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Vanderwolf C H. Limbic-diencephalic mechanisms of voluntary movement. *Psychol. Rev.* 78:83-113, 1971.
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Studies of the role of the diencephalon and hippocampal formation in behavior are discussed in relation to the concept that activity in ascending reticulocortical mechanisms is closely linked to voluntary movement. The importance of Jackson's concept of levels of function[1] is emphasized. [The *Science Citation Index*® (*SCI*®) and the *Social Sciences Citation Index*® (*SSCI*®) indicate that this paper has been cited in over 210 publications since 1971.]

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"When I arrived at McGill University in 1958, D.O. Hebb suggested that I work on the medial thalamus. I found that rats with large lesions of this region could not avoid a painful shock by running away although they could escape readily. As training continued, the rats began to squeal immediately prior to the shock (as if in fear), even though they did not move. If shock was omitted, the rats would often run away suddenly after a long initial delay. These observations made a great impression on me. The fact that the thalamic lesions interfered with the initiation of running, but not with vocalization, recalled Jackson's distinction between 'voluntary' and 'automatic' movements.[1]

"One day, over a beer, I described this work to Woody Heron who suggested that we could record from the medial thalamus at his lab at McMaster University, and look for a relation to motor activity. We discovered that rhythmical 'theta waves' occurred in both the medial thalamus and hippocampus during locomotion but were not ordinarily present during alert immobility or grooming behavior.[2] Since I suspected that the thalamic waves might be generated in the hippocampus, I began a detailed study of hippocampal activity in relation to movement.[3] The term rhythmical slow activity (RSA) was introduced because the editor (C. Ajmone Marsan) of *Electroencephalography and Clinical Neurophysiology* insisted that waves with a frequency up to 12 Hz could not be 'theta waves.' The term 'RSA' has since come into widespread use.

"The *Psychological Review* paper summarized what I had learned (including extensive references to the unpublished work of two able graduate students, Brian Bland and Ian Whishaw) and related it to the control of voluntary movement. It received two unenthusiastic reviews. I thought the criticisms were not entirely justified and the editor (C.N. Cofer) obtained a third review (from Steve Glickman as I learned later) which recommended publication.

"I think the paper is cited mainly because it contains a description of the relation between hippocampal slow waves and behavior. Many people regarded the idea that the hippocampus plays a role in the control of movement as not merely wrong but slightly crazy. However, the observations have been confirmed repeatedly and serve as the basis for further work on both the hippocampus and neocortex."[4-6]

1. **Taylor J,** ed. *The selected writings of John Hughlings Jackson.* London: Staples Press, 1958. 2 vols.
2. **Vanderwolf C H & Heron W.** Electroencephalographic waves with voluntary movement. Study in the rat. *Arch. Neurol.* 11:379-84, 1964.
3. **Vanderwolf C H.** Hippocampal electrical activity and voluntary movement in the rat. *Electroencephalogr. Clin. Neuro.* 26:407-18, 1969. (Cited 210 times.)
4. **Vanderwolf C H & Robinson T E.** Reticulocortical activity and behavior: a critique of the arousal hypothesis and a new synthesis. *Behav. Brain Sci.* 4:459-514, 1981.
5. **Vanderwolf C H.** The role of the cerebral cortex and ascending activating systems in the control of behavior. (Satinoff E & Teitelbaum P, eds.) *Handbook of behavioral neurobiology.* New York: Plenum Press, 1983. Vol. 6. p. 67-104.
6. **Robinson T E,** ed. *Behavioral approaches to brain research.* New York: Oxford University Press, 1983. 352 p.