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TOLERANCE TO RIDICULOUS IMPACTS IN SCHOOL CHILDREN WITH A GREAT RANGE OF PSYCHOLOGICAL WELL-BEING

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Abstract

The impact of the psychological well-being level of high school seniors on their tolerance for cognitive load was analyzed. The study involved 93 students: 45 males and 48 females – 11th-grade students from Dnipro (Ukraine), who were categorized into three groups based on their level of psychological well-being: I – individuals with a high level of psychological well-being, II – individuals with an average level of psychological well-being, and III – individuals with a low level of psychological well-being. To determine the level of psychological well-being, the "Scales of Psychological Well-Being" (SPWB) questionnaire was used, adapted by T.D. Shevelenkova and P.P. Fesenko. Cognitive load was assessed using the correction test by V.Ya. Anfimov and arithmetic tasks, allowing the evaluation of the ability to perceive significant information. Task performance efficiency was determined by the number of correctly solved tasks in 5 minutes (accuracy) and the total number of tasks completed (speed of execution). The level of tolerance to cognitive load was assessed using E.P. Il'in's tapping test modified by G.V. Okhromiy. Tolerance to cognitive load was evaluated based on the difference in the lability of the nervous system before and after the test. Statistical processing was conducted using the Statistica 6.0 application program for Windows. It was found that students with average and high levels of psychological well-being demonstrated better tolerance to cognitive load than students with a low level of psychological well-being. At a low level of psychological well-being, males exhibited a moderate-low type of nervous system and average lability of nervous system processes, while females showed a weak type of nervous system and low lability of nervous system processes. In these students, regardless of gender, tolerance to cognitive load was moderately reduced. In students with an average level of well-being, indicators of nervous system lability were average with preserved tolerance levels in the range of 71-85%. At a high level of psychological well-being, females showed better nervous system lability than males, and the level of tolerance to cognitive load was as follows: in males - 86-100%, and in females - 51-70%.

Keywords: tolerance; nervous system; psychological well-being; students; lability of nervous processes; strength of nervous processes.

Introduction

Education in secondary schools is one of the most critical periods in a person's life. The graduation class period is especially crucial when students face the challenge of taking exams, choosing a higher education institution, and deciding on their future profession. Researchers in the fields of developmental physiology and psychology note that a person's ability for conscious regulation of their behavior at the age of 16-17 is not fully developed, which can manifest in insufficient motivation and an inability to foresee the consequences of their actions. This is attributed to the constant psychological, nervous, and cognitive overload that students experience. According to many researchers, adaptive capabilities during this period depend on the activity of the nervous system, lability, and strength of nervous processes [1, 2].

Within typological studies aimed at identifying individual differences, lability is considered one of the fundamental properties of the nervous system [3, 4, 5].

The activity of the student is formed based on the mobility of the nervous system. A student with a highly mobile nervous system reacts quickly and adequately to changes in situations, easily abandons outdated stereotypes, acquires skills faster, adapts easily to new conditions and people, transitions easily from calmness to activity and from one activity to another. Emotions quickly arise and manifest in such individuals. They are capable of instant memorization and have an accelerated speech rate. Low mobility of nervous processes indicates high inertia, making it difficult for a person to acquire new skills [6, 7].

Psychologists consider psychological well-being a key element of mental and psychological health in a person's life, which can serve as a criterion for the quality of an individual's life. In the 20th century, psychologists focused on abnormalities related to human health, intrapersonal conflicts, and crises, leading to the neglect of the comprehensive study of psychological well-being as a separate subject. The issue of human well-being is also studied in the context of health psychology. It is believed that well-being is more influenced by self-esteem and a sense of social belonging than by the biological functions of the body, and it is associated with the realization of physical, spiritual, social, and material capabilities of the individual [8, 9, 10].

Establishing connections between the level of psychological well-being and tolerance to cognitive load will draw attention to the importance of issues related to self-perception and self-recognition of a child's personality in the context of academic success [1, 11].

Purpose

To analyze the impact of the psychological well-being level of high school seniors on their tolerance to cognitive load.

Materials and methods

In conducting research, ethical standards were followed in accordance with the provisions of the Declaration of Helsinki of 1975, revised and supplemented in 2002, and the directive of the Ethics Committee of the Faculty of Biology and Ecology of Oles Honchar Dnipro National University (Protocol No. 12/10/22-1 dated 12.10.2022).

Informed consent was obtained from the parents of all participants and all measures were taken to ensure the anonymity of the participants.

The study involved 93 students: 45 males and 48 females – 11th-grade students from Dnipro (Ukraine). All participants provided written voluntary consent to participate in the study. At the time of the examination, students did not report health complaints, headaches, physical fatigue, or sleepiness. Female participants took part in the study during the intermenstrual period. Individuals engaged in sports and those who had taken medication or coffee within 24 hours before the study were excluded from the examination. All participants were healthy and had no contraindications to performing test tasks. When conducting research received informed consent from the child's parents.

The study was conducted in a quiet, well-ventilated room with a constant temperature of +20−22°C in the morning hours, which eliminated the influence of daily fluctuations on the state of the nervous system. The examinations were carried out at the same time. Students were categorized based on their level of psychological well-being into three groups: I – individuals with a high level

of psychological well-being, II - individuals with an average level of psychological well-being, and III – individuals with a low level of psychological well-being. To determine the level of psychological well-being, the "Scales of Psychological Well-Being" (SPWB) questionnaire was used, adapted by T.D. Shevelenkova and P.P. Fesenko [8, 12].

After categorizing students based on the level of psychological well-being, each group underwent the determination of nervous system lability using E.P. Ilyin's tapping test modified by G.V. Okhromiy [3]. The study was repeated after cognitive load, which was conducted using V.Ya. Anfimov's correction test and arithmetic tasks to assess the ability to perceive significant information. Task performance efficiency was evaluated based on the number of correctly solved tasks in 5 minutes (accuracy) and the total number of tasks completed (speed of execution).

The assessment of tolerance to cognitive load (TC) was determined by the difference in nervous system (NS) lability before and after cognitive load and the deviation of the indicator from the mean value (5 points).

The interpretation of the results was as follows: when NS lability > 1, tolerance was considered reduced (36-50%); when NS lability = 1 - moderately reduced (51-70%); when NS lability = 0 - preserved (71-85%); when NS lability <0 - high (86-100%).

The research materials were processed using statistical methods, employing analysis and regression modeling with statistical packages such as "Statistica 6.0" and "Microsoft Excel." For statistical analysis, considering the normal distribution of data, parametric methods were applied using the paired Student's t-test for comparing dependent groups. Mean (M) and standard error of the mean (m) were used to describe the data. Statistically significant differences were considered at a significance level of $p < 0.05$.

Results

According to the results of the study on the level of psychological well-being of students (Table 1), from the examined number of students with a low level of psychological well-being, there were 15 males and 14 females, with an average level of well-being, there were 18 males and 20 females, and with a high level of psychological well-being, there were 12 males and 14 females. The results were analyzed based on six components: positive attitude towards oneself and one's past; autonomy; ability to meet (manage) the demands of daily life; personal growth; life goals; self-perception.

Table 1

Results of the survey «Scale of psychological well-being» K. Riff (adaptation T. D. Shevelenkova, P. P. Fesenko)

Level of Wellbeing		Positive attitude	Autonomy	Management of everyday life.	Personal growth	Life goals	Self-awareness	Overal score
Low	**Boys n=15**	48±3	43±2	47±4	48±3	48±5	45±4	**310±5**
	Girls n=14	49±4	45±2	49±2	47±3	45±3	38±2*	**305±6**
Middle	**Boys n=18**	60±4	55±5	60±7	59±6	65±6	59±11	**404±8**
	Girls n=20	67±3*	54±6	62±8	60±7	67±5	55±10*	**405±7**
High	**Boys n=12**	79±4	74±6	75±5	78±5	80±3	76±4	**470±9**
	Girls n=14	77±7	76±7	76±6	80±4	78±4	78±5	**475±11**

Note: * – reliability, the difference in indicators relative to boys of this level of well-being, at $p < 0.05$.

Comparing the obtained results, it was found that among students with average levels of psychological well-being, girls likely have a higher indicator of positive self-attitude and attitude toward their past compared to boys. Gender differences were also observed in the self-perception indicator. Thus, in girls with low and medium levels of psychological well-being, this indicator was likely lower than in boys. These results suggest that girls with low and medium levels of well-being perceive themselves more critically and find it harder to express themselves as individuals compared to others. Although girls with medium levels of well-being have higher indicators of positive attitudes, personal self-perception is more challenging to form compared to boys of the same level of psychological well-being.

After dividing the students by the level of psychological well-being, the tapping test was conducted, revealing the strength and lability of nervous processes, as well as the level of tolerance to cognitive load. Figure 1 shows the dynamics of the movement pace of students with a low level of psychological well-being during the simulation of cognitive load.

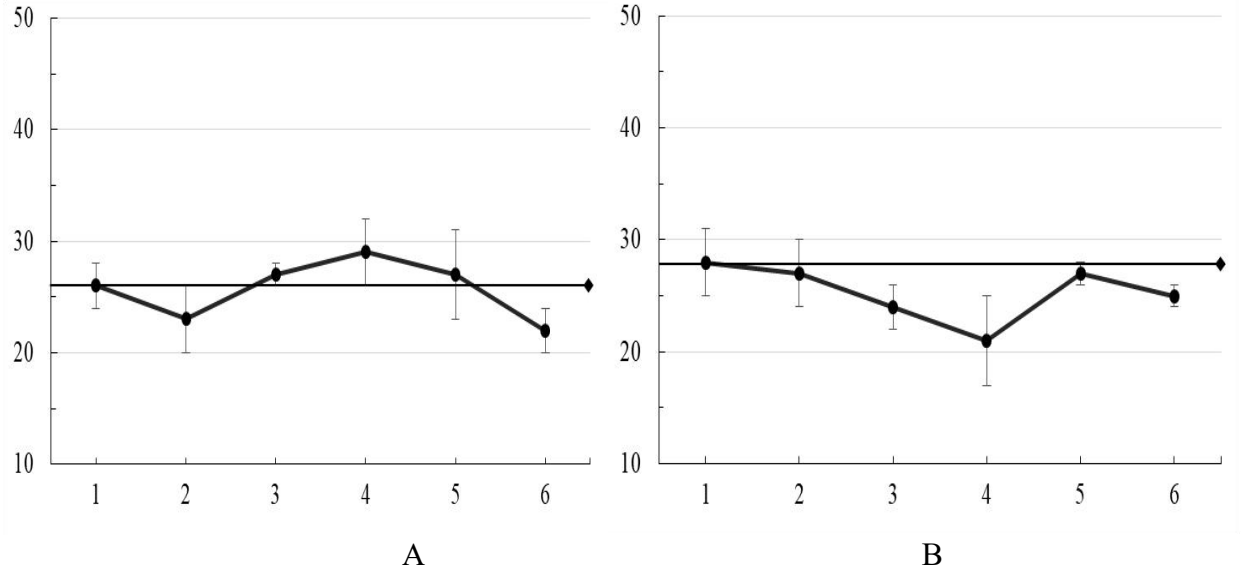
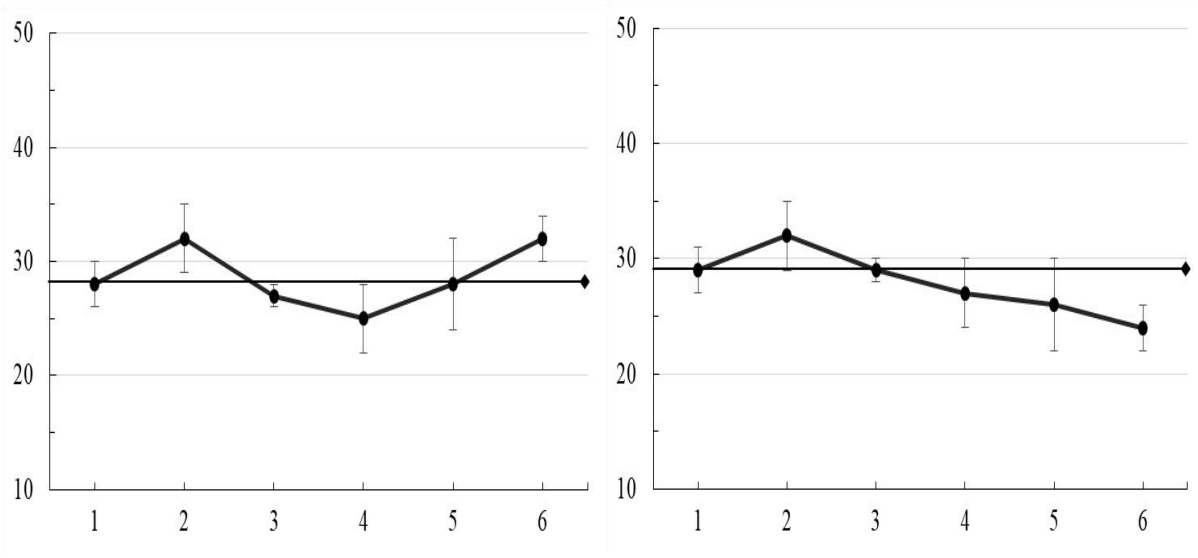


Fig. 1. Dynamics of the maximum pace of movements in boys (A) and girls (B) with a low level of psychological well-being.

Note: The time intervals are marked on the abscissa axis every 5 seconds, and the ordinate axis represents the number of dots in one square.

For boys (Fig. 1A), a concave type of diagram is characteristic, characterized by an initial decrease in pace, followed by a short-term mobilization of pace. These indicators characterize those with a moderately weak nervous system. For girls (Fig. 1B) with a low level of psychological well-being, a descending type of graph is characteristic, indicating a weak nervous system.

Analyzing the results of students with a medium type of psychological well-being (Fig. 2), it was found that both boys and girls had an equal type, indicating a nervous system of moderate strength. Thus, girls with a higher level of well-being have a stronger type of nervous system.

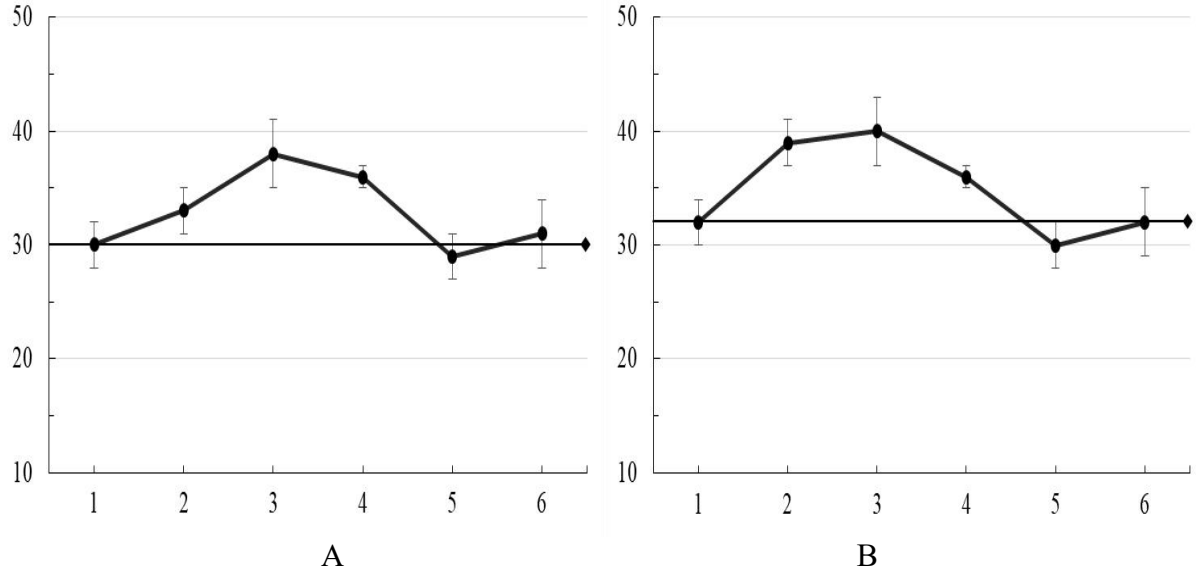


A B

Fig. 2. Dynamics of the maximum pace of movements in boys (A) and girls (B) with a medium level of psychological well-being.

Note: the markings are the same as in fig.1.

In students (Fig. 3) with a high level of psychological well-being, convex-type graphs were observed. For this type, reaching the maximum pace of movements occurs in the first 10-15 seconds. These results indicated the presence of a strong nervous system in the studied students. For girls with a high level of psychological well-being, higher values of the initial and maximum pace of movements were characteristic compared to boys with the same level of well-being.



A B

Fig. 3. Dynamics of the maximum pace of movements in boys (A) and girls (B) with a high level of psychological well-being.

Note: The markings are the same as in fig. 1.

In addition to the strength of nervous processes, we analyzed the lability of the nervous system. Conclusions about the lability of the sensorimotor analyzer were made based on the total number of dots on the sheet. For boys with a low level of psychological well-being, the total number of dots on the sheet was 160±11 (4±1 points), indicating a moderate level of lability of the nervous system. In girls with a low level of psychological well-being, this indicator was 145±8 dots (3±1 point) (Table 2). These values indicated a low lability of the nervous system in girls of this well-being level.

At the medium level of psychological well-being, students of both genders had an average, close to high, lability of the nervous system. In boys, the total number of dots was 172±11 (6±1 points), and in girls, it was 175±8 dots (6±1 point).

In boys with a high level of psychological well-being, the total number of dots was 200±8 (8±1 points), while in girls, it was 210±11 dots (10±1 points), indicating a very high lability of the nervous system.

Table 2

Indicators of the lability of students' nervous system under cognitive load

Indicator	Low level of psychological well-being		Middle level of psychological well-being		High level of psychological well-being	
	Boys	Girls	Boys	Girls	Boys	Girls
Sum of dots	160±11	145±8	172±11*	175±8*	200±8* **	210±11***
Mark	4±1	3±1	6±1*	6±1*	8±1* **	10±1* **

Note: * – significance, the difference in indicators compared to students with a low level of well-being, at $p < 0.05$; ** – significance, the difference in indicators compared to students with a moderate level of well-being, at $p < 0.05$.

Based on the obtained results, we observe that girls with a low level of psychological well-being had the slowest sensorimotor analysis speed, while girls with a high level of well-being had the highest. In boys with low and moderate levels of psychological well-being, there were slight differences between the levels of lability and strength of the nervous system.

After cognitive load, we obtained the following results. In boys with a low level of psychological well-being, the indicator of the strength of nervous processes did not show significant changes and amounted to 4±1 points, with a tendency to decrease the pace of movements (Fig. 4). In girls with a low level of psychological well-being, after cognitive load, the strength of nervous processes increased, amounting to 5±1 points, which is 1±1 point higher than the pre-cognitive load indicator.

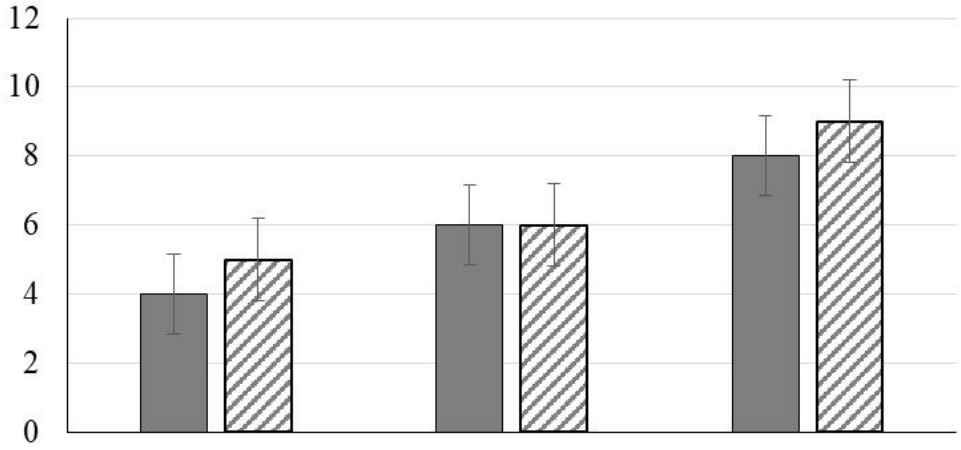


Fig. 4. Strength of nervous processes indicator in students with different levels of psychological well-being after cognitive load.

Note: on the x-axis, the level of psychological well-being, on the y-axis, the number of points. Boys are indicated in gray, girls are indicated with stripes.

In boys and girls with a moderate level of psychological well-being, the strength of nervous processes indicator was 6±1 points. Such values may indicate that the presented cognitive load had a greater impact on boys than on girls. Since in boys, this indicator likely decreased, while in girls, it remained almost at the same level. This may indicate a more resilient nervous system in girls compared to boys.

A likely decrease in the strength of the nervous system indicator was observed in eleventh graders with a high level of psychological well-being. In boys, the CNS indicator was 8±1 points, and in girls, 9±1 points. Analyzing changes in indicators of the strength of nervous processes in students of different genders and levels of psychological well-being under the influence of graded cognitive load, we see that with initially excessively high scores, the load led to their decrease. In girls with low and moderate levels of psychological well-being, the initial state of the strength of the nervous system was characterized as weak and medium, and after cognitive load, it likely did not change. Fluctuations in the total number of movements with the right and left hands after the load were within the range of points for a weak and medium strength of the nervous system. In contrast, in boys with a low level of psychological well-being, under the influence of cognitive load, the strength of the nervous system became weak, although before the load, it was moderate to weak. At a moderate level of psychological well-being, the nervous system of boys was characterized as medium, and it proved to be stable and able to withstand graded cognitive load while preserving all physiological characteristics of the nervous system. Students with a high level of psychological well-being had a strong nervous system in boys and an over-strong one in girls. After the load, boys experienced a decrease in this indicator in quantitative terms, but qualitatively, these values remained within the range characteristic of a strong nervous system. In girls with high well-being, the load caused both quantitative and qualitative changes in the strength of the nervous system indicator, which became characteristic of a strong type of nervous system. From the results obtained, we see that girls with low and high levels of psychological well-being were less resistant to cognitive load than all the students surveyed.

In addition to the effect of graded cognitive load on the strength of the nervous system in graduating students with different levels of psychological well-being, we investigated changes in indicators of the lability of the nervous system. We found that under the influence of the load, in students with a low level of psychological well-being, the total number of movements decreased compared to the indicators before the load. In boys with a low level of psychological well-being, the total sum of points on the sheet was 150±12, which equals 3±1 points and indicates a low level of nervous system lability. In girls with a low level of psychological well-being, this indicator was 129±9 points – 2±1 points (table 3), indicating a low lability of the nervous system in girls of this level of well-being.

Table 3

Indicators of the nervous system's lability in students after cognitive load

Indicator	Low level of psychological well-being		Middle level of psychological well-being		High level of psychological well-being	
	Boys	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**
Sum of dots	150±12	129±9	173±10*	180±10*	210±9* **	206±12***
Marks	3±1	2±1	6±1*	6±1*	10±1* **	9±1* **

Note: * - significance, the difference in indicators compared to students with low levels of well-being, at $p < 0.05$; ** - significance, the difference in indicators compared to students with medium levels of well-being, at $p < 0.05$.

At the average level of psychological well-being, students of both genders exhibited moderate, close to high, nervous system lability. In boys, the number of dots was 173±10, equivalent to 6±1 points, and in girls, it was 180±10 dots – 6±1 points.

For boys with a high level of psychological well-being, the total sum of dots was 210±9, which is 10±1 points – a very high level of lability. In girls - 206±12 dots (9±1 points), indicating a high lability of the nervous system.

Boys and girls with medium levels of psychological well-being had a likely higher movement speed compared to indicators of the nervous system's lability in students with low levels of psychological well-being. The lability of the nervous system in students with a high level of

psychological well-being was higher compared to the indicators of the nervous system's lability in students with low and medium levels of psychological well-being.

Using G.V. Okhromiy's method, we investigated the tolerance of students with different levels of psychological well-being to cognitive load based on the difference in indicators of the nervous system's lability. The calculated tolerance indicator for boys with low lability ranged from 1 to 2 points, indicating moderate tolerance reduction (51-70%). Reduced tolerance to cognitive load was also observed in girls with low levels of psychological well-being. On the other hand, students of both genders with a medium level of psychological well-being were resilient to the presented cognitive load. In this group of students, the tolerance indicator - the difference in lability - was 0, indicating preserved tolerance within 71-85%. In students with a medium level of psychological well-being, gender differences in tolerance to standardized cognitive load did not manifest. However, in students with a high level of psychological well-being, tolerance to cognitive load manifested differently. Thus, the nervous system of boys proved to be more prepared for the load than that of girls. In boys, the tolerance indicator was 2 points, indicating high tolerance to the load within 86-100%. In girls with high psychological well-being, a moderate decrease in tolerance to cognitive load was found within 51-70%.

Comparing the obtained results of the difference in lability indicators, we see that students with low levels of psychological well-being were characterized by a moderate decrease in tolerance to cognitive load. That is, the dosed cognitive load caused a decrease in the speed of attention switching and induced fatigue of the nervous system. Cognitive load in students with a medium level of psychological well-being did not cause significant changes in the lability level; as a result, tolerance to the load was preserved at the level of 71-85%. Students in this group had a fast nervous system and the ability to switch attention processes. In boys with a high level of psychological well-being, cognitive load caused likely changes, such as high speed of attention switching and the ability to maintain pace, indicating the preparedness of the nervous system for the load. In girls, under the influence of the load, the lability indicator decreased, suggesting low adaptive resources against the background of cognitive overload.

Our research results have shown that boys with low levels of psychological well-being exhibited a moderately low type of nervous system and average lability of nervous system processes. In girls with low levels of psychological well-being, cognitive load revealed a weak type of nervous system with low indicators of strength and lability of nervous processes. As the level of psychological well-being increased in students, better physiological qualities of the nervous system were observed based on the tapping test indicators. Thus, boys and girls with medium levels of psychological well-being showed average indicators of strength and lability of the nervous system. At a high level of psychological well-being, boys had high scores for the strength of nervous processes and a highly labile nervous system. Before cognitive load, girls with high levels of psychological well-being exhibited very high values of strength and lability of the nervous system indicators. This indicates a correlation between the level of psychological well-being and the state of the nervous system in students.

As the 11th grade is the most responsible year, involving preparation and taking final exams, career choices, we decided to assess students' tolerance to cognitive load. Dosed cognitive load caused probable changes in the strength and lability indicators of the nervous system in students with different levels of psychological well-being. For boys with low levels of psychological well-being, cognitive load turned out to be excessive, resulting in decreased indicators of lability and strength of the nervous system, and tolerance was moderately reduced (51-70%). This may indicate low adaptive and reserve capacities of the organism in boys of this well-being group [1]. In girls with low levels of psychological well-being, the level of tolerance to cognitive load, like in boys, was moderately reduced (51-70%). However, cognitive load caused an increase in the strength indicator of the nervous system, indicating high reserve capacities in the girls' organism [13]. Since the research results indicated prevailing inhibitory processes in the work of the nervous system in girls, this allows them to preserve reserves of adaptive responses.

For boys and girls with medium levels of psychological well-being, a preserved level of tolerance within 71-85% was characteristic. Indicators of the strength of nervous processes in students of this group were at an average level, and the total number of movements was slightly higher than the results before cognitive load. Such data may suggest that the proposed dosed cognitive load was correctly selected and adequate for students with a medium level of psychological well-being [14]. Boys and girls with medium well-being levels demonstrated high adaptation capacities of the nervous system.

In the group of students with a high level of psychological well-being, differences were observed between the indicators of boys and girls. In boys, a high level of tolerance to cognitive load was observed (86-100%). They had a highly labile nervous system, meaning the ability to quickly switch attention and cope with the proposed task [15-18]. However, the indicators of the strength of the nervous system decreased, indicating low reserves and the ability to work productively for a short period. Such students can handle high-level tasks but maintain this pace for a short duration. In contrast, girls experienced a decrease in the speed of attention switching, and the level of tolerance to cognitive load was moderately reduced at the level of 51-70%. Indicators of the strength of the nervous system also decreased, similar to boys. Girls with high levels of psychological well-being had high strength and lability indicators of the nervous system before performing cognitive load tasks, but during the adaptation processes, they reduced the speed and strength of reactions to maintain optimal nervous system functioning [19-21]. Among all the investigated groups, the best results were observed in students with high levels of psychological well-being.

Conclusion

Therefore, our research has shown that students with medium and high levels of psychological well-being have better tolerance to cognitive load than students with low levels of psychological well-being. In the current stage of societal development, the issue of the psychological well-being of students becomes particularly relevant when determining tolerance to cognitive load, as excessive volumes of educational programs and information in general, surrounding the child, require constant and intensive functioning of the nervous system. And the full functioning of the nervous system under the violation of the principles of psychological well-being is impossible.

Author Contributions

Conceptualization: Olena Khomenko, Iryna Kofan; Methodology: Iryna Kofan; Validation: Olena Khomenko; Formal Analysis: Olena Khomenko, Iryna Kofan; Investigation: Olena Khomenko, Iryna Kofan; Resources: Olena Khomenko, Iryna Kofan; Data Curation: Olena Khomenko, Iryna Kofan; Writing–Original Draft Preparation: Olena Khomenko, Iryna Kofan; Writing-Review & Editing: Iryna Kofan; Visualization: Olena Khomenko; Supervision: Iryna Kofan; Project Administration: Olena Khomenko, Iryna Kofan.

All authors have read and agreed with the published version of themanuscript.

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Ethics approval

The research protocol was approved by the Ethics Committee of the Faculty of Biology and Ecology of Oles Honchar Dnipro National University (Protocol No. 12/10/22-1 dated 12.10.2022).

Data Availability

The data sets used and/or analyzed in the course of the conducted research are available to the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflict of interest.

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