Developmental change of EEG in rat from 4th to 16th week

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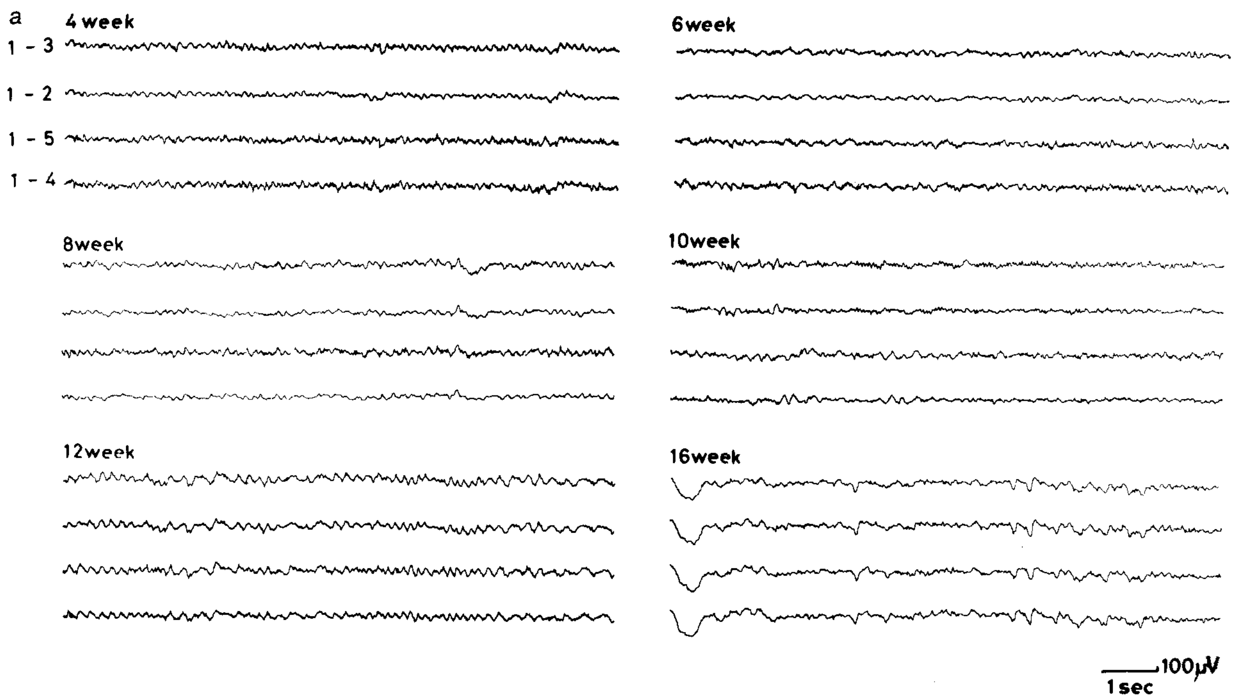
Summary. The development of EEG in 8 male rats from 4 to 16 weeks age were studied chronically. Theta band had the highest power at 5-16 weeks. Especially after 11 weeks, theta band presented a signigicantly higher peak than that of 4-week-old. In contrast to this, delta band, which had the highest power at 4 weeks, was markedly decreased.

It is considered that electroencephalography is one of the useful tools for the study of the development of the brain. There are a number of papers concerning the electrocortical activities in rats. However, many experiments were carried out acutely and mostly from the 1st to the 20th days after birth.

It has been recognized that the brain weight in rats gradually increased till 16 weeks after birth[1]. The aim of the present study was to clarify the development of EEG in rats from the 4th to the 16th week by the method of spectral distribution analysis.

Material and method. 8 male Wister HLA strain rats from



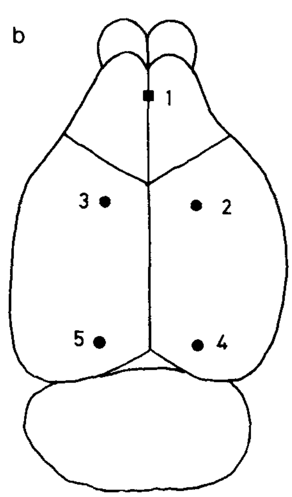


Fig. 1. EEG recordings in rat from 4-week to 16-week in quiet wakefulness.

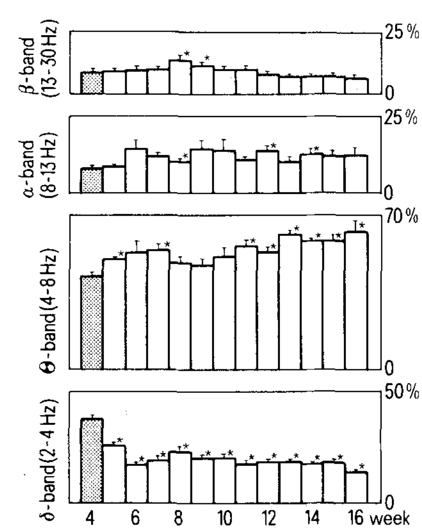


Fig. 2. Spectral energy distribution histograms of each frequency band of the left occipital area (1-5) at 4-16 weeks. * indicates significant difference ($p < 0.05$).

Nihon Doubutsu, 3 weeks old at the time of the operation for electrode implantation, were used. The animals were anesthetized with sodium pentobarbital (40 mg/kg, i.p.), and stainless steel electrodes (200 µm in diameter) insulated for a small loop formed at the tip to avoid any injury to the dura and cortex, were placed gently on the dura.

The electrodes were implanted on the right frontal cortex (area 3), the left frontal cortex (area 3), the right occipital cortex (area 17) and the left occipital cortex (area 17). The reference electrode was implanted in saggital line 7 mm anterior to the bregma (figure 1). The first EEG recording was made 3 days after implantation. During EEG recordings, rats remained free in a transparent cage.

The socket on the rat's head was connected to a electroencephalography by a flexible cable which did not hamper the rat's movement. Monopolar EEG were recorded from the frontal cortex and the occipital cortex in quiet wakefulness for 15 min by electroencephalography (Nihon Koden ME-92D), and EEG from the left occipital cortex was analyzed by EEG frequency analyzer (Sanei-Sokki, 7p-11). And spectral energy distribution of each frequency band (δ, θ, a, β) was computed.

Results and discussion. The development of EEG in rats from 4 weeks old to 16 weeks old is shown in figure 1. In visual analysis, EEG consisted mainly of 5-6 Hz mixed with 3-4 Hz high voltage slow waves at 4-10 weeks. After 12 weeks, 8-9 Hz alpha waves occurred intermittently and were slowly increasing. The amplitude varied from 200 to 300 µV at 4-5 weeks and became lower in older ages. After 8 weeks, they were around 100-200 µV.

Spectral energy distribution analysis is shown in figure 2. Frequency components are divided into 4 bands, that is, delta (2-4 Hz), theta (4-8 Hz), alpha (8-13 Hz) and beta (13-30 Hz). Theta band had the highest power at 5-16 weeks. Especially after 11 weeks, theta band increased step by step and presented significantly higher peak than that of a 4-week-old. Delta band of 4-week-old rats occupied a large part among 4 frequency bands, but after 6 weeks it was markedly decreased and theta, alpha bands were increasing. Beta bands were almost invariably exclusive of slightly significant peaks at 8-9 weeks.

Yoshii et al.[2] studied the EEG development of infant rats (2nd-21th day) acutely and reported that EEG of 21-day-old rats attained that of adults. Gramsbergen's[3] report said that after the 18th day no further changes occurred in the power spectra during various sleep stages. Yoshii et al. made the experiment on acutely implanted rats. Gramsbergen analyzed the EEG in rats of only 9-30 days in various sleep stages.

We analyzed EEG in the wakeful state of a rat from 4th to 16th week. So our results were different from their results. In our results EEG of 4-week-old rats, slow components were remarkable, and this slow component developed into medium-fast component progressively with age until 16 weeks. Overholser et al.[4] reported that the EEG of young rats of 4-8 weeks age showed the average frequency to be 30.8/sec. Timo-Iaria[5] reported that ECoG recorded from all areas were generally in the range of 30-40 Hz. These results are much higher than those in our experiment. Their EEG seems to mingle with electromyogram. Our data of energy power spectra in the 4th week are in accord with that of Deza's 28th day EEG[6]. It is interesting to note that fast component (13-30 Hz) was not altered comparably for different ages.

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Formation of glomerulus-like structures by the olfactory nerve after neonatal bulbectomy

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Summary. Evidence presented here suggests that glomerulus formation within the olfactory bulb of the rat, which is mostly a postnatal event, is directed by the olfactory nerve rather than by the influences of mitral and tufted cells.

The glomeruli (GL) of the olfactory bulb (OB) are round structures surrounded by short axon cells called periglomerular cells (PGLC). These structures contain the terminal dendritic branchings of the tufted and mitral cells (the 2nd order olfactory neurons), the axon terminals of the olfactory nerve (ON) and axons and dendrites of the PGLC[2]. Formation of these structures is mostly postnatal and their average number shows a 10-fold increase from the 1st day after birth to 2 months of age[3]. Their average diameter also increases 2-fold during this period[3]. The underlying mechanisms responsible for the formation of these structures is as yet unknown. Altman[4] has shown that cells originating in the proliferating zone of the subependymal layer around the lateral ventricle migrate to the OB, some of which surround the GL. It has been shown that the terminal branchings of the mitral and tufted cells are absent at birth and form postnatally[5]. It is therefore conceivable that the postnatal growth of these branchings induces the formation of the GL. In this study, however, we report results that indicate that, under experimental conditions where mitral and tufted cells are absent due to bulbectomy but the regenerated ON is present, glomerulus-like structure can be formed.

Albino rats were monolaterally bulbectomized at 3-4 days of age under ether anesthesia. At 25 and 60 days of age, their brains were removed and fixed with Bouin fixative. Paraffin sections were cut with a thickness of 14 µm and were stained with thionin for light microscopic studies.

Our findings reported here were essentially the same for both age groups. In most brains, the hemisphere ipsilateral to the lesion protruded and made contact with the regenerated ON. (The regenerative capacity of the ON has been well documented[6]). Light microscopic examination revealed that in specimens where the OB, the accessory olfactory bulb and the anterior olfactory nucleus were all removed, the plexus formed by the regenerated ON on the