'consolidation' of a reinforced response. The reciprocal, that consolidation can be suppressed or prevented by punishment, would be a logical consequence of this hypothesis.

It would be desirable in the light of this hypothesis to re-evaluate the various treatments known to facilitate and inhibit consolidation in terms of their possible rewarding and aversive effects, and thus to investigate the usefulness of a theory which tries to account for the modifications of memory processes by post-trial manipulations in terms of mechanisms of reinforcement and punishment, which would open the possibility of integrating 'memory-consolidation' theory with 'behaviour-modification' theory.

Zusammenfassung. Unter Verwendung einer passiven Vermeidungsreaktion mit Futterbelohnung nach verschiedenen Zeitintervallen zwischen 0 und 120 sec konnte gezeigt werden, dass Belohnung 20, 30 und 50 sec nach dem Fusschock signifikant verbessertes Lernen bewirkt. Diese Daten unterstützen die Hypothese, dass Gedächtnisprozesse – konzeptionell als operante Reaktion aufgefasst – durch Belohnung modifizierbar sind.

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Rhythmic Activity in Frog (*Rana pipiens*) Visual System

Oscillatory potentials have been demonstrated in the visual system of the frog[1,2] and many other visual systems[3-5]. These oscillations were observed in the retina and optic nerve. For a given species, the frequency of these oscillations was found to be constant despite changes in light intensity[3,4]. The oscillatory potentials are generated by the synchronous discharge of retinal ganglion cells. In the cat, the rhythmic potentials occurred after the onset of illumination as well as its offset[5]. In the present experiments, the occurrence and pattern of the rhythmic potentials was studied in *R. pipiens*.

Methods. 29 specimens of *R. pipiens* were used. The frogs were anaesthetized by immersion in 0.1% tricaine methanesulfonate[6]. The sciatic and branchial nerves were severed to inhibit movement. The frogs were pinned onto a holder, covered with a damp sponge, and presented 95% O_2-5% CO_2[7]. Recordings were made either extracellularly from class III cells of the left retina or from the right optic tectum[8]. All recordings were made on awake frogs which had been dark adapted for 1 h before commencing the experiment. The electrodes used were metal filled, and had tip diameters of 2–5 µm[9].

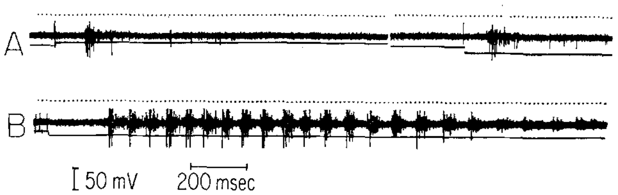

Fig. 1. Recordings of the off-response. Both flashes 30 sec duration. Trace A photopic level stimulus; trace B mesopic level stimulus.

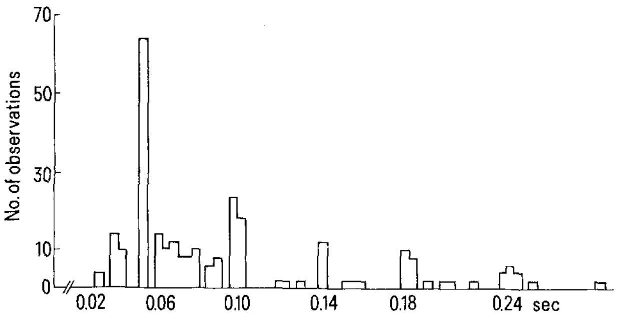

Fig. 2. Interval histogram of interspike intervals excluding the intervals shorter than 0.02 sec. The interspike intervals tend to cluster at interval of 0.048 sec, 0.096 sec, 0.144 sec, and 0.192 sec. Histogram based upon mesopic level stimulus of 30-sec-duration.

The frogs were placed behind a screen which covered the visual field of the left eye. A drop of water was periodically presented to the left eye to prevent drying. The light stimuli covered the full range of intensity levels from scotopic to photopic. The durations of the stimuli ranged from 0.05 to 90 sec duration. The responses to the stimuli were monitored auditorally and visually as well as recorded for later playback and photography.

Results. The results are based upon 686 recordings from class III cells. One-third were activity recorded from the tectum; the remainder were extracellular recordings from class III cells in the retina. Within a narrow range of stimulus intensities and flash lengths, when stiumli were presented to a previously dark adapted retina, a rhythmic bursting firing appeared. The pattern was most clearly observed in response to the extinguishing of a 30-sec-period of illumination using a 3.6 neutral dentisity filter. Calibration of this filter demonstrated the stimulus to be approximately 0.02 lux. This value falls in the mesopic range[10]. The pattern was occasionally observed in response to a slightly brighter stimulus (3.2 N.D. filter) of the same duration.

The firing pattern can be seen in Figure 1. Interval histograms were generated by measuring the interspike intervals between single cells spikes in response to the

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30-sec-periods of illumination and the mesopic level stimulus. The histogram (Figure 2) indicates some clustering of interspike intervals around values of 0.048 sec, 0.096 sec, 0.144 sec and 0.192 sec. This indicates a regular firing pattern.

In many cases the electrode recorded activity from a number of cells in which the rhythmic activity appeared on bursts of spikes. The duration of the burst was examined. The mean burst duration was 0.047 ± 0.002 sec. The silent period between bursts was found to be 0.028 ± 0.006 sec. The average burst frequency of 12.8 ± 0.3 bursts/sec was observed for the mesopic stimulus of 30 sec duration. When a slightly brighter stimulus was used (3.2 N.D.) with a 30-sec-duration, these values were observed to change. The first duration was found to be 0.032 ± 0.002 sec with a silent period of 0.031 ± 0.003 sec. The average bursting frequency was found to be 15.6 ± 0.5 bursts/sec.

Discussion. The rhythmic activity was found to be identical when recorded from either the optic tectum or retina. Since the activity was recorded from unanaesthetized frogs, it is unlikely that the activity was the result of anaesthetic influences. Hypoxia was reduced by keeping the frog moist and the presentation of an enriched O_2 atmosphere. The activity recorded in the frog is similar to that observed in the cat. In both, bursts of spikes were separated by silent periods of inactivity. One difference was observed. In the cat, the bursting frequency was constant and did not depend on the stimulus intensity[5]. In the frog, the bursting frequency was observed to change with a slight change in stimulus intensity. Steinberg[4] studied the oscillatory potentials in the cat retina, and concluded that this type of ganglion cell discharge was probably related to a process of neural light adaptation. Other workers[3] speculate that efferent fibers may be involved in regulating the rhythmic firing of the ganglion cells. Experiments are presently under way to determine if efferent fibres in the frog optic nerve may be involved in the genention of the rhythm bursting firing pattern.

Zusammenfassung. Nachweis, dass die Netzhaut-Ganglienzellen dritter Klasse bei *Rana pipiens* auf Beleuchtungsperiodenausgleich reaktiv rhythmische Potentialfolgen von «bursts» und «firing» erzeugen. Als wirksamste Beleuchtungsperioden erwiesen sich solche im mesopischen Bereich bei Mindestdauer von 15 sec. Weder skotopische noch photopische Belichtungen führten zu rhythmischer Aktivität.

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Changed Chronotropic Sensitivity to Sympathomimetic Amines in Isolated Atria from Rats Following Cold Acclimation

It has been established that cold acclimation sensitizes the animals to the metabolic effect of noradrenaline (NA) and of isoprenaline (ISO), which effect is mediated by the β-adrenoreceptors[1,2]. Some authors have also observed an increase in cardiovascular sensitivity to NA and to ISO[1,3-5], whereas some have found a decreased sensitivity[6]. Moreover, Himms-Hagen and Mazurkievicz-Kwilecki[7] did not find any change in the sensitivity to NA in isolated tissues from cold-acclimated rats.

A possible reason for the variability in the cardiovascular responses may be the variable extent of reflex adjustment. In addition, the cardiac responses to sympathomimetic amines in vivo are dependent on the duration of cold exposure[8]. Therefore the problem of the changes in response to sympathomimetic amines was studied in isolated cardiac tissues by measuring the chronotropic

The basic contraction rates, the pD_2-values (-log molar ED_{50}) and the maximum responses (± SE) to isoprenaline, noradrenaline and phenylephrine in isolated atria from control rats (kept at 23 °C) and from animals transferred to 5 °C for different lengths of time

Days at 5 °C	Basic atrial rate/min	Isoprenaline		Noradrenaline		Phenylephrine	
		pD_2	Maximum response/min	pD_2	Maximum response/min	pD_2	Maximum response/min
Control	228 ± 8 (29)	8.23 ± 0.12 (6)	137 ± 14	7.10 ± 0.08 (7)	138 ± 7	5.39 ± 0.08 (7)	134 ± 10
4	220 ± 10 (21)	8.22 ± 0.09 (8)	124 ± 15	7.08 ± 0.15 (6)	142 ± 6	4.76 ± 0.06[c] (6)	91 ± 8[b]
7	196 ± 6[c] (26)	8.30 ± 0.11 (6)	133 ± 8	6.60 ± 0.13[b] (7)	136 ± 10	4.96 ± 0.04[c] (6)	101 ± 12[a]
12	204 ± 13 (6)			7.06 ± 0.11 (6)	139 ± 16		
40–45	228 ± 9 (17)	8.12 ± 0.12 (6)	167 ± 6[a]	7.38 ± 0.10 (6)	172 ± 7[b]	5.29 ± 0.06 (5)	130 ± 17

Significant difference from the control: [a] $P < 0.05$; [b] $P < 0.01$; [c] $P < 0.001$. Figures in parentheses indicate number of rats in the groups.

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