LINOLEIC ACID ALTERS LICKING RESPONSES TO SWEET, SOUR, AND SALT TASTANTS IN RATS.

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Introduction
It is known that rats can discriminate and prefer dietary fats, particularly corn oil, on the basis of orosensory information. One possible explanation of the fat preference involves a role for the gustatory system in the detection of fat in the oral cavity. If we assume that dietary fat is detected by the gustatory system, then free fatty acids are a likely candidate to be the “tastable” chemical component.

Corn oil, the prototypical dietary fat in rodent research, has three major free fatty acid components: linoleic acid (52%), oleic acid (31%); and palmitic acid (13%). In isolated rat taste receptor cells, linoleic acid inhibited delayed-rectifying K+ channels. This research suggests a transduction mechanism for the detection of linoleic acid by the gustatory system. Furthermore, the net effect of inhibiting the delayed-rectifying K+ channels would suggest prolonged depolarization in response to taste stimuli. Therefore, a given concentration of tastant would theoretically produce a larger gustatory neural signal when in the presence of linoleic acid.

We hypothesized that the presence of linoleic acid would increase the neural signal for a given concentration of tastant producing a greater perceived intensity than when that tastant was presented alone. The licking responses of rats to sweet, salty, and sour tastants with and without 88µM linoleic acid was measured.

Methods

CHEMICAL STIMULI
Sucrose: 16, 31, 62, 125, 250 mM
NaCl: 31, 62, 125, 250, 500, 1000 mM
Citric Acid: 2, 4, 8, 15, 30, 60 mM
Bitter: 1, 2, 4, 8, 16, 30 mM EXP A only
Linoleic Acid: 88 micromolar (28 µl / 1 L solution)
All solutions were mixed in 5 ml ethylene (ETOH)

BEHAVIORAL TESTING
All testing was conducted in a MS-100 Davis Rig. Each daily test session included 2 ascending order presentations of the test stimuli. Test stimuli were presented in 0.050 ml taste stimuli in 10s inter-trial intervals. Each rat was tested on 24 trials per session. The taste stimuli were water, NaCl, sucrose, citric acid, & quinine-HCl. Each taste trial was 20s with a 40s inter-trial interval. Testing under the water restriction conditions, a water stimulus (3.5m ETOH) was presented every 3rd trial.

EXP A:
Subjects: 10 naïve male Sprague-Dawley rats (CRL:CD(SD)IGS) greater than 90 days old at the start of the experiment
Training: Days 2-23.5 hr water access – Week 1: 30 min water access in the Davis Rig (15 90 trials with 10s inter-trial interval); Week 2: 500 mM sucrose (10 20s trials with 40s inter-trial interval)
Testing Paradigm: 4 weeks each consisting of 4 days of testing (Tuesday-Friday). One tastant was tested per week (week 1: sucrose; week 2: NaCl; week 3: citric acid; week 4: QHCl). Within each week, Days 1 & 2 = training days; Day 3 = testing days; Day 4 = testing & 88µM linoleic acid.

EXP B:
Subjects: 12 naïve male Sprague-Dawley rats (CRL:CD(SD)IGS) greater than 90 days old at the start of the experiment
Training: Days 2-23.5 hr water access – Week 1: 30 min water access in the Davis Rig (15 90 trials with 10s inter-trial interval); Week 2: 500 mM sucrose (10 20s trials with 40s inter-trial interval)
Testing Paradigm: 4 weeks each consisting of 4 days of testing (Tuesday-Friday). One tastant was tested per week (week 1: sucrose; week 2: NaCl; week 3: citric acid; week 4: QHCl). Within each week, Days 1 & 2 = training days; Day 3 = testing days; Day 4 = testing & 88µM linoleic acid.

Results
Linoleic acid increased the licking response to sucrose at almost all concentrations. The addition of linoleic acid never decreased the licking response to sucrose.
Linoleic acid decreased the licking response to NaCl as the concentration of salt increased toward aversive amounts. The addition of linoleic acid never produced an increase in the licking response to NaCl.
Linoleic acid decreased the licking response to citric acid. In EXP A, linoleic acid appeared to increase the licking response to NaCl, whereas in EXPB linoleic acid decreased the licking response to citric acid. Differences in training and testing paradigms may exert considerable influence on the behavioral gustatory responses of rats. Based on the response rate data (Table 1), the data collected in EXPB most likely reflects the true effect of linoleic acid on citric acid intake.

Conclusions
Linoleic acid acts to increase the intensity of sweet, salty, and sour tastants such that the natural preference or avoidance of each tastant is enhanced.
Future areas of interest include:
• the ability of other free fatty acids, such as palmitic acid and oleic acid, to alter tastant intake
• the effect of increasing the concentration of linoleic acid on the modulation of tastant intake
• the ability of other free fatty acids, such as palmitic acid and oleic acid, to alter tastant intake
• the applicability of this rodent model to human detection and perception of free fatty acids

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Our latest research on the taste of fat can be found at: http://FastTaste.ontheweb.nu