Sensitivity of the Auditory Neurons in Rat and Chicken in Response to the External Stimulus Delivered into Endolymph

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Abstract:
Auditory neural response and stimulated neural potentials were observed in rats and chickens with the help of microelectrode surgically implanted in the scala tympani which filled with perilymph. Response patterns were recorded from both animals properly recovered from the effects of proper anesthesia. In rats the cochlear auditory neurons showed a thin band and spikes with high amplitude at a frequency about 300 Hz. In chicken the peak was15-20 dB higher in amplitude than the stimulated cochlea above the constant frequency of amplitude peaks. In rat the amplitude of peak was 8-12 dB higher in amplitude but it was very obvious because a clear null in a narrow band of constant frequencies just bottom of the peaks. The amplitude and the sharp null in peaks in both animals were markedly altered by level of anesthesia so their response patterns were somewhat different over all stimulating frequencies.

Index Terms: Scala tympani, Auditory, Neurons, Cochlear, Perilymph.

Introduction

It was also found that the cochlear sensory neurons have different sensitivity in different animals, there are only a few observation have been carried out on the properties of cochlear sensory neurons in chickens and rats. The first studies on cochlear microphonic potentials in bats were carried out by pollak et al (1972) and they were demonstrated that the auditory neurons are very sensitive at the level on constant stimulus frequencies. It was also recorded that in bats the cochlear microphonic potentials revealed a sharp tone bursts near about 61 kHz, it was obviously different from those were observed at other frequencies (Henson et al. 1973).
The main purpose of the current study was to use the same procedure to studies the cochlear potential in chickens and rats and to make comparisons of the physiological properties in both animals. This is a unique interest because these two animals have evolved completely independently and although the experimental principles were very similar, through such comparisons we hope to understand the important of structural dissimilarity in the design of cochlear receptor organ in both animals.

Materials and methods

The animals used in present studies were procured from veterinary college, Mhow, Indore, the cochlear potential
(CP) data to be presented here are based on the long term observation of both animals. The experimental materials and methods used in the present studies have been described elsewhere in detail (Henson and Pollak 1972).
Each animal was anesthetized from the effect of inhaled chloroform in anesthesia induction chamber, after some time 60 mg/kg ketamine was administered intramuscularly, the hourly supplement of ketamine (45 mg/kg) was given to maintain the anesthesia level throughout the experiment. The head stabilized with the head holder and dental cement. The prepared animals were secured in SAEB (sound attenuate experimental booth).
We were used audio oscillator for generating a constant stimulus (from 32 Hz to 10 kHz), it connected to the wave analyzer (Oscilloscope Hantek 6022BE) and it has been fully described previously (Koppl, C. 2011). Endolymph stimuli were produced under computer control by a custom-built arbitrary waveform generator.
A wave analyzer (Oscilloscope Hantek 6022BE) connected to the audio-oscillator (Modal no.me-150), used for recording the amplitude of the cochleo-vestibular potentials (VP) over a constant frequency and assessing the potential as SDR (spike discharge rate).

Results

The cochlear potential were determined by the evaluation of spikes discharge rate (SDR), frequency selectivity (FS), CVs (coefficient variation) and ISI (inter spike intervals). There are SDR for chickens and rats respectively ≤200 sp/s and ≤162 Sp/s. these values are much contrasted in both animals. For data analysis, very low spikes were avoided so that the inter spikes intervals (ISI) clearly discriminated in both animals. The stimulus from 45 to 90 Hz also was avoided for calculating the SDR throughout the experiment, SDR calculated by total number of spikes divided by total time period of recording.

Table 1: Spikes discharge rate of the stimulated cochlear endolymph in chickens and rats.

Subject	TNS (Minimum)	TTR (Minimum)	SDR
Chicken AS	±4000 Spike	20 Second	200 Sp/s
Rat AS	±3240 Spike	20 Second	162 Sp/s

TNS = Total Number of Spikes; TTR = Total Time of Recording; SDR = Spikes discharge Rate; AS = Acoustic System; VS = Vestibular System; Sp/s = Spikes Per Second.

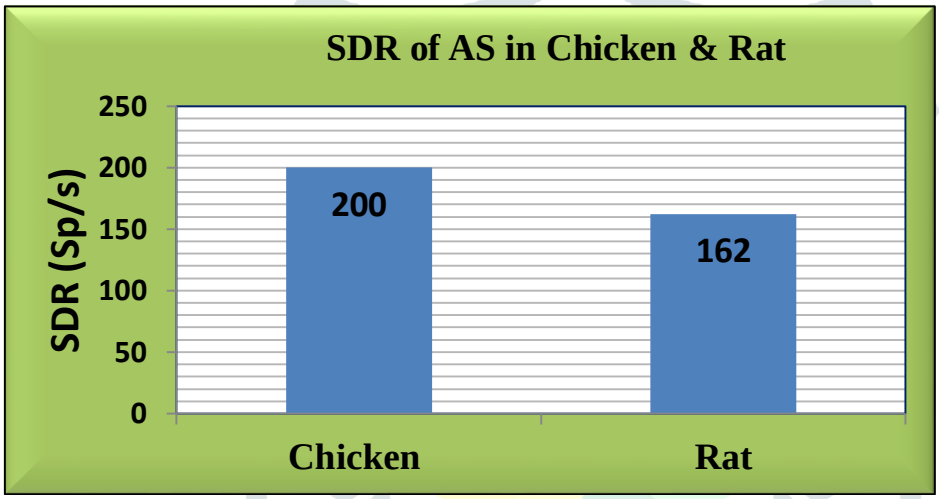

Fig 1: The spikes discharge rate revealed by the sensory neurons of the acoustic system in chickens and rats which represent to different habitat and classes

Discussion

Low and high spontaneous discharge rates have been recorded for stimulated auditory afferent neurons in developing animals. The mature spike discharge pattern for mean spontaneous discharge rate in rats and chickens are less clear. Manley *et al* (1991a) suggested that no difference in rates at ages from P2 to P21, similar spontaneous rates were observed in emu chicks aged from P1 to P14 (Manley and Koppl 1997), these values are contrasted with rates in mature rats (162 Sp/s) and chicken (200 Sp/s).

Conclusion

The results of current observation suggest that the significant sensitivity of the mature auditory neurons are present in chickens and rats. Furthermore, auditory neurons of both animals revealed fundamentally different spontaneous spikes discharge features as is the case in other mature birds and mammals. Different stimulus intensity alters the discharge rates in both animals.

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