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BRIEF COMMUNICATION

Learned Taste Aversions Induced by High Doses of Monosodium L-Glutamate

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VOGEL, J. R. AND B. A. NATHAN. *Learned taste aversions induced by high doses of monosodium l-glutamate.* PHARMAC. BIOCHEM. BEHAV. 3(5) 935–937, 1975. – Learned taste aversions, as measured by increased time to complete 100 licks of a sweetened condensed milk solution, were demonstrated by laboratory rats 4 days after consumption of the milk solution paired with high oral doses of monosodium l-glutamate (MSG). The hesitancy of the rats to consume milk on the test session cannot be simply attributed to direct action of the drug on motivation (e.g., hunger) or to drug debilitation. MSG has been reported to occasionally cause aversive effects in humans (Chinese restaurant syndrome), and the present experiments demonstrate that the effects of MSG are aversive to laboratory rats as well.

Learned taste aversions Monosodium l-glutamate MSG

MONOSODIUM l-glutamate (MSG) is marketed as a food additive and flavor enhancer. Large quantities (20–45 percent) of MSG are reportedly added to food, especially during the preparation of oriental dishes [9]. Tadokoro *et al.* [9] reported suppression of fixed ratio food-reinforced lever pressing by rats following oral administration of MSG. Their results suggested that large doses of MSG might have aversive properties which, in turn, suppressed responding.

The association of novel preferred solutions with administration of certain drugs leads to reduced consumption of those solutions, commonly referred to as learned taste aversions. Learned taste aversions have been demonstrated with a variety of sickness-inducing treatments including x-irradiation [2], apomorphine [3], lithium chloride [6], cyclophosphamide [11] and rotation [4]. In addition, taste aversions can be induced by doses of a variety of psychoactive drugs which are not likely to produce sickness [1,10].

In order to examine the possible aversive properties of MSG, we paired administration of MSG with the novel flavor of sweetened condensed milk and tested animals for learned taste aversions.

METHOD

Animals

Fifty-one male Holtzman rats weighing approximately 200–250 g at the start of the experiment were used. Rats were maintained in individual cages on a 12 hr light, 12 hr dark illumination cycle with ad lib food and water available except 24 hr prior to training and test sessions.

Apparatus

Training and test sessions were carried out in a cubicle which measured 23.5 X 20.5 X 19.3 cm high (Scientific Prototype Model A-100). A bottle containing a solution of sweetened condensed milk (1 part Borden's Eagle Brand sweetened condensed milk to 2 parts distilled water at room temperature) was attached to the outside of the cubicle. A metal drinking tube extended up to and was flush with a 19 mm opening in the end wall of the cubicle. Individual licks on the tube were monitored with a drinkometer connected to electronic programming equipment.

Procedure

On the training day, each rat was weighed and placed in the cubicle. The time to complete 100 licks of the milk solution was recorded to the nearest 0.1 sec. After completion of 100 licks, the rat was removed from the apparatus and injected according to its group designation with 0.25, 0.50, 1.00 or 2.00 g/kg MSG (Ajinomoto Co.) dissolved in distilled water or with distilled water alone (0 g/kg). Doses were administered orally at a constant volume of 10 ml/kg. The rat was then returned to its home cage

and observed for approximately 30 min. Food and water were returned to the cages 3 hr after training.

The test session was carried out 4 days after training and was identical to the training session except that no drug was administered. If a rat failed to complete 100 licks in 600 sec, it was removed from the apparatus and assigned a score of 600.0.

RESULTS

Casual observation of the rats approximately 30 min after injection on the training day failed to reveal any marked changes in home cage behavior.

A dose-related aversion to the taste of sweetened condensed milk was evidenced on the test session (Fig. 1). The control group drank milk rapidly on the test session. Similarly, rats which had received 0.25 or 0.50 g/kg MSG on the training session also drank rapidly on the test session. Rats trained with 1.00 g/kg MSG showed significant taste aversions as compared with the control rats (two-tailed t test, $p<0.002$). Rats trained with 2.00 g/kg MSG showed even greater taste aversions. This group took significantly longer to complete 100 licks than the control group (two-tailed t test, $p<0.001$) and the group which received 1.00 g/kg MSG (two-tailed t test, $p = 0.05$).

DISCUSSION

A widely reported aversive reaction in humans to food which contains MSG is called the Chinese restaurant syndrome – a burning sensation spreading from the back of the neck to the forearms and thorax, facial pressure and chest tightening [8]. This reaction occurs 15–25 min after eating and usually lasts 1 hr. Although Chinese restaurant syndrome has been reported in human volunteers [8], a recent double blind study in which subjects were given 3 g of MSG in beef broth failed to confirm that aversive reactions follow MSG intake [5]. Tadokoro *et al.* [9] reported that high doses of MSG (1.0–2.0 g/kg) disrupted fixed ratio food-reinforced responding in rats. They also mentioned that, in other experiments, MSG (dose not specified) failed to disrupt discriminated avoidance and fixed interval food-reinforced behaviors. The results of the present experiment support suggestions that MSG has aversive effects. A single pairing of the novel taste of sweetened condensed milk with 1.0–2.0 g/kg MSG led to a marked inhibition of milk drinking. This result cannot simply be attributed to a direct action of MSG on motivational processes (e.g., hunger) or drug debilitation because the test session was conducted 4 days after administration of the drug. It is unlikely that pharmacologic activity was present at that time and Tadokoro *et al.* reported that suppression of food-reinforced responding by MSG completely disappeared about 40 min after administration of the drug. Further, the dose levels used in the present study are below those which may produce neurological damage in adult rodents (mice) [7]. This suggests that MSG has aversive effects in rats which are reflected by dramatic learned taste aversions.

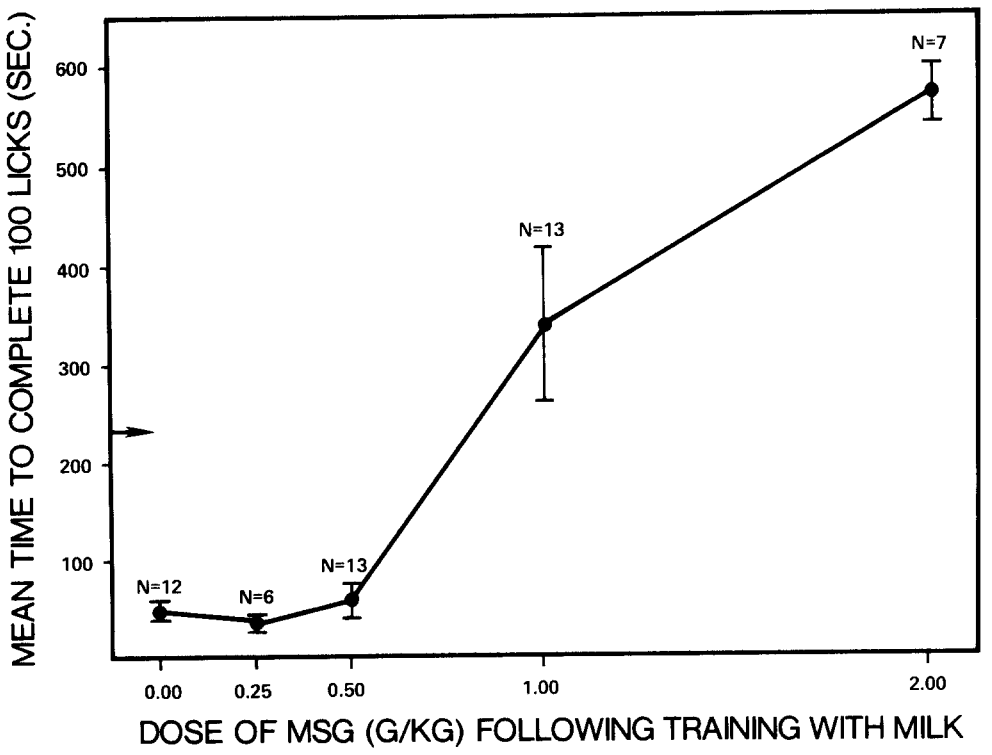

FIG. 1. Mean times ± SEM to complete 100 licks 4 days after sweetened condensed milk was paired with monosodium l-glutamate. The arrow on the ordinate represents the mean time to complete 100 licks on the training session (prior to injection) for all rats shown.

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