УРОВЕНЬ РАЗВИТИЯ МАТЕМАТИЧЕСКИХ СПОСОБНОСТЕЙ И ТОЧНОСТЬ ВОСПРИЯТИЯ: ПСИХОЛОГИЧЕСКИЕ ОСОБЕННОСТИ ВЗАИМОСВЯЗИ

LEVEL OF DEVELOPMENT OF MATHEMATICAL ABILITIES AND ACCURACY
OF PERCEPTION: PSYCHOLOGICAL FEATURES OF INTERRELATION

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Аннотация:

Статья посвящена исследованию психологических особенностей взаимосвязи точности восприятия и разных уровней развития математических способностей. Актуальность работы обусловлена необходимостью исследования психологических особенностей, обуславливающих высокий уровень развития академических способностей. Цель работы состояла в установлении психологических особенностей перцептивного прайминга людей с разным уровнем развития математических способностей. В эксперименте приняли участие 76 студентов Смоленского государственного университета 17-20-летнего возраста, обучающихся на физико-математическом и психолого-педагогическом факультетах. Исследованы особенности тактильного прайминга с помощью специально разработанного прибора, позволившего избежать вербальные ответы и уточнить особенности имплицитной памяти испытуемых. Исследование уровня развития математических способностей осуществлялось с помощью методики «Аналитические математические способности». В работе осуществлен компаративный анализ результатов тензометрических измерений точности воспроизведения заданных образцов испытуемыми с разными уровнями развития математических способностей в различных психических состояниях: спокойного бодрствования и психоэмоционального напряжения. Экспериментально установлено статистически значимое различие между точностью восприя-

Abstract:

The article is devoted to the study of the psychological characteristics of the relationship between the accuracy of perception and the levels of development of analytical mathematical abilities. The purpose of the work was to establish the psychological characteristics of perceptual priming of people with a high level of development of mathematical abilities. The experiment was attended by 76 students 17-20 years of age. The features of tactile priming with the help of a specially designed device, which avoided verbal answers and clarified the features of the implicit memory of the subjects, were studied. The study of the level of development of mathematical abilities was carried out using the methodology: «Analytical mathematical abilities». A comparative analysis of the results of tensometric measurements of the accuracy of reproducing given perceptual samples of subjects with different levels of development of mathematical abilities in various mental states: calm wakefulness and psychoemotional stress is carried out. A significant correlation (according to Spearman) was established experimentally between a high level of development of analytical mathematical abilities and perception accuracy; subjects with a high level of development of mathematical abilities retained high accuracy in reproducing a given sample in a state of psychoemotional excitement. The results obtained indicate that people with a high level of development of mathematical abilities retain a

тия обучающихся с различными уровнями развития аналитических математических способностей. Испытуемые с высоким уровнем развития математических способностей сохранили высокую точность воспроизведения заданного образца в состоянии психоэмоционального возбуждения. Полученные результаты свидетельствуют о том, что люди с высоким уровнем развития способностей сохраняют более высокий уровень стрессоустойчивости в условиях психоэмоционального напряжения. Эффективное решение задачи развития точности восприятия связано с освоением профессиональной деятельности на высоком уровне.

Ключевые слова:

восприятие, точность восприятия, перцептивный прайминг, аналитические математические способности, психоэмоциональное возбуждение, состояние спокойного бодрствования, устойчивость сознания.

higher level of stress resistance in the face of psychoemotional stress.

Keywords:

perception, accuracy of perception, perceptual priming, analytical mathematical abilities, psychoemotional arousal, state of calm wakefulness, stability of consciousness.

Relevance

Analytical mathematical abilities (AMA) are related to academic abilities. They ensure the development of a wide range of academic disciplines and adaptation to the changing conditions of the cultural and historical environment. The relevance of the development of academic abilities is reflected in documents of the Ministry of Education of the Russian Federation [1,2]. It is well known that students with a high level of development of mathematical abilities master educational material better not only in mathematics, but also in a wide range of disciplines. Students with a low level of the development of mathematical abilities experience difficulties in mastering not only in mathematics; they are also characterized by greater impulsivity in behavior and activity [3].

Researchers define AMA as a complex structural formation [4], which are differentiated into substructures in accordance with the operations and properties of thinking. They point to the relationship between thinking and perceiving abilities: «Those who are more capable can perceive correctly... the role of each element in the complex. Students with average academic results are able to perceive individual elements; they perceive their complexes with difficulties. Weak students perceive only the numerical material of the problem» [5, p.152]. The ability to receive mathematical information and the volume and quality of the perceived information are interrelated. It is clear that such a result is provided by the operational and technical properties of the sensory-perceptual system, and these properties in persons with

AMA differ from the characteristics of mental activity of people who do not have a high level of development of these abilities [6].

People with a high level of AMA «... are more reflective and rational in terms of personality questionnaires in decision-making situations... are more self-reliant and do not feel the need to raise awareness about the situation. ... they either insufficiently assess the uncertainty of the situation of choice, or are insensitive to changes» [7, p.29]. It's about reflection, not empathy. The desire for greater awareness is shown by students with reduced indicators of interpersonal emotional intelligence (a predisposition to mastering foreign languages is associated with a high development of the affective-emotional sphere [8]).

The list of components or qualities of perception, in addition to traditional ones (objectivity, integrity, structure, etc.), includes, for example, «analytic-synthetic types» [9], «accuracy, volume and constancy of perception» [10, p.38], «perceptual sensitivity» [11, p.80] and others. These properties may have some unifying feature: accuracy.

The concept of perception accuracy is traditionally associated with a certain autonomy from the conditions of perception, due to which the likelihood of subjective transformations of the reflected content decreases. For example, constancy is understood as the independence of the reflected phenomenon from physical changes; objectivity – as the ability to differentiate a figure from the background; integrity is considered as the independence of the perceived object from possible transformations or changes in the components that make up its structure.

Accuracy of perception to a large extent ensures a person's ability to adapt to a changing world [12]. Thus, the development of AMA is associated with a specific transformation of the properties of mental processes, which is manifested in the fact that they, being integrated into more complex formations, acquire an «analytical» character. Perceptual accuracy can be viewed as a component included in the AMA structure.

Aim and objectives

The subject of our work is the relationship between the development of mathematical abilities and the accuracy of perception. The aim of the study was to study the psychological characteristics of the relationship between the accuracy of perception of subjects with different degrees of AMA development. The objectives of the study included identifying the AMA level of development, the accuracy of perception and their relationship. As a hypothesis, it was suggested that the accuracy of perception and the AMA level of development are interrelated. The question of the accuracy of which particular perceptual modality should be studied was decided in favor of the kinesthetic (tactile) one, since, firstly, it underlies the development of thinking. Secondly, the results obtained using kinesthetic stimulation made it possible to avoid verbal responses of the subjects, which increased their objectivity.

Materials and Methods

The study involved 76 students aged 17-20, enrolled in the junior courses of the Physics and Mathematics and Psychological and Pedagogical Faculties of the Smolensk State University. The research was carried out jointly with M. Novikov, a second-year master's student. The students were offered two methods: «Analytical mathematical abilities» and the method of tensometric measurements [3,6].

The «Analytical Mathematical Abilities» technique is used to diagnose AMA and allows differentiating the results according to their severity: low, medium, and high. The stimulus material of the test consists of 24 rows, each of which includes 10 numbers that are in a certain relationship with each other. One of the 10 numbers is missing, the student must establish this number. The determination of AMA was carried out in a group, the execution time was limited to 15 minutes.

The determination of the accuracy of perception was carried out using a special device for tensometric measurements (we constructed it ourselves), which included a dial voltmeter and a special key connected to it. The students pressed with their thumbs. The sample was fixed with a red line on a dial voltmeter, the student was asked to align the voltmeter arrow with the line by pressing the keys and remember the effort. After that the voltmeter was removed and the subject had to reproduce the sample under the same conditions, that is, the conditions of perception were comparable to those of reproduction. The results of the efforts were generated automatically within three seconds, and the total reproduction error was recorded on the second voltmeter.

The reliability of the results obtained in comparison with other methods is quite demonstrative. The accuracy of the indicators is based on the generation of indicators during the time periods that are the same for all subjects. In addition to the described advantages, it should be noted the technical convenience of data registration. They were fixed without interfering with the studied processes and without influencing the subject. Thus, the study included manifestations of mental activity hidden from direct observation.

The study consisted of three stages: at the first stage the students were offered to test their AMA using a test, at the second stage they performed tensometric studies. They carried out in different modes of the subjects' vital activity: in a state of habitual work activity and emotional stress. The state of emotional stress was created with the help of short-term intense physical exertion, after that the students were asked to reproduce the sample given by the experimenter. Thus, each series of measurements in different mental states was carried out twice: alternately with the right and left hand.

Finally, at the third stage, obtained results were processed with the Pearson test.

Results and Discussion

Table 1

The results of subjects (methodology of AMA and strain-gauge measurements)

№	AMA level	Number of students (%)	A playback error					
			Before stress			After stress		
			Right hand	Left hand	Error rate	Right hand	Left hand	Error rate
1	High	14.4	0.25	0.31	0.06	0.36	0.37	0.01
2	Average	63.2	0.28	0.40	0.12	0.58	0.50	0.08
3	Low	22.4	0.23	0.32	0.09	0.53	0.45	0.08

The results of the students were differentiated by AMA-levels (column 2, Table 1) in accordance with received points. There were 11 students in a high level of AMA development group, 48 students in an average level of AMA development group and 17 in a low level of AMA development group (14.4; 63.2 and 22.4%, respectively; column 3). A high AMA level was detected only in the results of the students of the faculty of physics and mathematics. We did not find gender differences in any group (5 and 6, respectively, including among those who scored the highest).

The second part of the table (columns 7-9) contains the results of strain measurements of the students before and after stress. Right and left hands are presented separately. The error rate columns (7-9) represent the difference between the right and left hand errors modulo before and after stress.

It follows from the table data that the accuracy of reproduction of a given sample in the state of quiet wakefulness with the right leading hand is higher, the playback error is less (column 4) than with the left hand (column 5). The results of the «left-handed» students were recorded «transpositionally», the results of the leading left hand were entered in the table as the right and accordingly the results of the right hand as the left. Left-hand playback error was higher in all groups.

The accuracy of reproduction of students in both mental states (quiet wakefulness and psychoemotional arousal) with a high AMA level is higher than that of the other groups of students. The accuracy of reproduction of the sample by the students in emotional stress state (after intense physical activity, columns 7 and 8) is reduced. The reproduction error with medium and low AMA is significantly more than that of students with high AMA (0.36 and 0.58; 0.53 – right hand, 0.37 and 0.5; 0.45 – left hand, respectively). The accuracy of perception after stress has specific features: the dynamics of reducing the playback error with the left hand is lower than with the right hand in all groups.

It is well known that in case of mistaken identifications activation of the left hemisphere is ahead of activation of the right hemisphere [13]. Thus, the lower dynamics of reduced reproduction accuracy in the state of psychoemotional left-hand reproduction obtained in our case is a consequence of the «left hemisphere error». In this case, high AMA level and perception features are interrelated: the cognitive analysis of the students

with a high level of AMA hinders the dynamics of reducing the «right hemisphere error».

Similar results were obtained in accuracy of perception of athletes studies [6]. We assume that systematic activities related to the development of stability of consciousness (sports, mathematics, etc.) affect the formation and functioning of «perceptual priming», in terms of Yu. I. Alexandrov [11], which is realized in the form of perceptual operations that are resistant to the conditions of psycho-emotional stress [11]. In our study this manifests itself in reduction of the error of the left hand after stress. As revealed the research process the average stress errors were higher in two groups: the group with high AMA left hand begins to play as the standard perception with less accuracy, namely «not involved» (-0,23); the group with the average AMA right arm begins to «push harder» after stress (0,23).

To establish the relationship between the accuracy of perception (error rate) and the level of AMA development, the Pearson criterion was used. A high and very high correlation was found between the studied signs both before and after stress, respectively: the correlation coefficient (r) is equal to -0.770 and -0.986 ($p < 0.005$). The relationship between the studied features is inverse, that is, the higher the level of AMA development, the smaller the reproduction error (the higher the accuracy of perception). After stress, this relationship is very high in individuals with a high level of AMA development.

Thus, students with a high AMA level maintain similar indicators of perception accuracy in a state of calm wakefulness and in a state of psychoemotional tension. The accuracy of perception of a given sample of students with medium and low AMA levels in a state of psychoemotional stress significantly decreases.

The results obtained in the study coincide with similar indicators of accuracy of perception of athletes: the accuracy of their perception under stress also remained at a high level [6]. Achieving high results in sports and math classes is associated with long and intensive exercises. An effective solution to the problem of developing the accuracy of perception is associated, among other things, with the development of a certain type of activity at a high level. A high level of perceptual accuracy provides an appropriate level of stability of consciousness, stress resistance, which makes the student more resilient in constantly changing learning conditions.

Conclusions

1. The study revealed a significant relationship between mathematical abilities and the accuracy of perception of students.
2. Students with a high level of AMA development maintain high accuracy of reproduction of a given sample in a state of psychoemotional excitement.
3. Accuracy of perception of students with medium and low levels of AMA development decreases in a state of psychoemotional stress.

There is no conflict of interest.

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