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SEXUAL DIMORPHISM OF THE INTERHEMISPHERIC ASYMMETRY DYNAMICS DURING THE PROCESSING OF THE TRANSCALLOSAL SIGNAL

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The characteristics of the dynamics of the functional interhemispheric asymmetry (FIAs) of the transcallosal influences in male and female rats were compared in this study through an analysis of the amplitude-temporal parameters of the homotopic transcallosal responses (TCR) in the course of their multiple topographical pickup from the dorsolateral surface of the cortex of both hemispheres in the time interval of the realization of the components of the responses. Two principal types of patterns of hemispheric dominance have been distinguished. The first type was described in accordance with the rule of the right–left–right shift of FIAs; the second type was described in accordance with the rule of its left–right–left shift. The changes in the FIAs of the temporal parameters of the positive components and the amplitude parameters of the positive and negative fluctuations were characterized by the identical type of dynamics in rats of both sexes. The dynamics of the FIAs of the temporal parameters of the negative components unfolded in accordance with the first type in the females, but in accordance with the second type in the males. The dominance of the investigated zones of the cortex of the right hemisphere was expressed more markedly in the females at the initial and terminal stages of the processing of transcallosal information. The phases of the dominance of the left hemisphere, by contrast, were identified and detected in a relatively larger territory of the neocortex examined in the males by comparison with the females. The results obtained suggest the relatively greater participation of the cortex of the right hemisphere in the females, but of the left hemisphere in the males during the processing of a transcallosal signal.

The investigation of the paired brain in man and animals, taking account of sexual dimorphism, is acknowledged at the present time to be one of the most promising avenues for the study of this problem [1, 2, 5, 7, 13]. The analysis of the sex differences of the functional interhemispheric asymmetry (FIAs) in animal models is an important approach along these lines. We have previously studied the dynamic properties of the FIAs of the transcallosal influences on the basis of the amplitude-temporal parameters of the transcallosal responses (TCR) in the neocortex of rats without their differentiation with respect to sex [4]. It was demonstrated that the time sequence of hemispheric dominance during the processing of transcallosal information is a triad of phases, and is realized in accordance with the rule of the right–left–right shift. Further, at first, the right hemisphere carries out relatively diffuse processing of information, utilizing the majority of the sensory areas of the cortex. Then, the left hemisphere, functioning more diffusely, carries out processing of information primarily through areas of the cortex with predominantly associative functions. After this, the relatively diffusely functioning right hemisphere again enters the picture. It is hypothesized that the mechanism of the physiological dominant underlies the described dynamics of the FIAs [2, 4]. Along with this, considering the presence of sex differences in rats in the ultrastructure of the corpus callosum [6, 10], it seems important to investigate the specifics of the dynamics of the FIAs of the transcallosal influences differentially with respect to the sex of the experimental animals. Hence, the objective of the present study consisted in a comparison of the characteristics of the temporal dynamics of the interhemispheric asymmetry of the transcallosal influences in various regions of the neocortex in male and female rats. The methods of multiple topographical recording of homotopic TCR from the dorsolateral surface of the cortex of both hemispheres in white Wistar rats were used.

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METHODS

The experiments were carried out in 17 male and 18 female sexually mature Wistar rats, weighing 200-250 g. A mixture of 30 mg/kg chloralose and 15-20 mg/kg nembutal (intraperitoneally) was used as the anesthetic. A concentric platinum electrode with a diameter of the internal core of 0.3 mm and an external ring of 1 mm was used for the stimulation of the cortex; this created the conditions for the activation of a transverse cylinder of cortex with a diameter of about 1 mm^2 [sic]. The stimulation was carried out using rectangular pulses of current, 0.3 msec in duration, at a frequency of 1 imp/sec, and with an intensity of 2-3 times the threshold of occurrence of homotopic transcallosal potentials in the focus of maximum activity of the area under investigation. The monopolar pickup of the TCR was accomplished by means of two platinum needle electrodes with a tip diameter of 30 μM [sic], located at a distance of 0.5 mm from one another homotopically to the stimulation site. The indifferent electrodes were placed in the neck muscles. The TCR were recorded under the conditions of the symmetrical placement of the stimulating and pickup electrodes, which were shifted stereotaxically with an interval of 1 mm in the mediolateral and rostrocaudal directions within the limits of the visual area (fields Oc1M, Oc1B, Oc2L), and the parietal (fields Par1, Par2, HL, FL), auditory (fields Te1, Te, Te3), and motor (fields Fr2, Fr1) regions of the cortex, the boundaries of which were determined in accordance with the coordinates of the stereotaxic atlas of the neocortex of the rat [16]. As a result, the TCR were picked in each animal from 36 points of the visual area, and 48 points of the parietal, 30 points of the auditory, and 22 points of the motor regions. Sixteen individual realizations of the TCR were summed at each pickup point on a "Biokod-Neiron-1" analyzer. The alternation of the stimulation and TCR pickup from the left and right hemispheres were changed to the opposite from experiment to experiment.

The FIAs of the amplitude-temporal parameters of the TCR were studied separately in the group of males and females. The interhemispheric differences were assessed on the basis of the latent periods (LP) of the first component (interval 0), as well as on the basis of the LP and the amplitude of the development up to the maximum of the positive and negative components in four time intervals (msec): 7-14 (I), 17-27 (II), 31-46 (III), and 53-92 (IV). The parameters of the TCR in the samples of males and females were analyzed statistically using the Wilcoxon-Mann-Whitney and Student tests at $p < 0.05$ on an IBM PC XT. The hemisphere in which the amplitude parameters were significantly greater in magnitude, while the temporal parameters, to the contrary, were smaller, was considered the dominant hemisphere. The value of the FIAs was calculated from the formula: $K_{as} = F(\Sigma(A - B)/\Sigma(A + B))$, where K_{as} is the coefficient of asymmetry of the cortical area in question; A is the parameter of the point of the right hemisphere under investigation; B is the parameter of the symmetrical point of the left hemisphere; Σ is the sum of the points examined. Positive values of K_{as} correspond to the dominance of the investigated region of the right hemisphere, while negative values of K_{as} correspond to the dominance of the corresponding area of the left hemisphere.

INVESTIGATION RESULTS

The changes in the magnitude and direction of the FIAs of the temporal parameters of the components of the TCR picked up from the cortical regions in rats of the two sexes in Fig. 1.

In relation to the temporal parameters of the positive components of the TCR, the FIAs dynamics over the entire pickup territory were collectively realized in accordance with the rule of the right–left–right shift (pattern of the first type) in rats of both sexes (Fig. 1A, B). At the same time, the right hemispheric asymmetry (positive K_{as} values) in the 0-I intervals changed its sign to left hemispheric asymmetry (negative K_{as} values) in the II-III intervals, and then became right hemispheric again in interval IV. As follows from Table 1, the average values of the temporal parameters of the positive components over the entire area of the right hemispheric cortical zones investigated were smaller than of the left hemispheric, in the males in intervals 0, I, and IV, and in the females in intervals 0 and IV. The reverse ratio of the values of these parameters of the responses in both hemispheres was observed in the males in interval III (Table 1).

The regional specificity of this type of FIAs pattern in the rats of the two sexes consisted in the following (Fig. 1A, B; Table 1). The right hemispheric asymmetry in interval 0 appeared in the males due primarily to the visual and motor areas of the cortex; in the females, this was due primarily to the visual and parietal areas. In interval I, right-sided FIAs was found in the males in the parietal, motor, and auditory areas, whereas in the females, this was so only in the last. In interval II, right hemispheric asymmetry took place in the visual and parietal areas of the males, but in the motor cortex of the females. Counterphasic left-sided FIAs was observed simultaneously in the auditory cortex of the males, but in the visual area

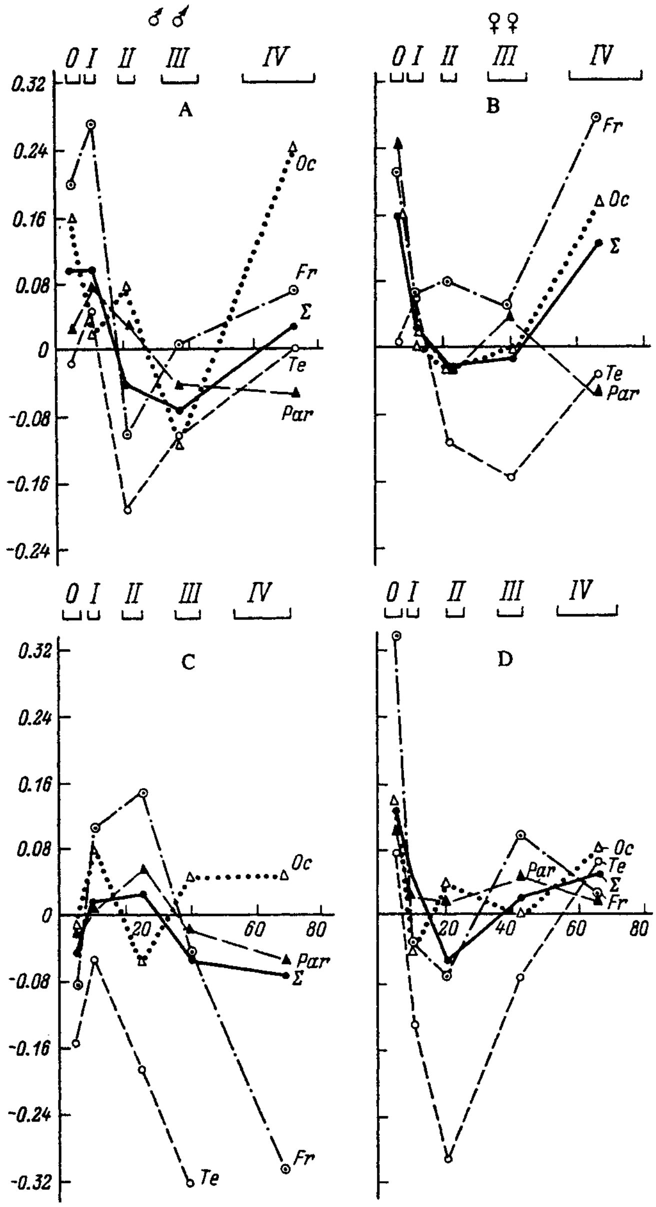

Fig. 1. Dynamics of the interhemispheric asymmetry of the temporal parameters of the positive (A, B) and negative (C, D) components of the transcallosal responses in various regions of the cortex in male (A, C) and female (B, D) rats. Along the abscissa) time from the moment of application of the stimulus, msec; along the ordinate) magnitude of interhemispheric asymmetry (K_{as}). Positive values of K_{as}) right hemispheric asymmetry; negative values) left hemispheric. Segments parallel to the abscissa) time intervals (msec) corresponding to the latent period of the first component (0), to the development up to the maximum of the first (I), second (II), third (III), and fourth (IV) components. Oc) asymmetry of the visual region; Par) of the parietal; Te) of the auditory; Fr) of the motor; and Σ) of the total territory of the pickup.

of the females. In interval III, left-sided FIAs was identified in the males over the entire pickup area, whereas in the females, in the auditory cortex alone. And finally, in interval IV, the dominance of the right hemisphere was established in rats of both sexes in a larger territory of the neocortex examined.

TABLE 1. Temporal Parameters of the Positive Components of the Homotopic Transcallosal Responses in the Cortex of the Right and Left Hemispheres in Rats of Different Sexes

Pickup region	Sex	Hemisphere of pickup	Latent period, msec				
			of the response	of the maximum of the components			
				I	II	III	IV
Visual	Males	Right	4.5 ± 0.2	10.5 ± 0.4	21.7 ± 0.7	42.5 ± 1.3	67.1 ± 3.0
		Left	6.3 ± 0.4**	11.3 ± 0.4	23.6 ± 0.8**	38.9 ± 1.1*	73.1 ± 3.1*
	Females	Right	4.7 ± 0.5	11.1 ± 0.5	22.1 ± 0.5	39.7 ± 1.9	64.8 ± 2.8
		Left	6.5 ± 0.5**	11.4 ± 0.5	21.2 ± 0.6	39.5 ± 1.8	75.3 ± 1.0*
Parietal	Males	Right	5.6 ± 0.3	11.6 ± 0.6	21.5 ± 0.7	37.9 ± 0.8	72.7 ± 1.6
		Left	5.0 ± 0.3	12.1 ± 0.4*	22.5 ± 0.6*	36.6 ± 0.8	77.1 ± 3.0
	Females	Right	4.3 ± 0.2	10.5 ± 0.4	22.9 ± 0.5	39.8 ± 1.1	65.8 ± 2.8
		Left	6.7 ± 0.6**	10.8 ± 0.5	22.6 ± 0.6	42.2 ± 1.1**	64.8 ± 3.7
Auditory	Males	Right	5.1 ± 0.8	10.7 ± 1.0	22.1 ± 1.1	36.7 ± 1.6	—
		Left	5.0 ± 0.0	13.9 ± 1.3*	20.4 ± 1.2*	38.8 ± 1.8	—
	Females	Right	5.9 ± 0.5	10.8 ± 0.5	22.0 ± 1.2	38.8 ± 2.4	60.5 ± 1.5
		Left	6.9 ± 0.8	11.2 ± 0.7*	21.4 ± 0.6	33.4 ± 1.4*	58.0 ± 1.1*
Motor	Males	Right	3.9 ± 0.3	9.9 ± 0.6	19.5 ± 0.6	36.2 ± 1.3	74.6 ± 2.5
		Left	5.3 ± 0.6*	12.5 ± 0.5**	19.7 ± 0.6	36.6 ± 1.0	81.7 ± 8.1
	Females	Right	5.8 ± 0.9	11.7 ± 0.8	21.7 ± 0.8	45.4 ± 3.1	61.4 ± 2.4
		Left	8.3 ± 1.2	11.6 ± 0.6	24.4 ± 0.8*	41.5 ± 2.5	—
Total of areas	Males	Right	4.8 ± 0.2	10.7 ± 0.3	21.2 ± 0.4	39.2 ± 0.6	71.7 ± 1.3
		Left	5.4 ± 0.2*	12.0 ± 0.2*	22.3 ± 0.4	37.7 ± 0.6*	76.4 ± 2.2*
	Females	Right	5.1 ± 0.2	11.0 ± 0.2	21.9 ± 0.3	39.9 ± 0.8	63.1 ± 1.2
		Left	7.0 ± 0.3**	11.3 ± 0.2	22.2 ± 0.3	40.6 ± 0.8	69.2 ± 5.3*

Note (here and in Tables 2-4): Significance of difference of means at the $^*p < 0.05$; $^{**}p < 0.001$ level.

TABLE 2. Temporal Parameters of the Negative Components of the Homotopic Transcallosal Responses in the Cortex of the Right and Left Hemispheres in Rats of Different Sexes

Pickup region	Sex	Hemisphere of pickup	Latent period, msec				
			of the response	of the maximum of the components			
				I	II	III	IV
Visual	Males	Right	4.9 ± 0.4	10.1 ± 0.5	24.8 ± 0.7	39.5 ± 1.2	71.0 ± 1.8
		Left	4.6 ± 0.3	11.2 ± 0.4*	23.9 ± 0.9	42.2 ± 1.2*	74.9 ± 2.2
	Females	Right	5.2 ± 0.5	11.9 ± 0.4	21.2 ± 0.5	44.4 ± 1.3	62.7 ± 1.4
		Left	6.9 ± 0.6*	10.7 ± 0.4	22.4 ± 0.5*	44.2 ± 1.3	64.7 ± 2.5*
Parietal	Males	Right	4.2 ± 0.3	9.1 ± 0.3	25.4 ± 0.7	41.4 ± 1.4	71.8 ± 1.9
		Left	4.3 ± 0.3	9.5 ± 0.2*	26.7 ± 0.7	42.2 ± 1.3	68.7 ± 1.3
	Females	Right	3.8 ± 0.2	11.6 ± 0.4	21.3 ± 0.5	41.4 ± 1.0	71.5 ± 2.3
		Left	4.8 ± 0.2**	12.4 ± 0.3*	20.1 ± 0.5	44.5 ± 1.0*	71.7 ± 1.8
Auditory	Males	Right	3.3 ± 0.2	9.5 ± 0.3	25.5 ± 2.3	38.4 ± 1.5	59.9 ± 0.1
		Left	2.3 ± 0.1*	8.3 ± 0.2	21.2 ± 2.3	37.2 ± 2.0*	
	Females	Right	4.4 ± 0.4	12.0 ± 0.3	22.7 ± 0.8	40.3 ± 1.5	54.6 ± 1.2
		Left	5.5 ± 0.4*	11.6 ± 0.4*	20.7 ± 1.2*	39.4 ± 1.3*	61.7 ± 4.7
Motor	Males	Right	5.1 ± 0.6	8.6 ± 0.6	25.2 ± 1.0	39.5 ± 1.8	72.0 ± 1.2
		Left	4.3 ± 0.6	9.7 ± 0.4*	26.8 ± 1.1*	36.5 ± 0.7	67.1 ± 1.6*
	Females	Right	3.8 ± 0.3	10.8 ± 0.7	22.4 ± 0.8	41.1 ± 1.2	65.0 ± 2.7
		Left	7.9 ± 1.1**	11.3 ± 0.6	20.2 ± 0.8	45.6 ± 1.3**	76.7 ± 2.1*
Total of areas	Males	Right	4.2 ± 0.2	9.3 ± 0.2	25.1 ± 0.4	40.0 ± 0.7	71.3 ± 1.0
		Left	4.0 ± 0.1	9.7 ± 0.1	25.4 ± 0.5	40.8 ± 0.7	70.7 ± 1.1*
	Females	Right	4.3 ± 0.1	11.3 ± 0.2	21.5 ± 0.3	41.3 ± 0.6	65.4 ± 1.2
		Left	5.9 ± 0.2**	11.5 ± 0.2	20.5 ± 0.2	43.1 ± 0.6	69.1 ± 1.2*

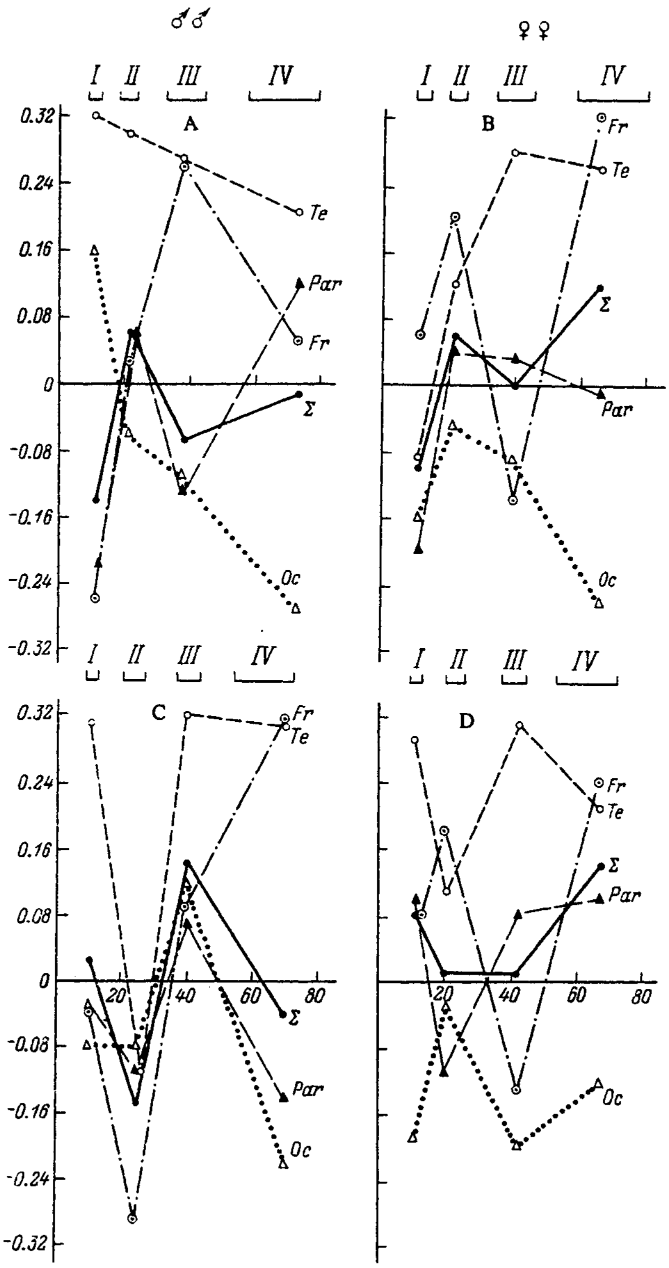

Fig. 2. Dynamics of the interhemispheric asymmetry of the amplitude parameters of the positive (A, B) and negative (C, D) components of the transcallosal responses in various regions of the cortex in male (A, C) and female (B, D) rats. Remaining designations as in Fig. 1.

In relation to the negative components of the TCR, the FIAs dynamics over the entire pickup area were collectively characterized in rats of the two sexes by roughly mirror patterns of hemispheric dominance (Fig. 1C, D). Thus, it conformed to the right–left–right shift rule in the females (the first type of pattern). At the same time, the asymmetry was right hemispheric in the 0, I, and III-IV intervals, but left hemispheric in interval II. By contrast with the females, in the males the FIAs changes were realized in accordance with the left–right–left shift rule (pattern of the second type), such that it was left-sided in the 0 and III-IV intervals, and right-sided in intervals I and II. As is shown in Table 2, the average values of the temporal parameters of the negative components over the entire pickup territory were smaller in the right hemisphere than in

TABLE 3. Amplitude Parameters of the Positive Components of the Homotopic Transcallosal Responses in the Cortex of the Right and Left Hemispheres in Rats of Different Sexes

Pickup region	Sex	Hemisphere of pickup	Amplitude μV of the maximum of the components			
			I	II	III	IV
Visual	Males	Right	47 ± 5.8	89 ± 8.7	54 ± 7.7	31 ± 12.4
		Left	35 ± 4.6*	93 ± 14.2	79 ± 13.0	36 ± 5.0
	Females	Right	42 ± 4.9	74 ± 7.6	72 ± 10.9	40 ± 4.5
		Left	59 ± 8.5*	82 ± 6.8	86 ± 13.7*	56 ± 7.4*
Parietal	Males	Right	51 ± 5.7	84 ± 6.9	61 ± 9.3	39 ± 4.5
		Left	71 ± 7.7*	80 ± 8.9	87 ± 13.3	36 ± 7.3
	Females	Right	34 ± 4.1	94 ± 7.2	57 ± 6.3	35 ± 4.5
		Left	49 ± 6.2*	89 ± 7.6	53 ± 5.0	39 ± 7.5
Auditory	Males	Right	47 ± 13.3	64 ± 14.2	44 ± 10.1	
		Left	29 ± 5.3	46 ± 12.2	34 ± 10.4	
	Females	Right	29 ± 3.9	64 ± 5.9	43 ± 6.2	52 ± 6.2
		Left	40 ± 6.0	60 ± 9.5	27 ± 5.8*	39 ± 3.5*
Motor	Males	Right	46 ± 10.4	132 ± 19.2	70 ± 12.7	34 ± 7.2
		Left	63 ± 9.0	156 ± 23.5	40 ± 7.2*	38 ± 8.9
	Females	Right	68 ± 8.4	97 ± 12.5	67 ± 9.1	33 ± 7.1
		Left	54 ± 6.7	62 ± 7.7*	73 ± 15.6	
Total of areas	Males	Right	48 ± 3.5	89 ± 5.4	58 ± 5.0	35 ± 4.0
		Left	55 ± 4.1	89 ± 7.3	72 ± 7.4	36 ± 3.9
	Females	Right	42 ± 2.9	81 ± 3.8	57 ± 4.1	42 ± 3.0
		Left	51 ± 3.5	75 ± 4.0*	59 ± 4.9	47 ± 4.9

TABLE 4. Amplitude Parameters of the Negative Components of the Homotopic Transcallosal Responses in the Cortex of the Right and Left Hemispheres in Rats of Different Sexes

Pickup region	Sex	Hemisphere of pickup	Amplitude μV of the maximum of the components			
			I	II	III	IV
Visual	Males	Right	58 ± 5.2	43 ± 5.5	66 ± 8.0	48 ± 5.0
		Left	64 ± 7.5	54 ± 6.3	51 ± 5.4	75 ± 9.0*
	Females	Right	39 ± 4.8	55 ± 6.1	48 ± 6.1	11 ± 9.2
		Left	56 ± 4.1*	56 ± 6.9	72 ± 6.6*	75 ± 9.6*
Parietal	Males	Right	45 ± 4.3	35 ± 5.1	68 ± 7.0	41 ± 4.0
		Left	51 ± 4.9	42 ± 5.2	61 ± 5.6	58 ± 6.1
	Females	Right	63 ± 5.1	52 ± 5.9	66 ± 7.0	68 ± 5.5
		Left	52 ± 3.3*	59 ± 5.2	54 ± 5.2	53 ± 4.5
Auditory	Males	Right	60 ± 8.3	26 ± 3.3	57 ± 9.2	87 ± 12.1
		Left	30 ± 3.2**	40 ± 16.3	38 ± 13.2**	
	Females	Right	61 ± 6.0	32 ± 5.1	45 ± 11.2	52 ± 7.3
		Left	43 ± 5.3**	47 ± 7.8	26 ± 3.4**	44 ± 9.5
Motor	Males	Right	63 ± 8.2	34 ± 4.8	103 ± 13.8	69 ± 7.6
		Left	61 ± 8.4	48 ± 13.8	86 ± 10.7	57 ± 10.5**
	Females	Right	46 ± 6.0	70 ± 10.8	65 ± 8.2	93 ± 6.7
		Left	43 ± 8.3	57 ± 12.5	75 ± 10.5*	64 ± 6.4**
Total of areas	Males	Right	55 ± 2.9	38 ± 3.0	72 ± 4.6	51 ± 3.1
		Left	52 ± 3.2	49 ± 4.4*	61 ± 3.7**	63 ± 4.6
	Females	Right	53 ± 2.6	52 ± 3.4	55 ± 3.2	81 ± 4.1
		Left	50 ± 2.2*	56 ± 3.6	54 ± 3.2	59 ± 3.7**

the left in the females in intervals 0 and III, IV, whereas in the males, the corresponding values in the left hemisphere proved to be shorter than the right in interval IV.

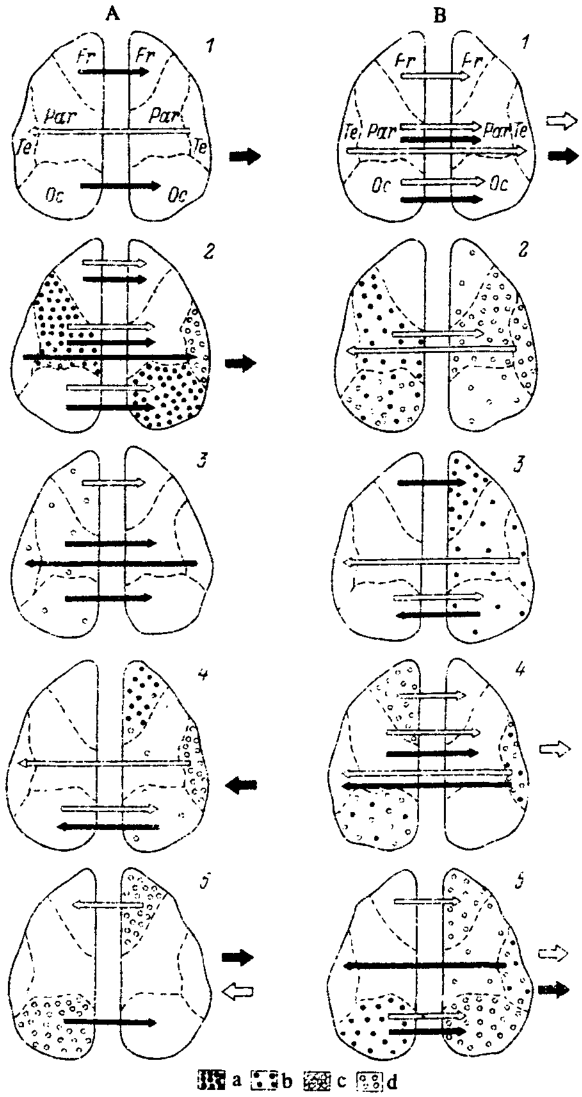

Fig. 3. Comparative characteristics of the dynamics of the interhemispheric asymmetry of the transcallosal influences in various regions of the cortex of both hemispheres in male (A) and female (B) rats. In the diagram, on the left) the left hemisphere; on the right) the right hemisphere. Boundaries of areas indicated by broken line. Oc) visual area; Par) parietal area; Te) auditory area; Fr) motor area. Phases of the dominance of the hemispheres: 1) Based on the latent period of the first component; 2) based on the amplitude-temporal parameters of the peak of the first component; 3) of the second component; 4) of the third component; 5) of the fourth component. Thin arrows) interhemispheric asymmetry of the temporal parameters of the area under investigation; thick arrows) of the total territory of the pickup. Arrows to the right) right hemispheric asymmetry; to the left) left hemispheric asymmetry; black arrows) positive components; white arrows) negative components. Dominance of a hemisphere based on the amplitude parameters of the positive components in the area under investigation (a) and on the total territory of the pickup (b); of the negative components in the area under investigation (c) and on the total territory of the pickup (d).

The zonal features of the FIAs dynamics in rats of the two sexes were manifested in the following manner (Fig. 1C, D; Table 2). The dominance of the right hemisphere in interval 0 was determined in the females by the participation of all the regions of the neocortex investigated, whereas in the males in the auditory cortex the left hemisphere was dominant. In interval I, right-sided FIAs took place in the males in the parietal, visual, and auditory areas, while in the females, only in the first of these. At the same time, left-sided FIAs was observed in the auditory cortex in the females. In interval II, the auditory area of the cortex of the females played the main role in the appearance of left hemispheric asymmetry. The presence of right hemispheric asymmetry was determined by the motor area of the cortex of the males, but by the visual region of the females. In interval III, left-sided FIAs was recorded in animals of both sexes in the auditory cortex, whereas right hemispheric asymmetry was observed in the parietal and visual cortex of the females and in the visual cortex of the males. In interval IV, the asymmetry on a larger area of the investigated cortical regions exhibited a counterphasic direction: it was right hemispheric in the females and left hemispheric in the males.

The dynamics of the FIAs of the amplitude parameters of the components of the homotopic TCR in the male and females rats are shown in Fig. 2. The changes in the magnitude and direction of the asymmetry in relation to the positive components of the TCR over the entire territory of pickup collectively in individuals of both sexes were characterized by variance dynamics of the second type (Fig. 2A, B). At the same time, the pattern of hemispheric dominance was similar in the individuals of male and female sex in intervals I-II, but differed in intervals III and IV. Comparison of the means of the amplitude of the positive components when they are picked up from the entire area of the neocortex examined made it possible to identify interhemispheric differences only in the females in interval II (Table 3).

The zonal features of the dynamics of the FIAs in relation to the amplitude of the positive components of the responses consisted in the following (Fig. 2A, B; Table 3). The left-sided FIAs in interval I occurred in the parietal and visual cortex of the females, but only in the parietal cortex of the males. At the same time, right-sided asymmetry was observed in the visual cortex of the males. Right-sided FIAs was more strongly pronounced in the females by comparison with the males in interval II in a greater territory of the investigated regions of the neocortex. The dominance of the left hemisphere in interval III was determined in the males by the parietal and visual zones, while in the females, it was determined by the visual and motor regions of the cortex. At the same time, right-sided asymmetry was created in the males with the participation of the auditory and motor cortex; in the females, by the auditory alone. And, finally, the left-sided FIAs in rats of both sexes in interval IV was observed in the visual cortex, while right-sided FIAs was observed in the auditory and motor zones.

The dynamics of the FIAs of the amplitude of the negative components of the TCR in rats of the two sexes are shown in Fig. 2C, D. Judging by the K_{as}, the changes in the direction of the asymmetry over the entire territory of pickup were collectively characterized by variance dynamics of the first type. Thus, in interval I, the FIAs in rats of both sexes was right-sided; it then attenuated in the females in intervals II and III, but increased again in interval IV (Fig. 2D). Along with this, in each time interval following interval I in the males, the FIAs altered its direction to the opposite (Fig. 2C). The interhemispheric differences of the means of the amplitude of the negative components over the entire pickup area occurred in intervals I and IV in the females, but in intervals II-III in the males (Table 4). At the same time, the regional specificity of the dynamics of the FIAs in relation to the amplitude of the negative components in rats of the two sexes was manifested in the following way (Fig. 2C, D; Table 4). Dominance of the right hemisphere in interval I was detected in the females on a greater area of all the regions of the cortex investigated, whereas it was mainly determined by the auditory cortex in the males. The left-sided FIAs in interval II was found in the males on a greater territory of pickup, while it was weakly expressed in the females. The FIAs in interval III became right-sided in the males over the entire territory of the examined neocortex collectively. Along with this, right-sided asymmetry was recorded in the females in the auditory cortex, while counterphasic left hemispheric asymmetry was recorded in the motor and visual cortex. And finally, dominance of the right hemisphere in interval IV occurred in the females over the entire territory of pickup, with maximal participation of the visual and motor cortex, whereas it was determined primarily by the motor zone of the cortex in the males. At the same time, counterphasic left hemispheric asymmetry was recorded in the visual cortex in male individuals.

DISCUSSION OF RESULTS

The results of the analysis of the dynamics of the FIAs of the transcallosal influences on the basis of the amplitude-temporal parameters of the components of the homotopic TCR in various regions of the neocortex in rats differentiated on the basis of sex are presented in the diagrams (Fig. 3).

To introduce the discussion of the results obtained, let us cite the principal information relating to the genesis of the response recorded. The components of the TCR picked up from the surface of the cortex have, as we know, an independant origin as a result of the arrival of the transcallosal influences along various systems of callosal fibers terminating in various layers of the cortex [1-4, 9, 12, 15]. At the same time, the negative components are regarded as the development of primarily activating (excitatory) influences in the surface layers of the cortex [9, 12, 15]. The positive components, on the other hand, reflect the development mainly of depressive (inhibitory) influences at the surface of the cortex and/or excitatory influences in the deep layers [9, 11, 12, 14, 15]. It is held that the temporal parameters of the components of the TCR correlate with the conduction speed along the fibers of the corpus callosum, while their amplitude correlates with the completeness or effectiveness of the callosal efferents in the given segment of the cortex [2-4, 9, 12, 14, 15]. The presence of FIAs of the temporal parameters of both components of the responses is explained by interhemispheric differences in the speed of their conduction [2, 3]. The FIAs of the amplitude parameters of the positive and negative components of the TCR demonstrates the predominance respectively of the activating for [sic] depressive influences of one of the hemispheres [2, 3].

Taking the above into account, let us compare the temporal dynamics of the FIAs of the homotopic transcallosal influences in rats of the two sexes.

Judging by the LP of the first positive and negative components, the transcallosal influences arrive at the majority of the right hemisphere points examined earlier in the female rats (Fig. 3B, 1). In the males, on the other hand, right-sided FIAs occurred only in relation to the positive oscillations, whereas counterphasic left-sided FIAs was recorded in relation to the negative components in the auditory cortex (Fig. 3A, 1). The conduction time of the transcallosal influences in interval I in relation to both components was less toward the majority of the regions of the right hemispheric cortex in the males (Fig. 3A, 2). At the same time, the dominance of the right hemisphere was more weakly expressed, being observed only in relation to the negative components in the parietal and auditory cortex (Fig. 3B, 2). In interval II, the FIAs of both components varied in direction, depending upon the zone of pickup both in the males and the females (Fig. 3A, B, 3). In interval III, judging by the LP of the development up to the maximum of positive component, the transcallosal influences reached the majority of the left hemispheric regions of the cortex investigated earlier in the males (Fig. 3A, 4). Along with this, the conduction of the transcallosal influences in the females was more rapidly effected toward the right hemisphere in relation to the negative oscillations of the TCR (Fig. 3B, 4). At the same time, the FIAs of the negative components in the males and the negative oscillations in the females had a different direction depending upon the pickup region. In interval IV, the transcallosal influences arrived more rapidly at the neocortex of the right hemisphere in the females in relation to both oscillations of the TCR (Fig. 3B, 5). At the same time, the direction of the asymmetry in the males over the entire territory of pickup proved right-sided collectively in relation to the positive component, but left-sided in relation to the negative oscillation (Fig. 3A, 5).

The temporal dynamics of the transcallosal influences with respect to the amplitude parameters of the TCR in rats of the two sexes were as follows. In interval I, judging by the amplitude of the negative component, activation processes predominated over a greater territory of the right hemisphere in the females, but mainly in the auditory cortex of this hemisphere in the males (Fig. 3A, B, 2). At the same time, in relation to the amplitude of the positive oscillations, depressive processes were more markedly manifested in the left hemisphere of the females by comparison with the males. Thus, in the females, left-sided FIAs occurred in the parietal and visual zones, while in the males, only in the former. Along with this, counterphasic right-sided asymmetry was observed in the visual region of the males. In interval II, activation processes predominated in the left hemisphere neocortex in the males (Fig. 3A, 3). At the same time, the activation of the right hemisphere in the females in interval I was replaced by its depression (Fig. 3B, 3). In interval III, activation processes shifted from the left hemisphere to the right hemisphere (Fig. 3A, 4). At the same time, in the females excitation processes predominated in the visual and motor zones of the left hemisphere cortex (Fig. 3B, 4). And, finally, in interval IV, activation processes again were found to be more prominent over a greater territory of the right hemisphere in the females, whereas processes of depression predominated in them in the visual cortex of the left hemisphere (Fig. 3A, 5). At the same time, in the males the level of activation was higher in the motor cortex of the right hemisphere and the visual region of the left hemisphere.

The general regularities of the dynamics of the FIAs of the transcallosal influences described above could thus be manifested in identical regional supply and the unidirectionality of the FIAs in rats of the two sexes. At the same time, changes in the asymmetry were effected in accordance with variants of a pattern of one and the same type. For example, the FIAs of the temporal parameters of the positive components and the amplitude parameters of the negative oscillation in animals of both sexes followed the right–left–right shift rule (the first type of dynamics).

Sex differences in the dynamics of the FIAs in the rats were found in nonidentical regional supply and/or the counterphasic character of the asymmetry in the time intervals analyzed. At the same time, the changes in the asymmetry in individuals of the two sexes could be characterized by approximately mirror patterns of hemispheric dominance. Thus, for example, the FIAs of the temporal parameters of the negative components of the TCR followed the right–left–right shift rule (the first type of dynamics) in the females, but its left–right–left shift in the males. Counterphasic FIAs was found also in rats of the two sexes in relation to the indices of the duration of the conduction of the transcallosal influences toward the visual, auditory, and motor cortex, while in relation to the flows of transcallosal excitation, the duration of the conduction toward the visual and motor zones of the neocortex. These sex differences are probably associated with anatomical–morphological and ultrastructural features of the organization of the rostral and occipital divisions of the neocortex and of the corpus callosum in white rat males and females [6, 8, 10].

Overall, the identified specifics of the character of the temporal dynamics of the FIAs of the transcallosal influences in the rat males and females are determined, it must be assumed, by significant differences in the analysis of transcallosal information by animals of different sexes. The right hemisphere of the females probably functions more diffusely than in the males, at least at the initial and final stages of the processing of the transcallosal signal. Thus, the right hemisphere of the females receives relatively more pronounced activating transcallosal influences to the majority of the cortical regions investigated in intervals I and IV. This is fundamentally valid also in relation to the durations of their conduction. A different pattern could be observed only in the intermediate stages of the processing of the transcallosal information, such that in a number of cases the right-sided FIAs in the males proved to be more strongly pronounced than in the females. The results which suggest the dominance of the investigated zones of the cortex of the right hemisphere in relation to the TCR indicator in the rats can be compared with the facts of the greater callosal supply of the sensory zones of this hemisphere in cats [2, 3]. The relatively greater thickness of the cortex and weight of the right hemisphere by comparison with the left [8] apparently create certain preconditions for the fuller realization in it of the processes of the integration of transcallosal information. In addition, the right hemisphere of rats, as we know, is dominant in the analysis of multimodal complexes of stimuli [2], and the corresponding right-sided asymmetry did turn out to be twice as pronounced as in the males.

On the other hand, the dominance of the left hemisphere was identified more often, and was found on a relatively greater territory of the investigated regions of the cortex in the males by comparison with the females. Comparison of the facts found in the study with the results of the behavioral investigations of the FIAs in the rats of the two sexes also makes it possible to conclude that the behavior of the males, to a greater extent than of the females, depends on the functioning of the cortex of the left hemisphere. In addition to this, the behavior of the females is controlled as a rule by the right hemisphere [1, 2, 5]. Taking into account the notion of the relatively greater diffuseness of the activity of the right hemisphere, but the relatively greater focality of the functioning of the left hemisphere, it must be assumed that the assertion of the greater diffuseness of the functioning of the cerebral hemispheres of females, but the greater focality and dynamism of the functioning of the brain of males, is valid.

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