METHODS

On the Accuracy of Evaluations of Temporal Characteristics of Visual Perception

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We studied the accuracy of evaluations of the temporal characteristics of visual perception: critical frequency of light flickers, time of perception, and time of visual analyzer recovery. Results of comparison of the accuracy of evaluations are presented.

Key Words: *visual analyzer; temporal characteristics; critical frequency of light flickers; time of recovery; time of perception*

The method of critical flicker frequency (CFF) is widely used in ophthalmology, ophthalmoergonomics, physiology, and hygiene of labor and athletics, as well as in experimental psychology. CFF is a temporal characteristic of visual perception: the frequency of light flickers per second at which an intermittent (flickering) light stimulus is perceived as a continuous light. CFF effect is determined by inertia of the visual analyzer and times of perception (TP) and recovery (TR).

TP is the interval between the moment of light exposure of the retina and the moment of formation of the corresponding visual sensation, depending on final velocity of physicochemical processes in the retina and optic nerve. TR is the interval from discontinuation of light exposure to disappearance of the corresponding visual sensation.

Despite wide use of the CFF method, it has a number of flaws, the main of which is low accuracy due to the absence of clear-cut threshold between visually discernible light flickers and their fusion, because these frequencies fall within the transmission band of the receptive fields of the neurons perceiving them.

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It is obvious that increase of the accuracy of temporal characteristics of visual perception is an important problem.

The authors developed methods for evaluation of temporal characteristics of TP and TR of the visual analyzer, the primary causes of CFF effect [2,3].

Here we compared the accuracy of evaluation of the temporal characteristics of visual perception.

MATERIALS AND METHODS

The study was carried out in 15 volunteers aged 18-22 years with normal or corrected vision after preliminary training. Before the study, all volunteers were subjected to 20-min light adaptation. Each volunteer performed series of measurements for evaluation of CFF, TP, and TR. The measurements were carried out binocularly in a room equipped in accordance with SNIP 23-05-95 requirements [4] during light hours (9.00-14.00) with 20-30-min rest intervals between the series. Each volunteer performed 13 measurements in each series, the 3 initial results were excluded from the analysis.

A yellow photodiod (5 mm in diameter) with light power of 3.5 mcd placed in the near vision point served as the source. The intensity of light pulses was regulated and equalized by visual pho-

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tometry to the intensity of the reference light source at a frequency of light flickers, corresponding to individual subthreshold CFF.

The frequency of light flickers at which their fusion was subjectively perceived was determined in CFF evaluation by the method of consecutive approximation. For evaluation of TP and TR, the volunteer was presented paired light pulses of fixed duration t_{pulse}, separated by an interval t_{min} and repeating after constant T interval (Fig. 1).

The duration of light pulses for evaluation of TP and TR was selected by the results of analysis of the dynamics of the neuronal receptive fields restructuring. The restructuring phases during perception of visual information depend on the duration of the stimulus. If the stimulus duration is 40-50 msec, the stimulatory and inhibitory processes are mainly formed by the time when the stimulus exposure is over, while at a stimulus duration of 100-200 msec they are completed by this time [6]. Therefore, the TR was evaluated using light stimuli of 50 msec, TP at 200 msec duration of the stimulus.

The interval for repeating paired light pulses was chosen so that to rule out masking between paired light pulses (superimposition of visual sensations caused by the sequence of paired light pulse), which impedes their visual perception. At an interval of 500 msec the masking effects are absent or minor [5]. For more comfortable visual perception during evaluation of TP and TR, the interval after which paired light pulse were repeated was selected individually for each volunteer in the 0.75-1.50 sec range.

The duration of the interval between pulses was reduced during evaluation of TP and TR and the threshold interval between the pulses at which the two light pulses fused into one (according to subjective perception) was determined by successive approximation.

RESULTS

The temporal characteristics of visual perception were evaluated using a programmed device complex for automated psychophysiological studies. The accuracy of their evaluation by the CFF, TP, and TR methods, the arithmetic mean and the mean square deviation were calculated, the decrease in the mean square deviation (in percent) indicating the error in evaluation of the temporal characteristics of visual perception by the TP and TR methods in comparison with the value obtained by the CFF method was estimated [1].

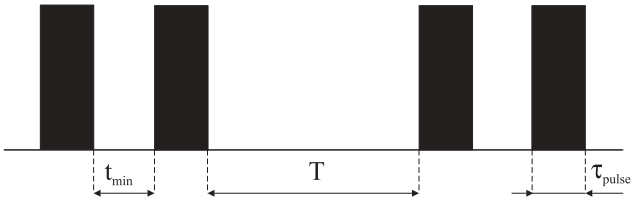

Fig. 1. Time diagram of sequence of paired light pulses for evaluation of TP and TR.

TABLE 1. Comparative Evaluation of CFF, TP, and TR of the Visual Analyzer (*n*=15)

Parameter	Mean arithmetic	Mean quadratic deviation	Decrease in the mean quadratic deviation, %
CFF, Hz	39.9-44.3	0.189-0.340	—
TP, msec	6.7-16.5	0.142-0.271	19.9-28.7
TR, msec	17.3-34.0	0.152-0.280	17.5-24.4

The data indicate that the accuracy of TP evaluation is 19.9-28.7% higher than evaluation by the CFF method, while evaluation by TR is 17.5-24.4% higher in comparison with CFF (Table 1).

Hence, the methods for evaluation of TP and TR are more accurate than evaluation of CFF and can be recommended for evaluation of temporal characteristics of visual perception for obtaining more reliable results.

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