



Psychoemotional Reactions to the Action of Light Pulses

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Abstract

The article presents experimental data on the stimulation of the human visual analyzer by light pulses of red, green and blue at the frequencies of the brain alpha rhythm. The aim of this study was to evaluate the effect of light-pulse stimulation on the psychophysiological state of a person. The work was carried out with the participation of volunteers. The study showed a significant improvement in the psychophysiological state of the subjects on the basis of assessment of well-being, activity and mood.

Introduction

Over the past ten years, done a series of experimental studies aimed at identifying the effects of light pulses in the visual range 455 nm to 655 nm. As a result, it was found that light pulses lead to functional changes in the visual function of a person. In case of reduction of visual acuity in ophthalmic diseases such as the initial form of cataract, age-related macular degeneration, glaucoma without severe retinal and optic nerve dystrophy, as a result of light impulse stimulation against the background of conventional drug treatment regimens, the frequency of cases with increased visual acuity by 0.1 units to 0.2 units was significantly increased [1].

In addition, many patients noted that after sessions of exposure to light pulses improved overall health, increased mood and a feeling of vivacity, comparable to the state after a short day's sleep.

Based on the electroencephalographic study, it was also found that light pulses supplied at a frequency of 10 Hz to 16 Hz are accompanied by an increase in the amplitude of alpha waves of the brain and an increase in the area of alpha waves [2].

The obtained data were the basis for the formulation of a new problem. We formulated it as follows. Is there a psycho-emotional reaction to light pulses and what is the characteristic of such a reaction? The hypothesis of the work was that the reaction in the form of increasing the amplitude and spread of alpha rhythm in the cerebral cortex should cause a sense of rest, quiet and improve performance. In order to obtain data for the evidence used the method of questionnaire, aimed at psycho-emotional assessment of the state in terms of: Health, Activity and Mood (H, A, M) [3].

Research Methods

14 people took part in the work. A total of 105 experiments were conducted. The subjects were mentally healthy, had no organic brain diseases and did not suffer from epilepsy, which was a direct contraindication for inclusion in the experimental group. The special ASIST optical device was used for photo stimulation [4]. The spectrum of Electromagnetic Waves (EMV) was in the range of 455 nm to 655 nm and included light pulses of red, green and blue colors. Participants of the study underwent a course of photostimulation, including up to 15 procedures, which were carried out no more than 2 times a day. The session lasted 10 minutes and corresponded to the Protocol, in which pulse cycles of equal duration were presented in the range of alpha rhythm with a frequency of 10 Hz to 16 Hz. The impact was carried out by packs of pulses alternately on the left and right eyes, which made it possible to timely regeneration of visual purple in the cells of the retina in the time intervals between them. This feature is "know how" of the developed algorithm [4] and is an important component that provides a stimulating effect.

Before and immediately after each stimulation session, a survey was conducted using the H, a, m assessment method. To analyze the results of such a survey, a generalized indicator was used without division into components H, A, M. This is due to a relatively small sample of observations and the need to reduce the probability of interpretation error.

Statistical analysis was performed using the program IBM SPSS (version 23) using a nonparametric Wilcoxon test.

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Table 1: Statistical indicator.

No test	Number of sessions	The average values of the generalized index H, A, M		Dynamics, %
		before the stimulation session	after the stimulation session	
1	9	4.38	4.16	-4.68
2	6	4.08	4.57	14.31
3	6	5.92	6.18	5.93
4	5	5.5	6.5	19.23
5	10	5.32	5.93	11.94
6	6	4.9	5.07	3.64
7	9	5.52	6.53	29.17
8	4	5.38	6.03	14.54
9	6	5.55	5.78	4.46
10	5	5.84	5.86	0.38
11	6	5.12	5.12	0.36
12	4	3.1	3.2	16.32
13	15	5.61	5.94	7.11
14	4	4.15	5.05	22
	Average values:	5.03	5.42	10.34
	Median:	5.35	5.82	9.53

However, there is a significant difference between the mean and median values within the sample before and after the photostimulation session

Table 2: Results of the Wilcoxon test aimed at assessing the results of light pulse stimulation in the General sample.

Null hypothesis	Criterion	Value	Results
The median difference between values of the generalized index H, A, M before and after stimulation is zero	Wilcoxon signed rank test for related samples	0.004	The null hypothesis is rejected

Results and Discussion

The survey showed that after a course of light pulse stimulation almost all (99.9%) generalized indicator H, A, M increased (Table 1).

In this situation, not only was rejected the null hypothesis of the absence of statistically significant differences in the associated indicators before and after exposure to photostimulation, but also proved the positive impact of the light impulses on psycho-physiological state of the total criterion, combining well-being, activity and mood. So the increase in the generalized index after all sessions of photostimulation on average for the entire sample exceeded 10% (Table1).

There was also established a reliable statistical relationship between the degree of improvement of well-being after photostimulation (the generalized index H, A, M) and the process of fatigue (work time before the session of photostimulation) (Figure 1).

It can be seen that before the 6th hour of working time, the generalized index indicator (%) fluctuated without a pronounced pattern, but in cases where photostimulation was carried out at the end of the working day or even after its end, the positive effect was more significant. The established statistical relationship is characterized by a reliable correlation coefficient: $R=0.717$ at the error probability level $p<0.05$ and is described by a linear regression equation: $Y = -11/292 + 3.537 \cdot X$.

As it seems to us, the described fact is caused, first of all, by emergence and increase of physical and emotional fatigue closer to the end of the working day. It is clear that the demonstration of the positive effects of photostimulation on the background of the initial good psycho-physiological state is simply impossible by definition.

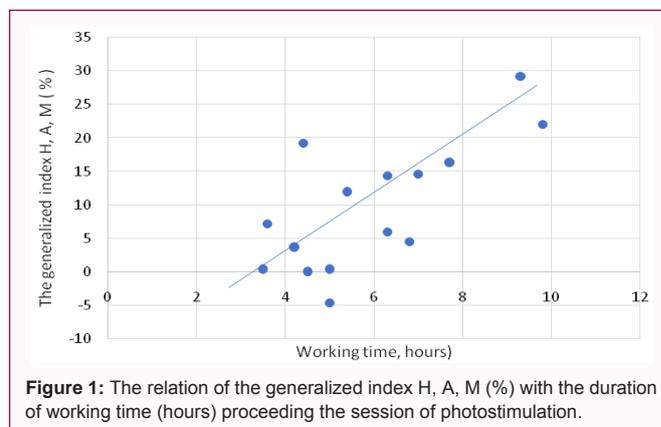


Figure 1: The relation of the generalized index H, A, M (%) with the duration of working time (hours) preceding the session of photostimulation.

And, conversely, with a reduced initial state of health as a result of fatigue, the reaction of restoring the functional state certainly indicates a positive effect of light impulse stimulation.

Thus, the main result of this work is to establish a positive effect of light impulse stimulation on the psycho-emotional state of the subjects during the day working cycle.

The results obtained are quite consistent with the expected improvement of the functional state as a result of the previously established activation of the brain alpha rhythm in response to photostimulation [3]. In other words, they objectively reflect the effectiveness of light-pulse stimulation of the visual analyzer to improve the psycho-physiological state of a person and allow us to recommend this technique for a wider approbation in various professional activities.

Of course, the continuation of research in this direction will

provide new data relating not only to the fine mechanisms of regulation of the functional state of the person, but also the possibility of modeling the given parameters of the basic psycho physiological functions necessary for the successful implementation of specific professional activities.

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