The articles in this issue are from a symposium on Operant Conditioning and Epilepsy which was arranged by Dr. M. B. Sterman for the November 1975 Meeting of the Pavlovian Society in Los Angeles, California. The second part of this symposium will be concluded in the next issue of the Pavlovian Journal of Biological Sciences.

Sensorimotor EEG Operant Conditioning: Experimental and Clinical Effects*

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Abstract—Neurophysiological studies in cats have established a functional relationship between waking 12-15 Hz sensorimotor cortex rhythmic EEG activity (the sensorimotor rhythm or SMR) and a similar pattern during sleep, the sleep spindle. Both result from oscillatory thalamocortical discharge involving ventrobasal thalamus and sensorimotor cortex, and both are associated with a state of suppressed motor excitability. Enhancement of the SMR with operant conditioning methods in the cat clearly led to reduced seizure susceptibility. The experimental application of this approach to seizure control in epileptics has resulted in (A) evidence that EEG patterns can be manipulated significantly in man with operant conditioning, (B) suggestive observations concerning a potential component of pathology in epilepsy, and (C) strong preliminary evidence that SMR operant conditioning in epileptics is specifically therapeutic.

Current research has focused upon the EEG during sleep in epileptics with primary motor symptomatology. This measure often reveals several hard signs of pathology. This measure often reveals several hard signs of pathology. These include the presence of abnormal activity in the 4-7 Hz frequency band and the absence or disturbance of activity in the 11-15 Hz frequency band. Power spectral analysis is being utilized to quantify these sleep EEG components in five groups of epileptic patients, studied with different frequency patterns rewarded in an A-B-A design which provides for counterbalancing of order effects. Initial laboratory training is followed by 9-12 months of training at home with portable feedback equipment. Reward contingencies are reversed within each group at approximately three month intervals. Clin-

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The work to be discussed here was initiated some time ago by the discovery of a discrete 12-15 cps rhythm over sensorimotor cortex in the cat during periods of learned motionlessness (Sterman and Wyrwicka, 1967; Roth et al., 1967; Sterman et al., 1969). Because of the localization to sensorimotor cortex this pattern was termed the "sensorimotor rhythm" or SMR. Recordings from the same area during sleep showed that the familiar sleep spindle was focused also in this region (Sterman et al., 1970). While the waking SMR appeared as sustained, rhythmic trains at moderate voltage in a background of low voltage fast (LVF) activity, sleep spindles developed at the same 12-15 cps frequency as envelopes of high voltage rhythmic activity in a context of diffuse slow waves (Fig. 1). Rhythmic 12-15 cps activity also appeared occasionally during the REM stage of sleep, when phasic events characteristic of this state were absent, thus confirming our earlier report of this EEG pattern during REM in the cat (Sterman et al., 1965). We were able to conclude from these EEG-behavioral observations that the appearance of rhythmic 12-15 cps sensorimotor EEG activity was associated strictly with the absence of movement, regardless of whether the animal was awake or sleeping, a fact which was supported subsequently by Rougeul and her associates (1972).

This relationship was explored further by utilizing a unique application of operant conditioning. Cats prepared with indwelling pairs of sensorimotor cortex electrodes were provided with food reinforcement for the production of 0.5 sec trains of SMR activity at a voltage 100 per cent above background LVF activity. Most animals learned rapidly to perform this instrumental EEG response, and did so by assuming stereotypical motionless postures (Wyrwicka and Sterman, 1968). EMG activity from the neck was sup-