

control kidneys, but the former markedly reduced and the latter increased of the clipped kidneys in uninephrectomized rats. The same effect was not clearly observed in the rats bearing untouched contralateral kidney. A decrease in renal pressor activity of the clipped kidney elicited by angiotensin in the rat was rather controversial to our previous observation made in the dog that renin release from the clipped kidney was augmented by infusion of very small amount of angiotensin⁸. The discrepancy may have been caused not only by a large difference of dose of angiotensin administered but also of duration of the action of this substance between the two experiments^{9,10}.

Zusammenfassung. Angiotensin erniedrigte nur bei ischaemischen Nieren die Reninproduktion und erhöhte

parallel dazu das Nierengewicht. Die Angiotensinwirkung ist somit abhängig von der Stoffwechsellaage der Niere.

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Visual Unpatterned Input Determines the Occurrence of Reward-Contingent Positive Variation

Cats deprived of food and trained to press a lever for 1 cm³ of milk reward, display bursts of high amplitude (180–200 μ V) α -activity of 5 to 9 c/sec over the primary and secondary cortical visual projections. This phenomenon triggered by consumption of reward, and termed postreinforcement synchronization (PRS)¹, recorded with reference to the skull, frontal cortex or subjacent white matter, is always associated with a transient (3–5 sec duration) and abrupt surface positive steady potential shift of 200 to 400 μ V over the same cortical region^{2,3}. The positive shift^{2,3}, like the PRS^{1,4}, depends not only on the presence of light but also on the relative taste and appropriateness of food reward; therefore, the steady potential shift was termed 'reward contingent positive variation' (RCPV)². The question was raised whether the RCPV and PRS responses depend upon visual perception of reward (and possibly of the environment which might have acquired conditional properties) or upon a diffuse visual input devoid of any conditional and informational properties. The following experiments were designed to answer this question.

Material and methods. A total of 48 experimental trials were carried out in 6 adult cats of either sex, trained to press a lever for 0.8 ml of milk reward presented on a schedule such that pressing a lever produced the reward aperiodically, approximately once every 4 or 10 sec. All subjects were kept on 23 h water and food deprivation schedule while being trained to press the lever until satiation, 5 days a week for 3 to 6 months. Approximately 80% of the training sessions were conducted in the absence of light. During the 4 weeks prior to this experimental paradigm, the subjects were allowed to perform only in the dark in order to induce extinction of possible conditional responses to light and perceived environment. Under pentobarbital anesthesia, 3–10 solid-type, non-polarizable Ag-AgCl electrodes⁵ were implanted over the parieto-occipital cortex. Reference electrodes were implanted in the subjacent white matter 3 mm below the surface for transcortical recording which was found free from any discernible influences caused by directional changes in the standing corneo-retinal potential associated with eye movements³. Lapping was monitored by using the milk delivery cup converted to a drinkometer⁶. The technique of recording and integration of RCPV responses was previously described². The integrating system was calibrated to produce 2 pen deflections 30 mm each in response to a 100 μ V positive shift lasting 1 sec. This value was arbitrarily accepted as one unit of RCPV

triggered by 0.8 ml of milk reward. During the control trials each subject was allowed to obtain 40–60 milk rewards in an illuminated test chamber (the intensity of light was set at approximately 26 cd/m²) and, subsequently, 30–50 rewards in the dark. Afterwards, this sequence was repeated. The control trials were alternated with the experimental ones, during which the subject was allowed to perform while its patterned vision was prevented by either a pair of translucent contact lenses or goggles. Statistical differences between the integrated average RCPV responses were determined by Student's *t*-test.

Results and discussion. All 6 subjects showed well-developed PRS and RCPV responses, but only in the presence of light, even though their patterned vision was prevented. After 2–4 trials, 75–80% of the averaged integrated RCPV responses (each based on 10 single integrated RCPVs) obtained while patterned vision was prevented were not statistically different from those obtained during control trials, i.e., while patterned vision was allowed ($P > 0.05$). A total 2900 consumptions of milk rewards in the dark were considered, and none of the subjects showed a single PRS or RCPV response, provided that all sources of light have been carefully eliminated. During a prolonged performance in the dark, usually a variant of PRS developed which was described

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² T. J. MARCZYNSKI, J. L. YORK and J. T. HACKETT, *Science* 163, 301 (1969).

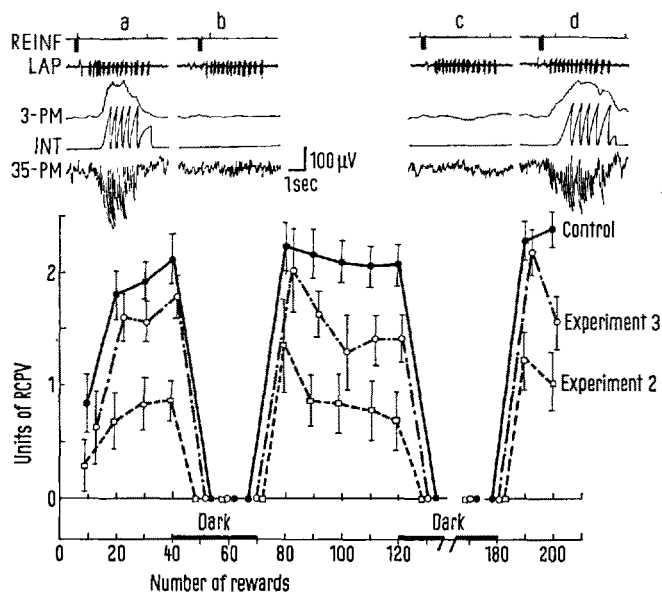
³ T. J. MARCZYNSKI, J. T. HACKETT, C. J. SHERRY, J. H. RICK and J. L. YORK, *Brain Res.*, in press. – T. J. MARCZYNSKI, J. T. HACKETT, C. J. SHERRY and SHARON ALLEN, *Brain Res.*, in press.

⁴ M. B. STERMAN and W. WYRWICKA, *Brain Res.* 6, 143 (1967).

⁵ H. W. BOND and P. HO, *Electroenceph. clin. Neurophysiol.* 28, 206 (1970).

⁶ The conversion of the milk delivery cup into a drinkometer was accomplished by feeding a continuous 50 c/sec train of impulses from a S-8 Grass stimulator into the milk container, and by subsequently recording this signal from one of the skull electrodes with reference to the 'common ground' every time the subject's tongue touched the cup.

before; it consisted of lower amplitude (70–120 μ V) and higher frequency (16–19 c/sec) spindle bursts which, however, was not associated with any consistent epicortical steady potential shift. Two subjects more rapidly became accustomed to unpatterned vision, and performed well during the first or second trial during which they displayed large amplitude PRS and RCPV responses comparable to those observed during control trials. The average integrated responses, expressed in units, obtained from one of the subjects have been plotted against the number of rewards, and are presented at the bottom of the figure. At the top, 4 samples or records are shown: from a control trial ('a' in the presence, and 'b' in the absence of light), and from a second experimental trial in the same subject whose patterned vision was prevented



The dependence of the reward-contingent positive variation (RCPV) on unpatterned light input in a food-and-water-deprived cat trained to press a lever for 0.8 ml of milk reward. The RCPV responses were recorded epidurally over the left posterior marginal gyrus (PM) with reference to an electrode in the subjacent white matter, 3 mm beneath the surface. Top left: a) shows a typical RCPV response in the control situation, i.e., while patterned vision was allowed. In the dark b), the RCPVs were abolished. Top right: representative samples of records obtained during subject's performance in the dark c) and in the light d), while patterned vision was totally prevented by translucent occluders. Note that the amplitude and patterns of RCPV responses, and the frequency of concomitant alpha waves, i.e., post-reinforcement synchronization (PRS) in inserts a) and c) are indistinguishable: It is noteworthy that either of the 2 RCPV responses shown here were triggered by a second presentation of reward after the light was switched on. Abbreviations: 35-PM and 3-PM, records filtered to half-amplitude response at 35 c/sec and 3 c/sec respectively; the polarity of the latter is reversed for convenience of recording. INT, integration of the 3-PM wave: one deflection of the pen of the integrator is equivalent to a 50 μ V positive shift lasting 1 sec; 2 such deflections equal one unit of RCPV; the baseline, i.e., zero output was set during several non-rewarded lever presses. REINF, rewarded bar press; LAP, bursts of 50 c/sec signal triggered by each contact of subject's tongue with the milk delivery cup. Bottom: average integrated RCPV responses obtained either in the presence or absence of light in the test chamber. Each average value (with standard error) expressed in RCPV units is based on 10 single responses. They were obtained: 1. during the control trial, i.e., allowing patterned vision (filled circles); and 2. during the second (open squares) and third experimental session (open circles), while patterned vision was prevented. There were no statistical differences between the control and experimental averages from the third trial ($P > 0.05$).

by translucent eye occluders ('c' in the dark, and 'd' during the second consumption of reward after the light in the test chamber was switched on).

Our observations on RCPV phenomena seem to be most consistent with the view that these responses result from temporal summation of synchronized and widespread inhibitory postsynaptic potentials that invade apical dendrites from cell bodies located in deeper cortical layers. Strong electrophysiological evidence for a collateral recurrent inhibitory pathway in the visual cortex of cat has been obtained. The long time course (100 to 200 msec) of the hyperpolarization of cell soma of presumably vertically oriented pyramidal cells, after electronic invasion of the apical dendrites, is reflected as a long-duration surface positive wave⁷. Hence, we postulate that the PRS-RCPV phenomena depend upon diffuse visual input because the phasic recurrent inhibition of large populations of neurons could not be triggered in an alert subject without a sufficient input. Such cortical mechanism would constitute an analogy to the recurrent hyperpolarizing inhibition, contingent on somatosensory input, postulated for the thalamic synchronizing mechanism⁸. If our tentative interpretation of synaptic mechanism responsible for RCPV responses is correct, it could be assumed that diffuse light input plays in an alert subject a not-yet-recognized role of an energizer in the process of widespread cortical inhibition. The additional indirect evidence for the occurrence of such inhibition, its functional implications in processing of visual and heterosensory information in the striate, parastriate and association cortex, and its role in internal Pavlovian inhibition have been discussed elsewhere⁹.

Résumé. Des chats porteurs d'électrodes corticales Ag-AgCl non polarisables et de lentilles de contact translucides, ont été entraînés, dans obscurité, à presser un levier pour obtenir 0,8 ml de lait. Ils montrent des périodes d'activité lente de haut voltage, c'est-à-dire un phénomène ECoG connu comme synchronisation de post-renforcement sur le cortex pariéto-occipital. Quand cette synchronisation associée à la variation positive de contingent est supprimée dans l'obscurité, ces phénomènes dépendent de l'influx de la lumière diffuse et non de la perception visuelle.

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