EFFECT OF MASKING INTERFERENCE ON INTERHEMISPHERIC AND BILATERAL ASYMMETRY OF LONG-LATENCY AUDITORY EVOKED POTENTIALS

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The degree of lateralization of auditory information processing chiefly in the left or right hemisphere is known to depend on the instruction, the conditions of stimulation, training, the experimental situation, and other experimental factors [3, 4].

To study the electrical correlate of the dynamic character of hemispheric dominance the writers have investigated the effect of noise on long-latency auditory evoked potentials (LAEP) in the right and left human cerebral hemispheres. The idea of using noise as a factor determining the degree of differential auditory information processing arose from the results of electrophysiological investigations, conducted previously on cats and demonstrating reversal of the sign of interhemispheric asymmetry when noise was applied as masking interference [2].

EXPERIMENTAL METHOD

Experiments were carried out on righthanded subjects with normal hearing, aged 18-43 years. LAEP were derived from symmetrical central parasagittal areas on the left and right sides of the skull. Reference electrodes were located on the mastoid processes on the corresponding side. Summation of single LAEP was carried out on the "Gistomat-S" computer. The number of summations was 50, the epoch of analysis 512 msec, and the counting step 1 msec. LAEP were recorded in response to clicks with an intensity of 65 dB (above the normal threshold of audibility), presented with intervals of 2 sec, either alone or against the background of continuous noise in the 20-1000 Hz band, with an intensity of 70 dB. The clicks were applied through telephones. The order of stimulation was as follows: 1) isolated application of clicks to one ear (control); 2) application of clicks and noise to the same ear (ipsilateral interference); 3) application of clicks to one ear and noise to the other (contralateral interference). The same order was adhered to when the clicks were applied first to one ear, and next, to the other.

EXPERIMENTAL RESULTS

The amplitude of LAEP in the control experiments was greater on the right side of the skull than on the left (Table 1). This fact, which is evidently due to the larger number of nerve cells activated by clicks in the right hemisphere than the left, correlates with the concept of right hemispheric dominance in the analysis of nonverbal information. In both the right and the left hemispheres LAEP had higher amplitude when clicks were applied to the corresponding contralateral ear than to the ipsilateral, due to the greater capacity of the contralateral auditory pathway than of the ipsilateral. Differences between LAEP recorded under similar conditions of stimulation from the right and left hemispheres, like differences between LAEP recorded in each hemisphere in response to stimulation of the corresponding contralateral and ipsilateral ear, i.e., interhemispheric and bi-

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TABLE 1. Amplitude (in μV) of P_1N_1 and N_1P_2 and SL of Waves (in msec) P_1, N_1, and P_2 of LAEP in Right and Left Hemispheres in Response to Stimulation of Corresponding Ipsilateral (I) and Contralateral (II) Ear by Clicks without (1) and with the Combined Action of Noise in the Same (2) and Opposite Ear (3)

Parameter	Procedure	LAEP of right hemisphere		LAEP of left hemisphere	
		I	II	I	II
P_1N_1	1	6,8±0,6 (0)	8,3±0,6 (0)	5,2±0,5 (0)	6,9±0,5 (0)
	2	3,4±0,4 (—50)	3,6±0,4 (—57)	2,9±0,4 (—44)	3,2±0,4 (—54)
	3	6,1±0,6 (—10)	7,3±0,7 (—12)	5,5±0,6 (+6)	6,6±0,5 (—4)
N_1P_2	1	11,2±0,9 (0)	13,1±1,1 (0)	10,2±0,9 (0)	11,4±0,9 (0)
	2	5,2±0,5 (—53)	5,6±0,6 (—57)	4,9±0,5 (—52)	5,0±0,5 (—56)
	3	10,6±0,9 (—5)	12,6±1,0 (—4)	10,1±0,9 (—1)	11,8±0,9 (+3)
P_1	1	40,8±2,0 (0)	37,0±1,4 (0)	42,2±2,2 (0)	39,2±1,6 (0)
	2	64,1±3,4 (+23)	65,0±3,9 (+28)	64,0±3,9 (+22)	62,0±3,7 (+23)
	3	44,2±2,6 (+3)	36,6±1,4 (0)	40,3±1,9 (—2)	41,6±2,1 (+23)
N_1	1	91,4±1,9 (0)	87,1±1,7 (0)	89,2±2,9 (0)	89,4±2,5 (0)
	2	113,2±3,9 (+22)	107,8±4,3 (+21)	113,1±4,9 (+24)	113,1±4,2 (+24)
	3	91,3±2,3 (0)	89,4±2,0 (+2)	92,7±2,1 (3)	89,6±3,1 (0)
P_2	1	175,1±4,8 (0)	176,7±4,6 (0)	174,7±6,9 (0)	175,9±4,4 (0)
	2	187,6±5,1 (+12)*	191,1±5,5 (+14)**	197,6±4,9 (+23)**	192,1±5,7 (+16)**
	3	173,7±4,3 (—1)	176,1±4,2 (—1)	172,5±4,5 (—2)	175,3±5,1 (—1)

Legend. Changes in amplitude, in %, and in SL (in msec) during exposure to noise compared with control, taken as 0, shown in parentheses. Values in row 2 (except those marked by an asterisk) differ from corresponding values in row 1 at the $P < 0.001$ level of significance. *$0.05 < P < 0.1$, **$P < 0.05$, ***$P < 0.02$ (Student's t test). Values in row 3 do not differ statistically significantly from the corresponding values in row 1.

lateral asymmetry of LAEP [1], were rather more marked in relation to the amplitude of P_1N_1 than the amplitude of N_1P_2 (Fig. 1). Interhemispheric asymmetry of spike latencies (SL) was less regular (Table 1). A tendency was observed for SL of the early components of LAEP to be shorter in the right hemisphere. In both hemispheres SL of the early components of LAEP were shorter in response to stimulation of the corresponding contralateral ear than to stimulation of the ipsilateral ear; the differences were rather greater in the right hemisphere than in the left.

Ipsilateral masking interference caused a marked decrease in both amplitude parameters of LAEP (Table 1). The decrease is evidence of a decrease in the number of neurons responding to clicks as a result of their involvement in the response to noise. Noise had a greater effect on the amplitude of LAEP in the right hemisphere than in the left. In both hemispheres the effects of noise were greater when the contralateral ear was stimulated than when the ipsilateral ear was stimulated. Selectivity of the effects of ipsilateral masking interference determined a marked reduction in the values of the parameters of both interhemispheric and bilateral asymmetry of the amplitude of LAEP (Fig. 1). Selectivity of the effects in turn must be considered to be the result of activation of a larger number of neurons by both types of stimuli in the right and contralateral hemisphere than in the left and ipsilateral hemisphere.

Weakening of interhemispheric and bilateral asymmetry under the influence of ipsilateral masking noise also is indicated by the results of analysis of the amplitude of LAEP by Wilcoxon's paired t test. Both parameters of the amplitude of LAEP (P_1N_1 and N_1P_2) were statistically significantly greater in the right hemisphere than in the left, during stimulation both of the corresponding ipsilateral ($P < 0.001$ and < 0.005) and contralateral ($P < 0.001$ and < 0.05) ear. Differences between LAEP recorded in response to stimulation of the corresponding contralateral and ipsilateral ear in both the right and the left hemisphere, also were statistically significant (for both amplitude parameters $P < 0.001$). Under the influence of ipsilateral masking interference both the interhemispheric and the bilateral differences in the amplitudes of LAEP ceased to be statistically significant.

Besides the fall in amplitude of LAEP, ipsilateral masking interference caused an increase in their SL (Table 1), which must be attributable to weakening of summation processes due to loss of the response of many neurons to clicks. The increase in SL of the early components was greater than that of the late components. Meanwhile parameters of the change in SL, unlike those of amplitude, were about equal in both hemispheres, and in response to stimulation of both the ipsilateral and the contralateral ear.

Contralateral masking interference did not cause a statistically significant decrease in the amplitude of LAEP (Table 1), evidence of activation of different groups of neurons by clicks and by noise. Individual analysis

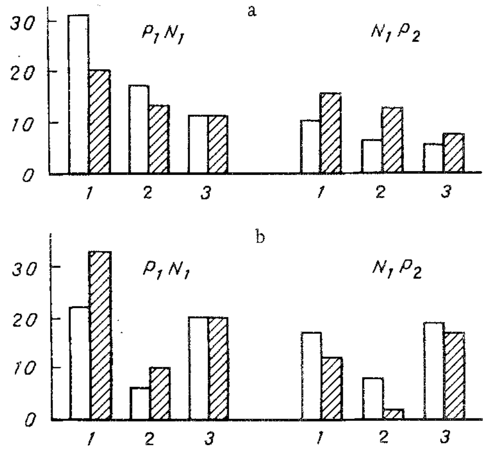

Fig. 1. Interhemispheric (a) and bilateral (b) asymmetry of amplitude of LAEP recorded in response to monaurally presented clicks without the addition of noise (1) and with the combined action of continuous noise on the same (2) and opposite (3) ear. a) Amplitude of LAEP recorded from right hemisphere during stimulation of corresponding ipsilateral and contralateral (right and left) ear – unshaded and shaded columns respectively (in % of amplitude of LAEP recorded from left hemisphere during stimulation of corresponding ipsilateral and contralateral left and right ear – 0); b) amplitude of LAEP recorded from right and left hemispheres (shaded and unshaded columns respectively) in response to stimulation of corresponding contralateral (left and right) ear (in % relative to amplitude of LAEP recorded from right and left hemisphere during stimulation of corresponding ipsilateral right and left ear – 0).

of the results, moreover, shows an increase in one or other parameter of amplitude of LAEP in 24 or 30 investigations, which is not apparent during analysis of the mean data because of the considerable intra- and interindividual scatter. The facilitating action of contralateral interference is evidently due to activation by the clicks, under these circumstances, of an additional number of neurons, brought up to a state of subthreshold excitability by noise. The role of a general increase in cortical reactivity due to activation of the nonspecific system of the brain likewise cannot be ruled out. An increase in the amplitude of LAEP, incidentally, was observed as a rule in the left hemisphere. In the right hemisphere contralateral interference most frequently led to a small decline. As a result the degree of interhemispheric asymmetry of the amplitude of LAEP was considerably reduced. In this connection it must be noted that during the action of contralateral interference, just as of ipsilateral, differences between the right and left hemispheres in the amplitude of LAEP, which were statistically significant in the control tests, were now not significant. Meanwhile contralateral interference, unlike ipsilateral, had no significant effect on bilateral asymmetry of amplitude of LAEP. The absence of effect was shown by the fact that under these circumstances differences in the value of the amplitude of P_1N_1 and N_1P_2 remained statistically significant between LAEP recorded during stimulation of the corresponding contralateral and ipsilateral ear, in both the right ($P < 0.02$ and < 0.001) and in the left ($P < 0.005$ and < 0.001) hemisphere. Contralateral interference had no effect on SL of LAEP. Correspondingly, it had virtually no effect on their bilateral asymmetry.

To judge from the amplitude parameters of LAEP, masking interference thus reduces the degree of right hemispheric dominance in the analysis of nonverbal auditory information. The decrease is observed in both monotic and dichotic presentation of stimuli and interference. Under conditions of monotic stimulation interference also reduces the degree of lateralization of monaurally presented information mainly in the contralateral hemisphere.

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