

Valenstein E S, Cox V C & Kakolewski J W. Reexamination of the role of the hypothalamus in motivation. *Psychol. Rev.* 77:16-31, 1970.  
[Fels Research Institute, Yellow Springs, OH]

Evidence challenging the prevailing view of discrete hypothalamic 'motivation centers' was presented. It was shown that: (1) identical hypothalamic stimulation evoked different behaviors following environmental changes; (2) individuals tended to respond idiosyncratically to stimulation; (3) motivational states such as hunger could not explain evoked behavior; and (4) anatomical specificity for evoking different behaviors had been exaggerated. [The *Science Citation Index*® (SCI®) and the *Social Sciences Citation Index*® (SSCI®) indicate that this paper has been cited in over 175 publications since 1970.]

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"It will be recalled that W.R. Hess<sup>1</sup> had observed that electrical stimulation at some hypothalamic sites made cats eat voraciously. Later, Greer<sup>2</sup> used electrical stimulation to demonstrate a hypothalamic 'drinking center' in rats and his report was soon followed by a succession of brief publications describing hypothalamic 'centers' not only for eating and drinking, but also for aggression, sex, hoarding, and other behaviors. Although the list kept increasing, there were few serious attempts to study the behavior that was evoked.

"In reviewing this literature, we were impressed by the anatomical overlap of what was presumed to be 'separate' motivational systems. Our first study clearly demonstrated that if animals were given the opportunity, they usually displayed several different behaviors when stimulated. It began to appear that much of the specificity was in the interest of previous investigators. We became most anxious to explore further.

"Our laboratory was in the Fels Research Institute where Verne Cox and I had recently been joined by Jan Kakolewski. These were heady times!

When we had an idea for an experiment, we usually continued discussing it as we pushed furniture into the hall to create a 'temporary' lab. Typically, we were operating on animals in an 'assembly line' on the same day. Antioch University undergraduates kept records, and handed us shaved, numbered, and anesthetized animals. After operating, we passed the animals to other students who were thrilled to be allowed to close the incisions. Usually, we were collecting data only a few days after our 'inspiration.'

"We soon completed several studies that questioned whether stimulation actually made animals hungry or thirsty as had been claimed. For example, animals that ate during stimulation usually switched from eating to another behavior rather than to eating a normally acceptable, but different, food. Or animals that drank would continue to lick empty water bottles when stimulated with no evidence of the behavior extinguishing. When we had accumulated a significant amount of histological data, we were forced to question the anatomical specificity others claimed. It also became clear that some animals were predisposed to display the same evoked behavior when aroused by stimulation at different sites. These results and others required a reexamination of hypothalamic function.

"The response to our article was enthusiastic, but bimodal. Many felt that an analysis of evoked behavior was long overdue and were pleased to see 'electrode phrenology' criticized. Others decided, however, that our approach was heuristically sterile and characterized it as 'Lashlian equipotentiality' theory in new clothes. Although the phenomena we described proved easy to replicate, the controversy has continued. Perhaps it's due to rose-colored glasses, but I believe our conclusions have gained support. Briefly, over the ensuing years, different types of evidence have indicated that stimulated animals are not hungry or thirsty; the same behavior was shown to be evoked after moving the electrode; arousal by such nonspecific stimuli as tail-pinch could also evoke several different behaviors.<sup>3,4</sup> The importance of individual predisposition has also been confirmed by additional studies. Recently, Guy Mittleman and I have found that animals that eat or drink during hypothalamic stimulation show the most ingestive behavior when aroused by other means than brain stimulation. We are not claiming, however, that we have a method for selecting animals that are arrested at Freud's 'oral stage' of development."

1. Hess W R. *The functional organization of the diencephalon*. New York: Grune & Stratton, 1957. 180 p.
2. Greer M A. Suggestive evidence of a primary "drinking center" in hypothalamus of rat. *Proc. Soc. Exp. Biol.* 89:59-62, 1955.
3. Valenstein E S. The interpretation of behavior evoked by brain stimulation. (Wauquier A & Rolls E T, eds.) *Brain-stimulation reward*. Amsterdam: North-Holland, 1976. p. 557-75.
4. .... Brain mechanisms of reinforcement. (Sweet W H, Obrador S & Martín-Rodríguez J, eds.) *Neurosurgical treatment in psychiatry, pain, and epilepsy*. Baltimore, MD: University Park Press, 1977. p. 27-49.