ORIGINAL ARTICLE
DOI: https://doi.org/10.30932/1992-3252-2022-20-5-11

World of Transport and Transportation, 2022,
Vol. 20, Iss. 5 (102), pp. 208–216

The Influence of the Socionic Characteristics of a Pilot on the Features of Perception and Interpretation of Displayed Flight Instrument Information

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ABSTRACT

The article continues a series of papers by the authors of the results of the study on perception and interpretation by a pilot of visual information provided by flight instruments. The data presented refer to experiments conducted in 2021–2022 with a sample of 50 cadet pilots. According to V. A. Sychev, the well-known aviation professor, in the piloting technique, perceptual errors are most common. Among many flight instruments important for piloting an aircraft, there is one whose influence on the «Loss of control in-flight» (LOC–I) problem is the greatest – this is the attitude indicator. Several catastrophes are associated with perceptual errors of the readings of attitude indicators. One of the most tragic accidents of this kind was the crash near Perm on September 14, 2008, of a Boeing-737 aircraft.

The paper presents the results of a comparative study carried out to identify individual differences in perception and interpretation by tested cadet pilots of the roll indications on the attitude indicator with the «inside-out» and «outside-in» display options. During task performance, the participants were presented with a sequential series of images in the form of slides with roll indications of the attitude indicator with different display options. The experiment was carried out using a stationary Eye Tracker Tobii REX device. The analysis and processing of the data obtained was carried out using a special computer software developed by A. P. Plyasovskikh at the All-Russian scientific Research Institute of Radio Equipment. The participants to the experiment underwent also psychodiagnostics using Keirsey and MM-1 socionic tests. Results were subject to mathematical processing with correlation analysis and G-sign test.

The arguments given by some authors in favour of the «outside-in» version of the indication were fully confirmed since the number of errors when determining the side of the roll on the «inside-out» display of the attitude indicator turned out to be seven times higher than on the «outside-in» display. The hypothesis that socionic characteristics are predictors of the pilot's correct perception and interpretation of visual instrumental information has not been confirmed. It is possible that the absence of significant correlations was also influenced by the significant uniformity in the socionic characteristics of the surveyed persons.

Keywords: air transport, artificial horizons, socionic characteristics, perception, eye-tracker, flight safety.

For citation: Arinicheva, O. A., Malishevsky, A. V. The Influence of the Socionic Characteristics of a Pilot on the Features of Perception and Interpretation of Displayed Flight Instrument Information. World of Transport and Transportation, 2022, Vol. 20, Iss. 5 (102), pp. 208–216. DOI: https://doi.org/10.30932/1992-3252-2022-20-5-11.

The text of the article originally written in Russian is published in the first part of the issue.
Текст статьи на русском языке публикуется в первой части данного выпуска.

INTRODUCTION

«The spatial disorientation of an aircraft (AC) pilot poses an extremely serious threat to flight safety since further development of situation, as a rule, causes serious consequences, such as a difficult spatial position, an aircraft upset; stall, that is, those that are classifying the events as belonging to «Loss of control in-flight» (LOC–I) category» [1, P. 212; 2, P. 46]. This statement can be confirmed by one of the numerous examples of this kind can, e.g., the incident on February 19, 1985, with the Boeing 747SP-09 of China Airlines flying from Taipei to Los Angeles over the Atlantic [3]. But if in the above case the LOC–I incident occurred due to inattention and distrust of the flight instruments on behalf of the aircraft commander, then the situation becomes much worse when the aircraft pilot misperceives the readings of the flight instrument, that is, when a «perceptual error» occurs [4, P. 35].

Therefore, the study of predictors that affect the correct perception and interpretation by an aircraft pilot of displayed information of flight instruments is, without a doubt, an important and relevant problem.

STATEMENT OF THE PROBLEM

«Clarity and distinctness of perception are of decisive importance for success of any kind of human activity. The more accurate is the perception, the more fully the person reflects the object of his activity, the more productive are his actions: he acts as he perceived» [4, P. 34]. According to the well-known aviation professor V. A. Sychev, «the most common errors in flying technique are errors in perception, less often are errors in assessing the situation and decision, and even less often are errors in implementing the decision, i.e., in motion»[1]. However, among many instruments important for aircraft piloting, attitude indicator[2] should be distinguished. Its influence on the LOC–I problem is difficult to overestimate. Thus, the well-known aviation psychologist, Professor V. V. Kozlov writes [5] referring to [6; 7]: «Aviators know that how long aviation exists, as long there are disputes about how the roll indication should be displayed on the attitude indicator: inside-out[3] («from the plane to the ground, i.e., the symbol of the aircraft is stationary, but the «ground» is movable), outside-in[4] («from the ground to the plane, i.e., the symbol of the aircraft is movable, but the «ground» is motionless»). At the same time, there are periods when the acuteness of the discussion on this problem subsides and it seems that it (the problem) has been solved, however, a new aviation accident with a spatial disorientation established during the investigation raises the problem of the type of roll indication with renewed vigour. Until today, despite numerous experimental studies on reliability of pilot actions when using attitude indicators with different roll display types, there has not been an unambiguous opinion in air professional community both in our country and abroad. On the contrary, a paradoxical situation has arisen when publications provide data in favour of the outside-in roll display type, and the [aerospace] industry (especially abroad) manufactures and installs on aircraft mainly attitude indicators of inside-out roll display type» [5, P. 108][5, 6, 7].

Very impressive results of an experiment are described in detail in works [6; 7] by the well-known aviation psychologist P. A. Kovalenko. In this experiment, «37 pilots of one of the leading Russian airlines, under conditions simulating a catastrophe, were determining the

[1] Sychev, V. A. Flight training A manual for initial training of pilots in circular flight. All-Union Voluntary Society for Promotion of Aviation. Moscow, DOSARM publ., 1950–1952. In 2 volumes, 1950, Vol. 1, 196 p. [Electronic resource]: http://akvictoria.by/wp-content/uploads/2016/02/В.-А.-Сычев-Обучение-полёту-Часть-1–1950.pdf. Last accessed 27.09.2022.

[2] Previously it was called gyro horizon or artificial horizon. – *Transl. note.*

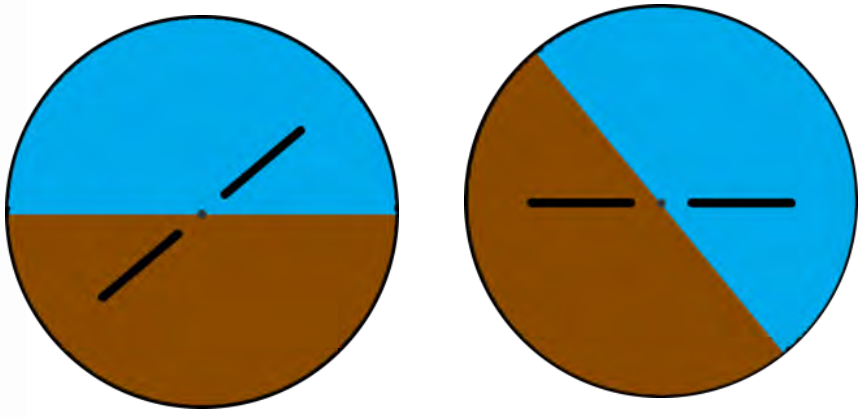
[3] If translated literally, the authors' term is «direct». It is also known as inside-out, moving-horizon–fixed-aircraft, horizon-moving display type. – *Ed. note.*

[4] If translated literally, the authors' term is «reverse». It is also known as outside-in, moving-aircraft-fixed-horizon, moving airplane display type. – *Ed. note.*

[5] Previc, F. H., Ercoline, W. R. The «outside-in» attitude display concept revisited. *The International Journal of Aviation Psychology*, 1999, Vol. 9 (4), pp. 377–401. https://doi.org/10.1207/s15327108ijap0904_5. [Access restricted for subscribers]. – *Ed. note*.

[6] Self, B. P., Breun, M., Feldt, B., Perry, C., Ercoline, W. R. Assessment of Pilot Performance Using a Moving Horizon (Inside-Out), a Moving Aircraft (Outside-In), and an Arc-Segmented Attitude Reference Display. Paper presented at the RTO HFM Symposium on «Spatial Disorientation in Military Vehicles: Causes, Consequences and Cures», held in La Coruña, Spain, 15–17 April 2002, and published in RTO-MP-086. [Electronic resource]: https://www.faa.gov/about/office_org/headquarters_offices/avs/offices/aam/cami/library/online_libraries/aerospace_medicine/sd/media/MP-086–30.pdf. Last accessed 07.08.2022. – *Ed. note*.

[7] Yamaguchi, M., Proctor, R. W. A Compatibility Analysis of Attitude Display Formats. International Symposium on Aviation Psychology, 2009, pp. 355–360. [Electronic resource]: https://corescholar.libraries.wright.edu/cgi/viewcontent.cgi?article=1058&context=isap_2009. Last accessed 07.08.2022. – *Ed. note*.



a) b)

Pic. 1 Display images of the attitude indicator: a) inside-out, b) outside-in [2, P. 47; 9, P. 283].

spatial position and turning the aircraft into level flight using the attitude indicator with an inside-out roll and pitch display type. While doing that, 29 pilots (78,4 %) made mistakes in determining the direction of roll and pitch, they made 61 (16,4 %) mistakes in determining the direction of roll and 44 (11,9 %) mistakes in determining the direction of pitch, that is they confused left and right roll, as well as pitching and diving. There were recorded illusions about spatial mobility and control of the ground (instead of aircraft) in flight, which may be one of the most important causes of subsequent catastrophic outcomes» [6: No. 2, P. 9; No. 3, pp. 10–11; No. 4, P. 11; No. 5, P. 9; 7, P. 2].

Such a catastrophic outcome, when it was the perceptual error of the pilot in reading inside-out display of the attitude indicator that became the cause of the outcome, occurred near Perm on September 14, 2008. Based on the results of the investigation of this catastrophe[8], the IAC in section 5 (5.5) «Recommendations for improving flight safety», among other things, recommended: «to organise and conduct studies to analyse the conditions for spatial disorientation by aircraft crews and getting into a difficult spatial position issuing practical recommendations to improve flight safety; to develop and implement, based on the results of the work, a special advanced training course for flight crews (of upset recovery type), providing for inclusion of theoretical and practical parts in it» [6, No. 2, P. 10; 7, P. 3]. As a matter of fact, the experiment described by P. A. Kovalenko in papers [6; 7] was carried out within the framework of these recommendations.

Both persons involved in Perm accident were familiar with the outside-in display. Judging by the average flight time of the experiment participants (9918,8±1101,9 and 6382,7±1052,6 hours [6, No. 2, P. 10; 7, P. 3] for commanders and co-pilots, respectively), they at least well knew it too (about half or more of their entire flight hours [6, No. 3, P. 18; 7, P. 31). Therefore, the question arises whether these results are consequence of a «force of habit», either of a shortcoming of the AI with inside-out display, and whether there are predictors that affect correct perception and interpretation of displayed flight instrument information by the pilot.

The *objective* of this article is to clarify the issues of the advantages of inside-out and outside-in display types.

MATERIALS AND METHODS

A comparative analysis was based on an experiment that, besides fixing the immediate results of the tasks performed by the participants, also employed a stationary Eye Tracker Tobii REX device to obtain additional information about the main areas of attention focus while perceiving a visual image[9]. «The analysis and processing of the data obtained was carried out using a special computer software (developed by A. P. Plyasovskikh, chief designer of the Research and Development Centre for Air Traffic Management of the All-Russian scientific Research Institute of Radio Equipment), designed to analyse various aspects of gaze shift

[8] Final report on the results of the accident investigation: Boeing-737- 500 VP-BKO 14.09.2008. [In Russian]. Interstate Aviation Committee. [Electronic resource]: https://mak-iac.org/upload/iblock/c2d/vp-bko_report.pdf. Last accessed 27.09.2022.

[9] Tobii. [Electronic resource]: https://www.tobii.com/. Last accessed 27.09.2022.

in the process of performing a given exercise» [8, P. 129]. «A comparative study was carried out on revealing individual differences in perception and interpretation of the roll readings of attitude indicator among the experiment participants [1; 2; 9] with «inside-out» and «outside-in» display options (Pic. 1). The task was presented as a series of slides sequentially shown to the tested person and containing roll readings of attitude indicators of both types. A total of 20 slides were shown, ten pieces of each type interspersed, on which a given roll of 10, 20, 30, 40 and 50 degrees was presented in both display options. The task was preceded by instructions that also emphasised that the task must be completed as quickly and as accurately as possible» [2, P. 46]. The Table 1 shows the list of the evaluated indicators and their designations.

For psychological diagnostics, tests were used that determine the socionic characteristics of the experiment participants:

• Socionic MM-1 test [10].

• Psychological type test developed by David West Keirsey [11].

Since there are significant differences in the conceptual approaches used in these tests [12; 13], it was decided to use both tests together.

The R programming language[10, 11] was used to analyse the results along with correlation analysis [14] and G-sign test [15].

This experiment involved 50 cadet pilots of St. Petersburg State University of Civil Aviation (SPbGU GA) studying at their 3rd to 5th year. All the participants had previously attended flight and simulator training exclusively using only AI of inside-out display type. That is, unlike the participants in the previously described experiment [6; 7], AI of outside-in display type were not familiar to them, but rather «alien».

The experiment was carried out in two stages.

At the first stage (spring 2021), under the guidance of O. V. Arinicheva, A. D. Voitik and V. D. Knyazheva tested 47 students of the fifth year at SPbGU GA pursuing Flight Operations Management course. The experiment results were partially published in the papers [1; 2; 9].

At the second stage (winter-spring 2022), also under the guidance of O. V. Arinicheva, P. M. Lavretsky and V. S. Mezentsev tested another 40 students of the third- and fourth years at SPbGU GA pursuing Flight Operations Management course.

Table 1

Indicators assessed during the experiment and their designations [performed by the authors]

Indicators	
L/R	roll direction
$N_{L/R}$	number of errors in determining the roll direction
γ	roll angle value in degrees
Δ_γ	average value of the error in determining the roll angle in degrees
N_γ	number of errors in determining the roll rate
N_Σ	total number of errors ($N_{L/R} + N_\gamma$)
T	amount of time spent
Remark:	
all indicators were evaluated for «direct» (D) and «reverse» (R) indications, as well as in total (S) for both.	

Note: all indicators were evaluated as for inside-out (IO) and outside-in (OI) display types, and for the sum (S) of two types.

The present study operates only the data of those 50 (24+26) participants who completed both socionic tests [10; 11]. Other psychodiagnostic methods are not considered in the article. The experiment was conducted on a voluntary basis, in accordance with the basic bioethical rules[12].

RESULTS AND DISCUSSION

It should be noted that both stages of the experiment fully confirmed the opinion of V. V. Kozlov [5], P. A. Kovalenko [6; 7] and a number of other researchers about the advantages of the outside-in display option.

If we consider only the results of 50 participants to the experiment, then the average time spent by them to proceed with a slide in outside-in display mode is less by 12 %, or by half a second, than for the inside-out mode ($T_{IO}/10 - T_{OI}/10 = 4{,}42–4{,}23 = 0{,}49$ s). Also, the number of errors in determining the roll in outside-in display mode is 6 % less, and the average error in determining the roll angle (Δ_γ), per one error in determining it, is 11 % less. In general, out of 50 participants, 21 participants as compared to 10 persons have fewer errors when determining the roll angle (N_γ) using outside-in display type, than when using inside-out

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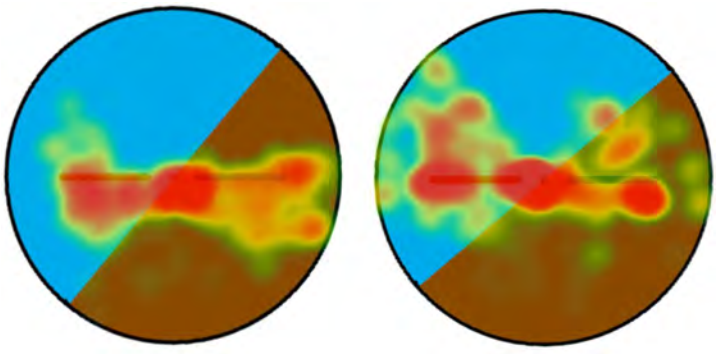
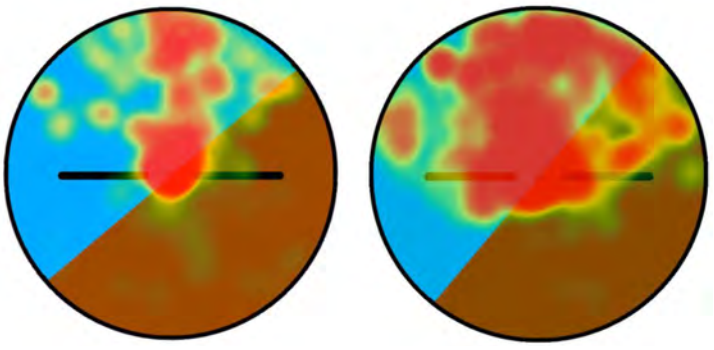
[12] Ushakov, E. V. Bioethics: Textbook and Educational Aid for Higher Schools. Moscow, Urait publ., 2019, 306 p. ISBN 978-5-534-01550-8.



a) the most characteristic heat maps of the participants



b) atypic heat maps

Pic. 2. Examples of heat maps generated for the entire task as a whole [performed by the authors].

one (19 people have the same number of errors per each type of the display). Therefore, according to the G-sign test [15], while considering the measurements according to inside-out and outside-in display types as «different indicators of the same subjects» [15, P. 76], and for the level of statistical significance $p \leq 0{,}05$ [15, P. 323], it is possible to consider reliable the predominance of a «typical» shift in the accuracy of determining the roll angle for outside-in indication as compared to inside-out indication ($G_{EMP.} = 10 \leq 10 = G_{CP0,05}$).

But these differences between the results of the experiment for inside-out and outside-in indications, for all their importance, cannot be even compared with what was revealed by the difference in the values of $N_{L/R\ IO} = 35$ according to the results of 11 people, and $N_{L/R\ OI} = 5$ of 4 people. The difference was of seven times (!!!) in the number of errors and almost three times (!) in the number of those who had made mistakes, what is very significant. The result of 7 % of errors with inside-out indications is less than 16,4 % in a similar experiment [7], but since the conditions of experiments are not identical, we can only say that there are identical trends.

It turns out that students, who used exclusively AI with inside-out indication during their studies, in the majority, used the outside-in indication faster and more accurately. And only a single mistake in perception of AI readings turned out to be fatal.

The use of Eye Tracker in the experiment «made it possible to identify several points that seem appropriate to be investigated in the future. Thus, the resulting heat maps, which display the areas of predominant focus of attention of the participants during the task (see Pic. 2) are quite curious» [1]. Heat maps and 47 participants (fifth year of study) of the first stage of the experiment, and 40 participants of the second stage (third and fourth years of study) showed that in both samples there were people whose attention distribution zones have pronounced differences from distribution, characteristic of the most participants. In most cases, «the main zones of focused attention and that for both types of indications were located along the symbol of the aircraft (Pic. 2a). However, in some cases, the locations of these zones have obvious differences, for example, they are located perpendicular to the silhouette of the aircraft or spread out over the entire upper semicircle (Pic. 2b). These differences are significantly noticeable

Table 2

Number of correlations between data obtained using Eye Tracker [performed by the authors]

First value	Second value	r_{corr}	Conclusion on correlation strength	Conclusion on correlation significance	
T_{IO}	$N_{\Sigma IO}$	+0,4299	moderate	$p \leq 0,01$	highly significant
T_{IO}	$N_{L/RIO}$	+0,3099	moderate	$p \leq 0,05$	significant
T_{IO}	$N_{\gamma IO}$	+0,3501	moderate	$p \leq 0,05$	significant
T_{IO}	$\Delta_{\gamma IO}$	-0,2880	weak	$p \leq 0,05$	significant
T_{OI}	$N_{\Sigma OI}$	+0,3573	moderate	$p \leq 0,05$	significant
T_{OI}	$N_{L/ROI}$	-0,2461	weak	$p \leq 0,05$	significant
T_{OI}	$N_{\gamma OI}$	+0,3217	moderate	$p \leq 0,05$	significant
T_{OI}	$\Delta_{\gamma OI}$	+0,0607	very weak	$p > 0,01$	insignificant
T_{S}	$N_{\Sigma S}$	+0,3805	moderate	$p \leq 0,01$	highly significant
T_{S}	$N_{L/RS}$	+0,2944	weak	$p \leq 0,05$	significant
T_{S}	$N_{\gamma S}$	+0,3127	moderate	$p \leq 0,05$	significant
T_{S}	$\Delta_{\gamma S}$	-0,2461	weak	$p > 0,01$	insignificant
$N_{\gamma IO}$	$\Delta_{\gamma IO}$	+0,1977	very weak	$p > 0,01$	insignificant
$N_{\gamma OI}$	$\Delta_{\gamma OI}$	+0,3610	moderate	$p \leq 0,01$	highly significant
$N_{\gamma S}$	$\Delta_{\gamma S}$	+0,1500	very weak	$p > 0,01$	insignificant

on the heat maps of the participants developed following the entire task» [2, P. 47; 9, P. 286].

The attention should be paid to «the fact of prevailing concentration of attention of the experiment participants on the upper part of the monitor screen» [2, p. 48] that was also recorded at both stages of the experiment, confirming the observations noted in our work [20]. This is clearly seen in Pic. 2.

Table 2 shows some correlations between the data that were obtained using Eye Tracker, more precisely, using the special computer software developed by A. P. Plyasovskikh, which made it possible, in particular, to record with high accuracy the time intervals spent by the participants on one or more another operation.

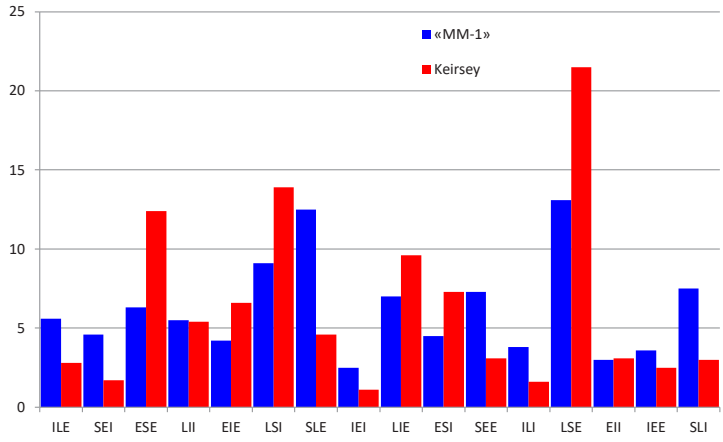
As can be clearly seen from the results presented in Table 2, especially for inside-out indication (index IO) there is a paradoxical picture: the more time is spent viewing the slide (the participants adjusted the time themselves), the more mistakes were made.

The results of the experiment are generally alarming. So, one of the participants managed to make a mistake with the definition of the side of the roll nine (!) times out of ten slides with inside-out roll indication. Two other participants also made eight and six mistakes out of ten, respectively. At the same time, all three spent not a record, but longer (more than 1,5 times) time to view the slide. What is this? Reluctance to stress? Alternatively, nevertheless, is this the obvious shortcoming of professional psychological selection, which we have already written about more than once [21; 22]?

Also, within the framework of this study, a hypothesis was put forward that one of the predictors that affect the correctness of the pilot's perception and interpretation of displayed instrument information can be associated with socionic characteristics. After all, it is believed that socionics determines the type of informational metabolism (TIM), i.e., «a way of exchanging information of a certain system with its environment, which determines the processes of obtaining, processing and transmitting information to the outside, and the predominant direction of these processes» [12; 23]. To check it, all participants underwent a psychodiagnostic examination with MM-1 [10] and Keirsey [11] tests. The resulting socionic models of the surveyed group are shown in Pic. 3.

Although the models obtained from these two different tests are clearly outwardly different, there is a highly significant correlation of average strength between them ($0,5 < r_{corr.} = 0,6495 < 0,7$; $H_{cr.0,001} = 2,87 > H_{act.} = 2,52 > 2,41 = H_{cr.0,01}$, i.e., $p \leq 0,01$) [14; 15; 24].

It was not possible to confirm the hypothesis that socionic characteristics affect the correctness of the pilot's perception and interpretation of displayed instrument information. As can be seen



Here types of informational metabolism (TIM) or sociotypes

LSE - logical-sensory extrovert;	SLE - sensory-logical extravert;
LSI - logical-sensory introvert;	SLI - sensory-logical introvert;
LIE - logical-intuitive extrovert;	ILE - intuitive-logical extravert;
LII - logical-intuitive introvert;	ILI - intuitive-logical introvert;
ESE - ethical-sensory extrovert;	SEE- sensory-ethical extravert;
ESI - ethical-sensory introvert;	SEI - sensory-ethical introvert;
EIE - ethical-intuitive extravert;	IEE - intuitive-ethical extravert;
EII - ethical-intuitive introvert;	IEI - intuitive-ethical introvert.

Pic. 3. Socionic models of the surveyed group [performed by the authors].

from Table 3, even significant correlations between the data obtained with Eye Tracker (more precisely, as already mentioned, with the help of its data processing software) and socionic characteristics do not exceed moderate strength values ($0,5 < r_{corr.} < 0,7$).

The worst results in terms of time spent were obtained by the participants whose socionic model was dominated by the sensory component ($M_{S/I}$).

CONCLUSIONS

The arguments in favour of the outside-in version of the indication, stated by several authors [5–7; 16–18], have been fully confirmed. The number of errors committed by participants to the experiment, when determining the roll side using inside-out indication of the AI, turned out to be seven times higher than when using the outside-in indication.

The hypothesis that socionic characteristics are predictors of the pilot's correct perception and interpretation of displayed flight instrument information has not been confirmed. Moreover, the worst indicators of sensory pilots clearly do not correspond to theoretical prerequisites, since (according to socionic theory [25]) they are «sensory people with a well-developed spatial orientation due to a reliable system of sensory organs».

It is possible that the absence of significant correlations was also influenced by the significant uniformity in the socionic characteristics of the participants. The same sensory component in the socionic model of the group of participants according to Keirsey test is 67,5 %, and according to MM-1 test it is equal to 64,9 %. Any fluctuations in this case will be reflected in the correlations. But most likely, one should consider, as V. V. Kozlov writes, that «there are people for whom the inside-out view of the roll indication is «closer to heart», and they easily determine the spatial position of the aircraft using such attitude indicators. On the contrary, it is more difficult for them to do this with attitude indicator with outside-in roll indication. Consequently, in some people, the innate mental mechanisms of spatial orientation do not have a geocentric coordinate system (I am mobile, and the ground is motionless), but egocentric one (I am motionless, and the ground is mobile). It is impossible to say whether this is good or bad. However, according to several studies, there are much fewer people with an egocentric coordinate system, and they make up to 15–20 %. It becomes obvious that by creating attitude indicators with inside-out roll indication, we are going against the nature of those who have a geocentric coordinate system in their psyche. And vice

Table 3

The most significant correlations between Eye Tracker data and socionic characteristics [performed by the authors]

First value	Second value	r_{corr}	Conclusion on correlation strength	Conclusion on correlation significance	
T_S	K_{ILI}	-0,3127	moderate	$p \leq 0,05$	significant
T_S	K_{EII}	-0,2967	weak	$p \leq 0,05$	significant
T_S	M_{SLE}	+0,3040	moderate	$p \leq 0,05$	significant
T_S	$M_{S/I}$	+0,3175	moderate	$p \leq 0,05$	significant
T_{IO}	K_{LIE}	+0,3223	moderate	$p \leq 0,05$	significant
T_{IO}	M_{SLE}	+0,3252	moderate	$p \leq 0,05$	significant
T_{IO}	$M_{S/I}$	+0,2794	weak	$p \leq 0,05$	significant
T_{IO}	ξ_M	-0,2890	weak	$p \leq 0,05$	significant
T_{OI}	K_{ILI}	-0,3420	moderate	$p \leq 0,05$	significant
T_{OI}	K_{EII}	-0,2994	weak	$p \leq 0,05$	significant
T_{OI}	$M_{S/I}$	+0,3192	moderate	$p \leq 0,05$	significant
$N_{\Sigma S}$	K_{LIE}	+0,2914	weak	$p \leq 0,05$	significant
$N_{L/RS}$	K_{LIE}	+0,3095	moderate	$p \leq 0,05$	significant
$N_{\Sigma IO}$	K_{LIE}	+0,3685	moderate	$p \leq 0,01$	highly significant
$N_{L/RIO}$	K_{LIE}	+0,3486	moderate	$p \leq 0,05$	significant

Note: K and M are the components of the socionic model of a person (SMP) [12] according to Keirsey and MM-1 test, respectively, the index for them is TIM, to which the corresponding component of the SMP belongs, and ξ_M is the coefficient of suitability according to socionic characteristics (according to MM-1 test) [12].

versa, the use of attitude indicators with outside-in display creates difficulties in operations for those pilots whose psyche functions is functioning in an egocentric coordinate system» [5, pp. 109–110].

It can be supposed that this coordinate system may not be connected in any way or very weakly connected with socionic characteristics. This issue is still to be researched.

However, the authors fully agree with the conclusions drawn in [5–7]:

1.«The results obtained indicate the viciousness of the concept of inside-out roll indication and the need to replace it with a outside-in indication on all civil aviation aircraft» [6, No. 5, P. 25; 7, P. 104].

2. «It is necessary to select for civil aviation people only with a geocentric coordinate system of functioning of the mental mechanisms of spatial orientation. For this purpose, a special test should be used in professional psychological selection» [5, P. 110].

3. «Equip aircraft with attitude indicators with outside-in type of roll indication, corresponding to functioning of the mental mechanisms of spatial orientation of people with a geocentric coordinate system» [5, P. 110].

Our studies, although they, of course, require continuation, have demonstrated feasibility of a number of directions in the study of the issue.

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Article received 05.08.2022, updated 14.11.2022, approved 18.11.2022, accepted 21.11.2022.