The highlight for January, 2006 is provided by Jan Bureš and Olga Buresova at the Institute of Physiology, Academy of Sciences of the Czech Republic in Prague. For the past 30 years, these two investigators and their research team have examined the role of brain mechanisms in conditioned taste aversion learning in rats. In their work, they have always noted the implications of their findings not only in terms of the functional brain anatomy of aversion learning but also in terms of the evolutionary significance of such learning (and how its evolutionary importance is reflected in its functional anatomy). Beginning in the early 1970's, Drs. Bureš and Buresova recognized some of the clear limitations of the use of permanent brain lesions in assessing learning and memory (in general and in the conditioned taste aversion preparation) and assessed the effects of a variety of reversible lesions on aversion learning. These reversible lesions allowed them to examine the effects of the removal of brain areas (cortical and subcortical) on the acquisition and retrieval of taste aversions. In so doing, they demonstrated that functional decortication by cortical spreading depression, hypothermia, anoxia and general anesthesia disrupted the processing of the taste stimulus, but had no effect on the association of tastes and poisoning, leaving aversion learning intact. These results are described in the summary of their exhaustive and impressive work on aversion learning. Their interpretation that the functional anatomy and evolutionary importance of aversion learning parallel each other is consistent with the origins of taste aversion conditioning as a biologically significant and unique form of learning.

Conditioned taste aversion – an example of implicit learning without awareness.

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The systematic study of the CTA literature by Riley and Freeman (2004) has considerably contributed to a better understanding of the neurobiology of the vitally important processes forming the basis of food selection learning. While CTA was discovered fifty years ago as a somewhat unusual form of conditioned reflex (Garcia et al., 1955), the proliferating research has rapidly established CTA as a vitally important learned reaction extremely resistant to interference. Since one of the basic tenets of learning theory is the belief that “an alert state of the nervous system is absolutely essential for successful conditioning” (Pavlov, 1927), loss of consciousness during general anesthesia, anoxia, deep hypothermia or post-convulsive coma should preclude perceptual awareness and rule out acquisition of conditioned reflexes. This is not true for CTA. Ten min of sodium saccharin (0.1% solution) drinking serving as CS and followed 30 min later by an intraperitoneal injection of LiCl (0.15 M, 2% body weight) elicits in rats severe gastrointestinal distress and is followed by strong aversion to saccharin on the next day. The same result is obtained when 15 min after saccharin drinking the rat is injected with pentobarbital and the LiCl is applied to the deeply anesthetized animal. This is surprising because a deeply anesthetized rat displays no memories for the events overlapping with the deepest stage of anesthesia. It seems that evolution has equipped animals with brain circuits which remain functional even when the poison has impaired the higher brain functions and has blocked conventional forms of learning. It is even possible that the loss of consciousness may precede the noxious visceral signals which remain below the awareness threshold. From this point of view, CTA is an example of implicit learning essential for coping with the inherent risks of omnivorous animals. The CTA circuit provides continuous recording of the visceral consequences of ingestion, which continues even under conditions blocking the conscious record of the information entering the brain. This exceptional feature of CTA learning is obviously due to the vital significance of this record which makes it possible to identify in the conscious record the events related to subsequent unconscious nausea and malaise. The first priority in food selection is to maximally reduce repeated poisonings. A dangerous experience is best exploited when the record of the preceding gustatory stimuli is preserved in spite of the poison-induced impairment of higher brain functions, loss of consciousness or coma incompatible with standard forms of cognition. The remarkable resilience of CTA to reversible brain damage is an impressive demonstration of biological optimism, of a deeply rooted refusal to give up hope as long as there is at least a spark of life. The organism still counts upon recovery and records the relevant information which should protect it against repetition of the near fatal error that caused the present disaster.

The CTA circuitry can be compared with the flight recorder (Bures et al., 1988), a sophisticated device carried on board of commercial airplanes, which records all commands, communications and important instrument readings during the flight. This record is the ultimate source of information allowing reconstruction of events preceding an accident and planning of preventive countermeasures. The device must have an independent power supply and communication system and the record must survive destruction of the airplane to be available to the investigators. The CTA engram represents a similar record formed in spite of the failure of the higher brain functions during critical imperilment of life. Although no episodic memory records the intestinal sensations elicited by the poison in anesthetized rats, the CTA record is implemented at some lower level of homeostatic regulation, documenting fundamental disruption of bodily functions. This feature of CTA is convincingly demonstrated by the fact that many people with clear aversion to a particular diet cannot describe the conditions when the aversion first appeared.

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