Peculiarities of Sensory Support of Psychomotor Activity that Requires Visual Attention

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Stable correlations between correction task characteristics and components of visual evoked potentials in response to light flash have been revealed. Faster task performance in males in comparison with females was established to be attained due to effective tuning and attuning of visual-motor system at the levels of specific and nonspecific systems related to visual analyzer. This determines potential for monotonous activity requiring constant visual attention.

Key Words: *visual-motor system; monotonous activity; correlation*

Efficiency of work is known to depend on integrations between elements of the forming functional system [1]. It was also established that sensory and effector functions in humans are characterized by certain correlational relationships of different direction and intensity. High functional activity of sensory systems is associated with more efficient work of the neuromuscular system [3]. We previously studied peculiarities of visual sensory support of complicated bimanual movements; visual-motor correlates were established and their sex differences were revealed [6-8]. However, the problems of sensory support of psychomotor activity requiring visual attention under monotonic conditions are still underinvestigated and became the objective of this study.

MATERIALS AND METHODS

The study included 38 men and 36 women at the age of 18-20 years. Monotonous psychomotor activity was modeled using a computer version of Landolt correction test used for evaluation of working capacity and tolerance to monotonous activity requiring constant visual attention. Subjects were offered to review line by line and mark the rings with the gap at the North. Total number of rigs was 1400. Based on the probe results for every 30 sec interval with subsequent averaging the following parameters were automatically calculated: running time (min), number of mistakes (missed or incorrectly marked rings), index of precision (ratio of the number lines worked out in the table to the number of mistakes) and the temp of performance (ratio of the number of sings in worked out part to the running time).

The state of the visual sensory system was assessed by the parameters of flash visual evoked potentials (fVEP) using an Neuromyan HMA-4-01 neuromyoanalyzer (Medicom MTD) with appropriate software. Unipolar electrodes were placed at the leads O1 and O2 according to international system 10-20%, reference electrodes were placed at the ipsilateral ear lobule. Stimulation with submaximal intensity with zero delay was performed monocularly in closed eyes using the flash of light-emitting diode matrix inserted into special spectacles at a 0.3 Hz frequency and 4 msec duration. Low frequency (1 Hz) and high frequency (100 Hz) filters were used, artifact notching by amplitude was done in the range 50-100 μV. Analysis epoch was 500 msec at 100 averagings. Registered potentials included early (P0, N1, P1, N2, P2) and late (N3, P3, N4) components, assessed by temporal and amplitude characteristics [2,4].

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TABLE 1. Mean Values of Landolt Test Parameters (*M±m*)

Subjects	Running time, min	Number of mistakes	Accuracy index	Temp
Males	8.48±0.28	17.60±2.41	721.09±178.11	2.77±0.08
Females	9.79±0.31*	15.91±2.13	513.16±64.28	2.40±0.06*

Note. *$p<0.001$ in comparison with males.

Statistical treatment included complete correlational analysis with the calculation of linear correlation (r) and curvilinear correlation (η) [5]. Coefficient of total multi-sided correlation was calculated as $\Sigma r+\eta$ with no regard to the sign [3]. Significance of the mean values of investigated parameters was assessed using Student's t test.

RESULTS

Comparison of correction test characteristic revealed higher level of psychomotor activity realization in males (Table 1). Analysis of mean values for men and women showed significant differences in time and temp of test performance: women had londer running time, whereas men had higher temp.

Mean latency and amplitude of fVEP components generally corresponded to typical values described in published reports. It should be also noted that the observed differences in fVEP parameters between the groups were also consistent with published data [2,4]: latencies for certain components were higher in men, amplitudes for some components were higher in women.

Correlation analysis results (Fig. 1) indicated higher level of interconnections of the studied parameters in male individuals.

Apparently, in men, velocity of information distribution in sensory system plays important role, particularly when it enters via left input. At the same time, no significance was revealed for any channel in women.

Structure of correlation relationships (Table 2) and current understanding of the origin of fVEP components indicated that in males the velocity of propagation through specific and nonspecific systems, pertaining to visual analyzer, as well as activation level of these elements are of importance in support the psychomotor activity [4]. In addition, interactions with all parameters of activity requiring constant visual attention were revealed. Pattern of curvelineal relations and their preponderance in comparisons indicate the ability of visual sensory system to the tunning directed toward optimal realization of the correction test in the course of its running. Moreover, lateralization of stimulus application is of importance, which apparently manifests in duplication of information in the system when it enters via subdominant input and, as a consequence, in higher level of correlation relationships.

In women (Table 3), the integration of the elements of visual-motor system focused on the optimal realization of activity requiring visual attention under monotonic conditions is less pronounced. In addition, the most important is the cortex activation stipulated by excitation propagation via fast fibers with high number of switches at the level of nonspecific and associative thalamic nuclei and striatal complex [2,4]. There were also noted marked correlations with correction test running time and the number of mistakes. Predominance of linear relationships and exclusive role of the right sensory input together with mentioned facts are indicative for stringent determinacy of the relationship and for weak ability of the elements of formed goal-directed system to tuning and attuning. It is also confirmed by low values of the coefficient of total many-sided correlation of the correction test parameters (Fig. 1).

Thus, obtained results suggest that males possess higher ability for monotonous activity, requiring sustained visual attention, and that they maintain the temp of the task performance and consume less time

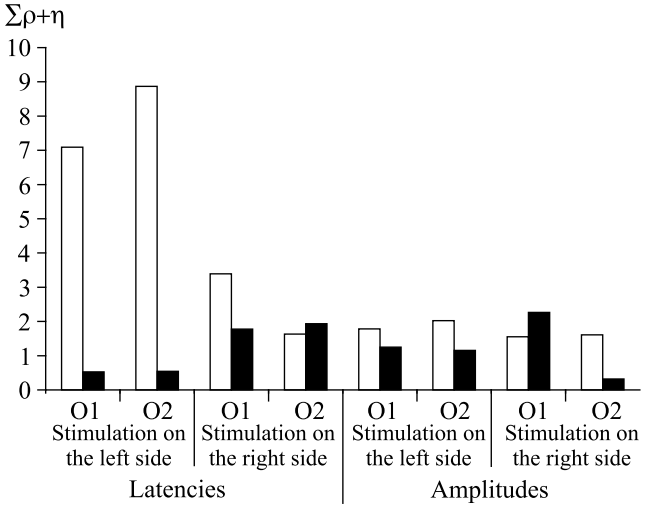

Fig. 1. Total many-sided correlation of amplitude-time characteristics of fVEP components with correction test parameters. Open bars: men, dark bars: women. Ordinate: sum of significant correlation coefficients and correlation relationships by modulus.

TABLE 2. Correlation of Landolt Test Parameters with Characteristics of fVEP Components in Men

Correlated parameters		Running time, min	Number of mistakes	Accuracy index	Temp
O1					
				0.663±0.090[1]*	
P0	latency	-	-	0.621±0.100[2]*	0.639±0.090[1]*
N1	latency	-	-	-	-
	amplitude	-	-	-	-
P1	latency	-	-	-	0.594±0.100[1]*
	amplitude	-	-	-	0.617±0.100[1]*
N2	latency	-	-	0.631±0.090[2]*	0.613±0.100[1]*
	amplitude	0.607±0.100[1]*	-	-	0.556±0.110[1]*
		0.312±0.150[2]+			
P2	latency	0.554±0.110[1]*	-	-	0.668±0.090[1]*
	amplitude	-0.214±0.170	-	0.616±0.100[2]*	
N3	latency	0.537±0.110[1]*	-	-	0.6±0.1[1]*
		-0.312±0.150[2]+			0.321±0.150[2]+
	amplitude	-	-	-	-
P3	latency	0.540±0.110[1]*	0.602±0.100[1]*	-	0.537±0.110[1]*
			0.523±0.110[2]*		0.321±0.150[2]+
	amplitude	-	0.626±0.090[2]*	-	-
N4	latency	-	0.680±0.080[2]*	-	0.542±0.110[1]*
	amplitude	-	-	-	-
O2					
P0	latency	-	-	-	-
N1	latency	-	0.664±0.090[1]*	-0.334±0.150[1]+	0.512±0.120[1]*
	amplitude	-	-	-	-
P1	latency	0.514±0.110[1]*	0.537±0.110[2]*	-0.369±0.150[1]+	0.652±0.090[1]*
	amplitude	-	-	-	-
N2	latency	0.554±0.110[1]*	-	-0.331±0.150[1]+	0.678±0.080[1]*
	amplitude	0.550±0.110[2]*	-	0.526±0.110[2]*	0.338±0.150[1]+
				0.530±0.110[2]*	
P2	latency	0.668±0.090[1]*	-	-	0.739±0.070[1]*
	amplitude	-	-	-	-
N3	latency	0.637±0.090[1]*	-	-	0.728±0.070[1]*
	amplitude	-	-	0.668±0.090[1]*	-
P3	latency	0.559±0.110[1]*	0.517±0.110[2]*	-	-0.346±0.150[1]+
	amplitude	-	-	0.627±0.090[1]*	-
N4	latency	-	0.576±0.100[2]*	-	0.601±0.100[1]*
	amplitude	-	0.392±0.150[1]+	-	-

Note. Here and in Table 3. Only significant correlation coefficients and correlations are presented. Correlation with fVEP component was noted in stimulation from [1]left and [2]right side. *Curvelinear correlation, +rectilinear correlation.

TABLE 3. Correlation of Landolt Test Parameters with Characteristics of fVEP Components in Women

Correlated parameters		Running time, min	Number of mistakes	Accuracy index	Temp
O1					
P0	latency	0.529±0.120[1]*	-0.406±0.150[2+]	-	-
N1	latency	-0.321±0.160[2+]	-0.374±0.150[2+]	-	-
	amplitude	-	-	-	-
P1	latency	-	-	-	-
	amplitude	-	-	-	-
N2	latency	-0.332±0.160[2+]	-	-	0.344±0.160[2+]
	amplitude	0.674±0.090[1]*	0.373±0.150[2+]	-	-0.358±0.160[2+]
		0.356±0.160[2+]			
P2	latency	-	-	-	-
	amplitude	-	-	-	-
N3	latency	-	-	-	-
	amplitude	-	-	0.574±0.110[1]*	-
P3	latency	-	-	-	-
	amplitude	0.539±0.120[2]*	-	0.641±0.100[2]*	-
N4	latency	-	-	-	-
	amplitude	-	-	-	-
O2					
P0	latency	0.545±0.120[1]*	-	-	-
N1	latency	-	-	-	-
	amplitude	-	-	-	-
P1	latency	-0.352±0.160[2+]	-	-	0.352±0.160[2+]
	amplitude	-	0.618±0.100[1]*	-	-
N2	latency	-0.329±0.160[2+]	-	-	0.328±0.160[2]*
	amplitude	0.321±0.160[2+]	-	-	-
P2	latency	-	-	-	-
	amplitude	-	-	-	
N3	latency	-	-	-	-
	amplitude	-	0.538±0.120[1]*	-	-
P3	latency	-	-	-	-
	amplitude	-	-	-	-
N4	latency	-	0.574±0.110[2]*	-	-
	amplitude	-	-	-	-

for it performance. That result may be attained due to more efficient tuning and attuning of the visual-motor system at the level of specific and nonspecific components of visual sensory system. Results of the study are in accordance with our previous results obtained in the study of bimanual coordination in other forms of motor activity and their sensory support [6,7,9].

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