_2| - |0.5 - \lambda_3|).$$

The fifth modification of the MM-1 test was used to test 2,857 people including students at St. Petersburg State University of Civil Aviation and the Institute of Philology, Foreign Languages and Media Communication at Irkutsk State University, flight crews from more than three dozen airlines in Russia, Azerbaijan, Belarus, Kazakhstan, Ukraine, Uzbekistan, and Estonia, air traffic controllers from almost all regions of Russia, and a number of flight attendants and representatives of transport management services who, despite the data given in (Leichenko et al., (-2006), were analyzed as a separate professional group called "service", as it is difficult to classify these jobs as belonging to such areas as engineering or humanities.

The fifth modification of the test differs from both the third and fourth ones. This is why, even though a lot of new data has been collected since 2015, this article covers only the results on 2,857 aviation professionals. A significant part of the previously collected experimental data could not be transferred from the previous modifications to the fifth one due to the loss of the initial test results (modifications of the MM-1 test do not differ in terms of the questionnaire itself; however, they differ in the method of processing the answer vector).

The numbers of the participants were as follows: 2,356 men and 501 women. All the pilots and air traffic controllers participating in the experiment were males.

Data was collected by the authors over the period from 1999 to 2019, making a representative sample.

A correlation analysis which included calculating the Pearson correlation coefficient (Bock et al., ł 2015) and conducting Pearson's chi-squared test (Bock, Velleman & De Veaux, 2015) was carried out using the R programming language (Data Science and Analytics (DSA), 2020), which is widely used as statistical software for data analysis and has virtually become a standard for statistical programs. It is available under the GNU GPL license (Free Software Foundation (FSF), 2020).

The studies conducted at the premises of various airlines, air traffic control centers, St. Petersburg State University of Civil Aviation, and Irkutsk State University were carried out in accordance with the fundamental principles of bioethics (Bioethics, 2020) and on a voluntary basis.

3. Results

The main drawback of the data collected is a significant bias towards engineering jobs: only 336 of the participants were involved in the "humanities" sector, and only 63 of them were males. The data is also biased in terms of gender: there were almost five times more men than women who took part in the studies. However, the reasons for these biases are obvious. Even though they reduce the validity of the results, a number of interesting conclusions can still be made.

The first point of interest to us is: what socionics characteristics are most relevant for operators and are there significant differences between professions in terms of their representatives' socionics characteristics?

The paper (Ivanov & Ivanov, 1996) raises a number of questions concerning whether the types of information metabolism inherent to the cadets in the study were identified correctly because a significant part of the results was obtained using "traditional" socionics methods rather than testing. However, we agree with the main conclusion made by D. A. Ivanov and A. A. Ivanov (1996).

Unfortunately, setting up flight experiments is a very difficult and expensive task. However, under the guidance of A. V. Malishevsky, A. A. Sinyakov, an instructor at the Sasovskoye flight school, set up an experiment in 2010 similar to the one described in (Ivanov & Ivanov, 1996), although only 15 cadets participated. Overall, the conclusions made by the authors of the Ukrainian experiment (Ivanov & Ivanov, 1996), at least in terms of trends, were confirmed. It was revealed that the optimal types of information metabolism are primarily sensory-logical and logical-sensory extraverts, as well as sensory-logical introverts. Also, as it had been forecasted, it was found that there was a correlation between ξ, the value which characterizes the career aptitude of the participant based on their socionics characteristics, and academic performance. This parameter was proposed by the authors of (Leichenko et al., (2006) and varies from 0 to 3.

Based on expert estimates (Ivanov & Ivanov, 1996; Leichenko, 2002) and experimental data presented in (Leichenko, 2002; Malishesk et al.y, (2005) and the degree paper by A. A. Sinyakov, a scale for ranking flight crew members based on their socionics characteristics was proposed in (Leichenko et al., (2006; Malishevsky et al., (2005; Leichenko, 2002) and is shown in table 2. In general, these criteria can be used to assess other operator jobs.

Table 2
Information metabolism types and their career aptitude in aviation
(ξ is the aptitude parameter (Leichenko, Malishevskii & Mikhailik, 2006))

ξ	Career aptitude	Type of information metabolism
0	Completely fit for aviation	SLE, LSE
0.75	Mostly fit for aviation	SLI, LSI, SEE, LIE
1.5	Unclear (rather fit than unfit)	SEI, ESE, LII, ILE
2.25	Unclear (rather unfit than fit)	ILI, ESI, EIE, IEE
3	Obviously unfit for aviation	IEI, EII

In (Leichenko et al., ‡2006), the concept of the socionics portrait of a professional group (SPPG) was introduced.

A socionics portrait is a distribution of information metabolism types in a certain sample being studied.

The socionics portrait of a professional group is a distribution of information metabolism types that is characteristic of this professional group. (The sample in this case, although finite at a given moment, is variable. Some new people become members of a professional group while others leave it.)

Table 3 contains the latest data (as of January 1, 2020) on socionics portraits, i.e. on the distribution of information metabolism types among representatives of different careers. All data was obtained using the fifth modification of the MM-1 test.

Table 4 contains the results of Pearson's chi-squared test (Bock et al., ‡2015) and the conclusions made.

Table 3
Socionics portraits of samples representing different profesional groups factoring in gender (as of January 1, 2020)

Information metabolism type	Aptitude parameter	Flight crew members			Air traffic controllers			Aircraft ground handling personnel		Humanities majors		Transport managers and flight attendants		TOTAL
		Professionals	Civil aviation students (St.Petersburg)		Professionals	Civil aviation students (St.Petersburg)								
			males	females		males	females	males	females	males	females	males	females	
SLE	0	319	184	8	182	31	15	85	23	11	55	26	21	960
LSE	0	201	143	8	133	36	12	76	16	8	30	29	10	702
SLI	0.75	121	38	3	74	7	3	30	14	5	11	11	11	328
LSI	0.75	81	47	3	57	13	1	29	9	6	15	11	4	276
SEE	0.75	30	15	1	25	7	1	17	10	5	30	8	9	158
LIE	0.75	5	3	0	8	3	1	15	6	6	15	3	0	65
SEI	1.5	12	5	0	17	1	1	2	5	2	9	8	4	66
LII	1.5	9	3	0	6	1	0	5	1	2	9	1	0	37
ESE	1.5	3	4	0	5	0	0	5	2	2	17	1	3	42
ILE	1.5	5	1	0	5	0	0	3	2	1	9	0	1	27
ESI	2.25	2	1	0	3	0	1	1	0	1	10	2	2	23
ILI	2.25	5	3	0	3	0	0	6	0	3	4	2	0	26
IEE	2.25	2	3	0	3	1	0	2	3	3	18	0	2	37
EIE	2.25	3	3	0	7	1	0	6	5	5	23	1	4	58
IEI	3	2	1	0	10	0	1	3	0	3	9	0	1	30
EII	3	3	1	0	3	2	0	1	0	0	9	2	1	22
Total		803	455	23	541	103	36	286	96	63	273	105	73	2.857
$\xi \geq 1.5$		5.7%	5.5%	0.0%	11.5%	5.8%	8.3%	11.9%	18.8%	34.9%	42.9%	16.2%	24.7%	12.9%
$\xi > 1.5$		2.1%	2.6%	0.0%	5.4%	3.9%	5.5%	6.6%	8.3%	23.8%	26.7%	6.7%	13.7%	6.7%
$\xi > 2.25$		0.6%	0.4%	0.0%	2.4%	1.9%	2.8%	1.4%	0.0%	4.8%	6.6%	1.9%	2.7%	1.8%

When analyzing the data given in tables 3 and 4, what immediately catches the eye is the fact that there are obvious differences between the samples in terms of professional identity. When comparing samples of individuals belonging to the same occupational group and of approximately the same age but of different genders, none of the five cases revealed significant differences ($p > 0.05$). This confirms the idea expressed by Aušra Augustinavičiūtė in (Augustinavičiūtė, 2016) that there are no differences between genders in terms of the distribution of information metabolism types; however, it runs contrary to Jung's theory (Jung, 1971) which argues that the ethics function is predominately found in females.

Table 4

The distribution of information metabolism types based on Pearson's chi-squared test

1st sample	N_1	2nd sample	N_2	Degrees of freedom, v	$\chi^2_{emp.}$	$\chi^2_{cr.}$	Conclusion
1	803	2	541	11	24.808	19.675 for p< 0.05 24.725 for p< 0.01	Differences are highly significant (p ≤ 0.01)
1	803	3	455	8	17.132	15.507 for p< 0.05 20.090 for p< 0.01	Differences are significant (p ≤ 0.05)
1	803	7	286	8	50.571	15.507 for p< 0.05 20.090 for p< 0.01	Differences are highly significant (p ≤ 0.01)
1	803	9	63	4	92.721	9.488 for p< 0.05 13.277 for p< 0.01	Differences are highly significant (p ≤ 0.01)
1	803	11	105	5	28.587	11.070 for p< 0.05 15.086 for p< 0.01	Differences are highly significant (p ≤ 0.01)
2	541	5	103	6	12.286	12.592 for p< 0.05 16.812 for p< 0.01	There are no significant differences (p > 0.05)
2	541	7	286	9	22.646	16.919 for p< 0.05 21.666 for p< 0.01	Differences are highly significant (p ≤ 0.01)
2	541	9	63	5	45.319	11.070 for p< 0.05 15.086 for p< 0.01	Differences are highly significant (p ≤ 0.01)
3	455	4	23	2	0.294	5.991 for p< 0.05 9.210 for p< 0.01	There are no significant differences (p > 0.05)
3	455	5	103	5	8.874	11.070 for p< 0.05 15.086 for p< 0.01	There are no significant differences (p > 0.05)
3	455	9	63	4	83.982	9.488 for p< 0.05 13.277 for p< 0.01	Differences are highly significant (p ≤ 0.01)
4	23	6	36	2	0.332	5.991 for p< 0.05 9.210 for p< 0.01	There are no significant differences (p > 0.05)
4	23	10	273	3	20.956	7.815 for p< 0.05 11.345 for p< 0.01	Differences are highly significant (p ≤ 0.01)
5	103	6	36	3	2.213	7.815 for p< 0.05 11.345 for p< 0.01	There are no significant differences (p > 0.05)
5	103	9	63	5	32.664	11.070 for p< 0.05 15.086 for p< 0.01	Differences are highly significant (p ≤ 0.01)
6	36	8	96	3	12.500	7.815 for p< 0.05 11.345 for p< 0.01	Differences are highly significant (p ≤ 0.01)
6	36	10	273	4	31.551	9.488 for p< 0.05 13.277 for p< 0.01	Differences are highly significant (p ≤ 0.01)
6	36	12	73	4	11.574	9.488 for p< 0.05 13.277 for p< 0.01	Differences are significant (p ≤ 0.05)
7	286	8	96	7	10.014	14.067 for p< 0.05 18.475 for p< 0.01	There are no significant differences (p > 0.05)
8	96	10	273	10	31.987	18.307 for p< 0.05 23.209 for p< 0.01	Differences are highly significant (p ≤ 0.01)
9	63	10	273	8	5.683	15.507 for p< 0.05 20.090 for p< 0.01	There are no significant differences (p > 0.05)
9	63	11	105	6	15.636	12.592 for p< 0.05 16.812 for p< 0.01	Differences are significant (p ≤ 0.05)
11	105	12	73	6	8.530	12.592 for p< 0.05 16.812 for p< 0.01	There are no significant differences (p > 0.05)
13	78	14	39	5	26.611	11.070 for p< 0.05 15.086 for p< 0.01	Differences are highly significant (p ≤ 0.01)

SAMPLES

1 Professional flight crew members. Males.
2 Professional air traffic controllers. Males.
3 Students studying to become pilots. Males.
4 Students studying to become pilots. Females.
5 Students studying to become ATC. Males.
6 Students studying to become ATC. Females.
7 Aircraft ground handling personnel. Males.
8 Aircraft ground handling personnel. Females.
9 Humanities majors. Males.
10 Humanities majors. Females.
11 Transport managers. Males.
12 Transport managers. Females.
13 Cadets with good academic performance (Ivanov & Ivanov, 1996).
14 Cadets with bad academic performance (Ivanov & Ivanov, 1996).

The differences between professional pilots and male representatives of all other professional groups are highly significant ($p \leq 0.01$). The differences between air traffic controllers, humanities majors, and aircraft ground handling personnel (both males and females) are also highly significant ($p \leq 0.01$). As it had been expected, the professional group called "service" turned out to be somewhat in between engineers and humanities majors in terms of their socionics characteristics, but even in this case, the differences between professional groups are significant ($p \leq 0.05$). There are no significant differences ($p > 0.05$) between students of the same gender studying to become pilots and those studying to become air traffic controllers and neither are there significant differences between male participants who are professional air traffic controllers and male students studying to become air traffic controllers, which was also to be expected.

The fact least understood is the significant difference ($p \leq 0.05$) between professional pilots and students studying to become pilots. It cannot be accounted for by a low quality of professional screening procedures resulting in a bigger number of students (compared to professionals) who are not fit for their jobs in terms of their information metabolism types because there are no differences between these two samples regarding the unfit information metabolism types. The main contribution to the value of $\chi^2_{emp.}$ was made by the relative predominance of the LSE type among students and the relatively small number of students with the SLI type. Given that the samples are representative enough, the reasons why the data here is skewed are unclear. This might be due to some imperfection of the MM-1 test or a change in the SPPG of the "new generation" of pilots.

The differences are highly significant ($p \leq 0.01$) between the samples of cadets with good and bad academic performance indicators discussed in (Ivanov & Ivanov, 1996), which was also to be expected based on the content of the paper.

All this makes it possible to claim (with certain reservations though) that there is such a thing as the SPPG which needs to be taken into consideration.

Another thing to take into account is that Table 3 presents the socionics portrait of a sample of 803 pilots rather than that of the whole professional group. However, based on table 3 and the data obtained earlier and discussed in (Arinicheva *et al*., 2008; Malishevskii et al., ł2015; Malishevskii & Arinicheva, 2019; Leichenko et al., ł2006); Arinicheva & Malishevskii, (2014); Arinicheva, (2008); Leichenko, (2002); Malishevsky et al., ł 2005), it can be argued that logical and sensory types will prevail in the socionics portrait of a pilot, with fairly big shares of extraverts and irrational (perceiving) types. The shares of pilots with different information metabolism types in the socionics portrait of the profession will be as follows: SLE – 30-40%; LSE – 20-25%, SLI – 13-17%, LSI – 9-11%, SEE – 3-5%, with other types taking up 2 to 25%. In fact, the socionics portraits of the samples in (Arinicheva *et al*., 2008; Malishevskii et al.,ł 2015; Malishevskii & Arinicheva, 2019; Leichenko et al., ł 2006; Arinicheva & Malishevskii, 2014; Leichenko, 2002; Arinicheva, 2008; Malishevsky et al., - (2005) and other studies on this topic are quite close to the information metabolism type ideal for the pilot which is discussed in (Leichenko et al., ł2006) and was determined based on the test assessing the interaction between the pilot and the aircraft. Apparently, although socionics tests are not included in the current professional screening procedures, people with suitable socionics characteristics are selected in a "natural" way, i.e. through tests checking their professional qualities and the trend of dropping out of the career if the person's psychological characteristics are not fit for the job. However, more data is needed to make the socionics portrait of the pilot more accurate. As for other professions, it is too early to discuss their socionics portraits.

4. Conclusions

For a long time, the authors of this article have been engaged in research aimed at solving the issue of reducing the negative impact of the human factor on flight safety, trying to understand its causes and factors (Arinicheva *et al*., 2018; Smurov *et al*., 2017; Arinicheva *et al*., 2008; Mukhtarov et al., ł1999; Lejchenko et al.,ł 2002;

Arinicheva et al., ‡2019); Paşayev *et al*., (2005); Malishevskii et al.,,(2015); Malishevskii & Arinicheva, (2019); Arinicheva & Malishevskii, (2019a); Arinicheva & Malishevskii, (2019b); Arinicheva & Malishevskii, (2014); Dzhapharadze & Malishevsky, (2013); Malishevskij et al., , (2015).

Based on the materials discussed in this article, the following can be stated:

● the socionics characteristics of aviation professionals play an important role in information processes and in the processes of interaction between flight crew members (which is true for working in any other team characterized by the perception, processing, and exchange of a large amount of information between team members, especially at a forced pace resulting from an emergency);

● the most promising method for finding the information metabolism type of aviation professional is a method that uses fuzzy set theory, one of which is described in this article;

● it has been confirmed that such a phenomenon as the socionics portrait of a professional group exists;

● it has been shown that the most important socionics characteristics of the so-called ideal pilot are the predominance of such psychological functions as logic and sensing in their information metabolism type.

It appears that the inclusion of socionics characteristics as qualities relevant at work into professional selection and screening procedures will help to reduce the negative impact of the human factor on the functioning of the air transport system.

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