SUMMARY OF Ph.D. DISSERTATION

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Title

Neuronal Activity for Duration Discrimination in Guinea Pig Primary Auditory Cortex

Abstract

Temporal features of sound sequence are most essential information to be processed in the brain. It is well known that animals can automatically discriminate the change in the temporal features from the auditory stimuli in environment. Especially, auditory duration discrimination is most important for the perception of speech and music in human. An event-related potential (ERP) in human indexing the discrimination is well investigated. This ERP generally termed "mismatch negativity (MMN)" widely developed for clinical application as well as for clarifying the mechanisms of the discrimination. MMN involved in the duration discrimination is called duration MMN. The neuronal basis of the duration discrimination is, however, remained unclear since direct electrophysiological methods are hard to apply in human. Because the duration MMN can be observed in non-human animals, the neuronal basis of auditory duration discrimination was investigated in the animal model (guinea pigs) of duration MMN in this study.

Chapter 1 describes the general view of this study among neuroscience researches for higher cognitive brain functions and refers to the aim of this study.

Chapter 2 describes establishment of animal model of duration MMN in guinea pigs. Guinea pigs have been extensively used in neuroscience studies of auditory system as well as in other various types of researches. However, MMN in guinea pigs were still indefinite. First of all, I have investigated about ERP in guinea pigs elicited by a traditional auditory paradigm in detail. Consequently, duration MMN can be induced in guinea pigs and may originate from the primary auditory cortex (AI) as well as other mammals. Thus, it is proposed that guinea pigs are available to investigate the neuronal mechanisms of duration MMN by direct electrophysiological methods.

Chapter 3 focuses on the electrophysiological study for neuronal activity involved in duration discrimination in guinea pig AI. More refined auditory paradigm, which can also induce duration MMN were employed and response in AI neurons were characterized under the paradigm. It was shown that responses in AI neurons were adapted by successive auditory stimuli and this adaptation mechanism was different for individual types of the responses. Especially the response that sustains during auditory stimulus (sustained response) showed the adaptation that was induced only when the stimuli with identical duration were repeated. Duration MMN, which was also observed in Chapter 2, has a property that its amplitude increases as the change in auditory stimulus duration is larger. The adaptation in AI neurons had similar properties as duration MMN. Thus, they fulfill the condition to be a neural substrate of duration MMN.

Chapter 4 discusses the general neuronal basis of MMN involved in auditory duration discrimination according to the above results and discussions. The conclusion in this study proposed the contribution to further studies for neuronal mechanisms of various brain diseases with a dysfunction of duration discrimination during auditory sequence.