the rate of salivary secretion is not correlated to the size of the secretory potential but rather to the size of the inward passive sodium current. The size of the inward sodium current should depend on the size of the secretory potential, the electrochemical gradient favouring sodium entry being greater at higher membrane potentials. The effect of varying the perfusate potassium concentration on the secretory rate may thus be explained by the varying sizes of the secretory potentials influencing the sizes of the sodium currents.

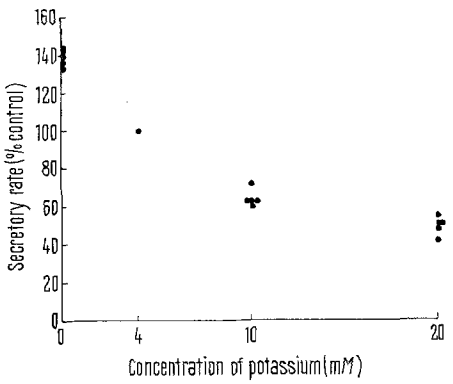

Fig. 3. The salivary secretory rate as a function of the potassium concentration in the perfusion fluid.

Zusammenfassung. Es wird gezeigt, dass die Speichelsekretionsrate der perfundierten Submandibulardrüse der Katze stark von der Natriumkonzentration im Perfusat abhängt. Die Sekretionsrate wird erhöht bei Perfusion mit kaliumfreier Lösung und reduziert während der Perfusion mit Lösungen erhöhter Kaliumkonzentrationen. Es ist möglich, dass ein durch Acetylcholin induzierter Natriumstrom in die Azinarzellen hinein den Sekretionsmechanismus aktiviert.

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Neuroanatomical Regions Relevant to Production and Analysis of Vocalization within the Avian *Torus semicircularis*

Vocalizations have been elicited by electrical stimulation of the *torus semicircularis* (ToS) of the Japanese quail, *Coturnix coturnix japonica*[1]. Comparison between elicited vocalizations and natural calls, using sound spectographic analysis, shows that elicited vocalizations closely resembled examples of 8 of the 15 natural calls emitted by adults of this species[1]. Vocalization has also been elicited from other avian species by stimulation of this neuroanatomical region[2–4]. Large lesions within the ToS result in long-lasting loss of 'alarm' calls in the redwing blackbird, *Agelaius phoeniceus*[5]. Both evoked potentials[6] and changes in single unit activity[7] in response to acoustic stimulation have been recorded in the large celled region of the ToS, the *nucleus mesencephalicus lateralis pars dorsalis* (Mld). Two experiments reported in this paper indicate that the region within the ToS containing low threshold sites for eliciting vocalization is spatially separate from the area responsibe to acoustic stimulation.

In the first experiment, tungsten microelectrode exploration of the right optic lobe was conducted in urethane anesthetized Japanese quail, *Coturnix coturnix japonica*, after removal of the overlying forebrain. As the microelectrode was advanced the bird was stimulated with repetitive 100 msec bursts of white noise. An attempt was made to ascertain the most effective frequency for stimulating each single unit encountered using 'pure' tones from 250–6000 Hz.

Tracks were run at 0.4 mm intervals in the sagital and anterior-posterior planes. Marker lesions were made at least 0.2 mm below and above the depths of the first and last 'acoustic' units or at a fixed depth if no acoustic units were encountered.

The results from 8 male quail are contained in Figure 1, A. All 30 tracks that penetrated the MLd located acoustic units within the MLd. None of the 17 tracks that penetrated the adjacent parvocellular region of the ToS, the *nucleus intercollicularis* (ICo), produced evidence of auditory activity within the ICo. 6 tracks that penetrated the ICo located single units responsive to auditory stimulation within the *formatio reticularis lateralis* (ventral to the ICo) as did one track that penetrated the medial portion of the MLd. This is in accord with neuroanatomical work which indicates that many fibers afferent and efferent to the MLd run through this region[8]. No acoustic units were recorded in 6 tracks that penetrated lateral to the ICo (not shown in Figure 1, A).

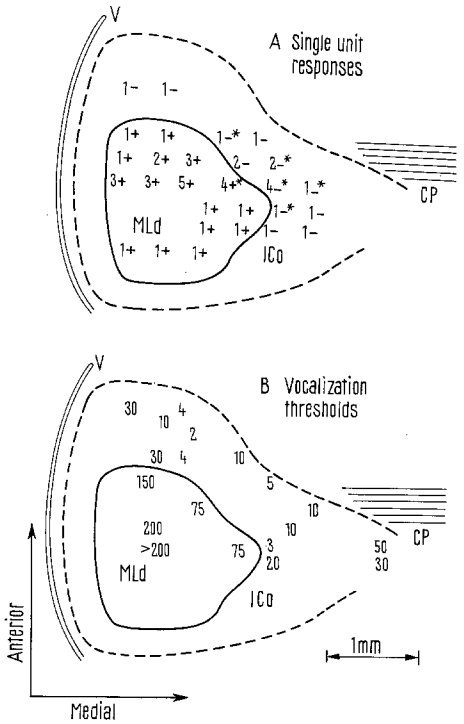
Tonotopic organization in the vertical plane was found within the MLd. The 'best frequency' of single units increased with distance from the dorsal border of the MLd.

Localization of acoustic units within the MLd supports previous neuroanatomical[8] and neurophysiological[6,7] evidence indicating that the MLd is homologous with the mammalian inferior colliculus. Thus the MLd probably plays a role in analysis of natural calls whereas the data reported above do not indicate such a role for the ICo.

In the second experiment, the right optic lobe of locally anesthetized birds was explored to determine thresholds for eliciting vocalization by electrical stimulation. A concentric electrode (inner core diameter 0.13 mm, outer electrode 29-guage stainless steel tubing) was lowered in 0.3 mm steps. At each step the animal was stimulated with biphasic pulses delivered at 60 pulses/sec, maximum current of negative phase being 200 μA. Once vocalization was elicited, the electrode was lowered in 0.2 mm steps and a threshold was determined at each depth by lowering current strength in a standardized sequence until no vocalization was elicited. A marker lesion was made at

[1] L. POTASH, Behaviour, in press.
[2] J. BROWN, Science *149*, 1002 (1965).
[3] R. MURPHEY and R. PHILLIPS, Nature *216*, 1125 (1967).
[4] J. NEWMAN, Doctoral Dissertation, University of Rochester (1969).
[5] J. BROWN, Bull. ecol. Soc. Am. *46*, 194 (1965).
[6] A. HARMAN and R. PHILLIPS, Expl. Neurol. *18*, 276 (1967).
[7] M. THORSON, J. Physiol. *193*, 695 (1967).
[8] H. KARTEN, Brain Res. *6*, 409 (1967).

least 0.4 mm beyond the depth yielding the lowest threshold. 4 tracks were run through the right optic lobe of each subject at intervals of 1.0–1.5 mm, 2 tracks to a sagital plane.



Dorsal view of the *nucleus mesencephalicus lateralis pars dorsalis* (MLd) and the *nucleus intercollicularis* (ICo) depicting (A) single unit responses to acoustic stimulation and (B) vocalization thresholds for electrical brain stimulation. ——— border of MLd, ····· border of ICo, ═══ lateral border of ventriculus (V), ▒▒▒ *commissura posterior* (CP). A) Each + or − symbol respectively indicates the presence or absence of acoustic units at that approximate position. The number of electrode penetrations within a given area is indicated by the accompanying arabic numeral. Sites that yielded 'acoustic' units within the *formatio reticularis lateralis* (ventral to the MLd and ICo) are marked with asterisk. B) The position of each number indicates the approximate position of a stimulating electrode track. The magnitude of the number indicates the lowest vocalization-elicitation threshold in μA within the MLd or the ICo.

The results from 9 male quail are summarized in Figure 1, B. All tracks that entered the medial anterior portions of the ICo produced vocalization at low threshold. Different sites within the ICo of the same subject sometimes yielded different types of vocalizations. This is in accord with previous results demonstrating a degree of neuroanatomical separation within the ICo of regions from which different natural calls can be elicited[1].

The threshold for eliciting vocalization from within the medial and anterior portions of the ICo were quite low when compared with stimulation within the MLd (electrodes penetrated the MLd in 5 out of 9 subjects). The threshold for vocalization within the MLd tended to vary with distance of the track from medial and anterior portions of the ICo. This suggests that vocalization elicited by stimulation within the MLd resulted from current spread to these portions of the ICo. Concurrent work by NEWMAN[4] with the redwinged blackbird, using evoked potentials as a criterion for responsiveness to acoustic stimuli, also shows that electrical stimulation of the MLd and other midbrain auditory areas does not elicit vocalization at current strength levels that elicit vocalization in the ICo. These results indicate that the ICo, and not the MLd, probably plays some role in the production of natural vocalization. Whether the fact that the MLd and the ICo are adjacent is of functional significance remains to be determined[9,10].

Zusammenfassung. Das Gebiet innerhalb der *torus semicircularis* eines Vogels mit niedriger Schwelle zur Vokalisierung der Natur sehr ähnelnder Rufe ist räumlich von demjenigen Gebiet getrennt, das auf akustische Reize reagiert.

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Response to Adrenaline, Acetylcholine and Change of Contraction Frequency in Early Human Foetal Hearts

The foetal cardiovascular system is considered to be under control of nervous and hormonal influences during the latter part of gestation[1]. However, little information is available concerning the time course of development of receptors to autonomic transmitter substances in man. Adrenergic innervation cannot be detected histochemically in the human foetal heart ventricles before the 12th week of gestation[2]. The present report describes observations concerning inotropic and chronotropic responses to adrenaline and acetylcholine in 2 human foetal heart preparations of 9 and 10 week gestational age. The positive inotropic effect of adrenaline was compared to that evoked by an increase in contraction rate. Recordings of electrical transmembrane potentials were performed in the same hearts to obtain data concerning the electrophysiological maturity of the myocardium at this gestational age.

Material and methods. 2 foetal hearts were obtained at legal evacuation of uterus in the 9th and 10th week of gestation, respectively. The crown-rump length of both

[1] N. S. ASSALI, *Biology of Gestation* (Academic Press, London/New York 1968), vol. 2.

[2] G. GENNSER and CH. OWMAN, unpublished observation.