GUSTATORY DETECTION OF A FREE FATTY ACID, LINOLEIC ACID, BY 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 with a net effect of prolonged depolarization in response to taste stimuli. This research suggests a transduction mechanism for the detection of linoleic acid by the gustatory system.

This experiment defined the ability of rats to behaviorally detect and avoid low concentrations of linoleic acid. If rats could successfully detect and avoid linoleic acid based on neural signals in the gustatory system, then selective transection of the gustatory pathways should allow identification of necessary neural signals for the detection and avoidance of linoleic acid.

Methods

Conditioned Taste Aversion (CTA)

- Subjects: 16 Naïve male Sprague-Dawley rats greater than 90 days old
- Rats were placed on a 23.5hr water restriction 4 days prior to CTA Day
- Conditioning Day (CTA Day):
  - 1hr access to 2-bottles of the conditioned tastant:
    44, 66, or 88μM linoleic acid mixed with 5 mM ethanol (ETOH)
  - 30 min following the 1hr access all rats received i.p. injections (20ml/kg dosage) of either 150 mM LiCl (n=8); 150 mM NaCl (n=8)
- Test Day Access:
  - 1hr access to 2-bottles: 1 bottle containing the conditioned tastant and 1 bottle containing 5 mM ETOH (control solution)

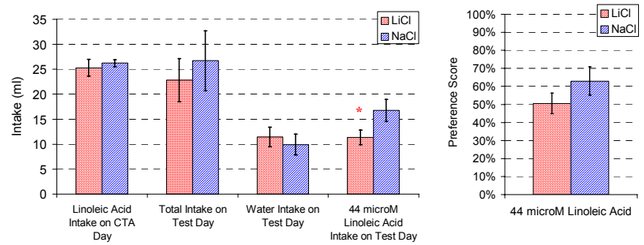
Chorda Tympani Transection (CTX)

- Subjects: Naïve male Sprague-Dawley rats greater than 90 days old
- Surgery Conditions:
  - CTX: bilateral transection of the chorda tympani nerve in the middle ear (n=13)
  - Sham: bilateral puncture of the tympanic membrane (n=15)
- Conditioned Taste Aversion Paradigm: same as above
  - Injection Groups: LiCl-CTX (n=8), NaCl-CTX (n=5), LiCl-Sham (n=10), NaCl-Sham (n=5)
- Confirmation of Surgery Condition: Following the CTA testing, bilaterally transected or intact chorda tympani nerves were confirmed through analysis of existing fungiform papillae (FP) & taste pores.

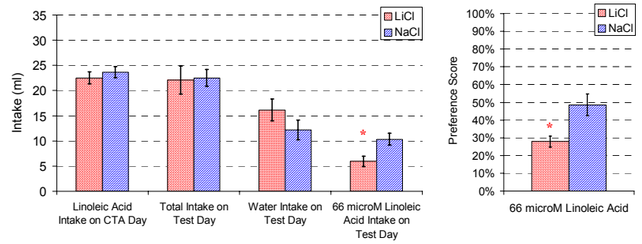
Data Analysis

- Tastant Intake measured by difference in bottle weight
- Preference Score = ratio of conditioned tastant to total intake
  PS = Intake of linoleic acid / (Intake of linoleic acid & 5 mM ETOH)
  < 50% Preference Score = Avoidance of linoleic acid
  > 50% Preference Score = Preference for linoleic acid

Ability to Detect Linoleic Acid in a Conditioned Taste Aversion Paradigm

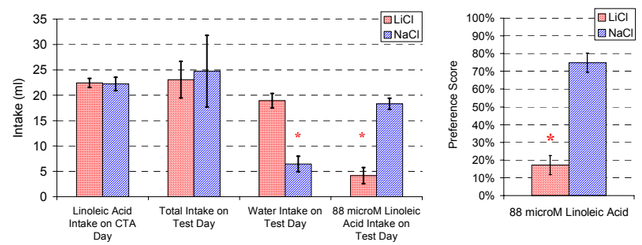


Far left: Rats receiving a LiCl injection consumed less linoleic acid than the NaCl group. There was no difference between linoleic acid and control solution intake for the LiCl group producing a preference score of 50%.



Far left: Rats receiving a LiCl injection consumed less linoleic acid than the NaCl group.

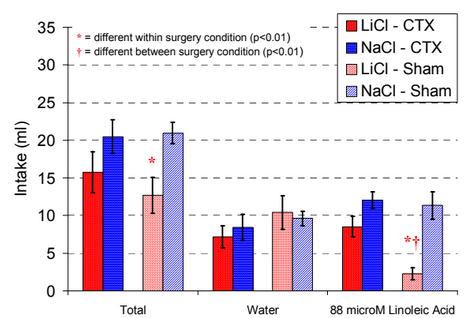
Left: Compared to the NaCl group, the LiCl group significantly avoided the linoleic acid.

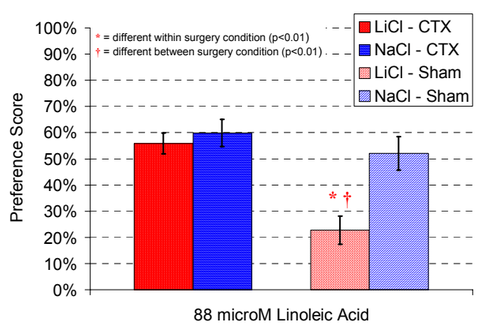


Far left: Rats receiving a LiCl injection consumed less linoleic acid and more control solution than the NaCl group. The total intake did not differ between groups.

Left: Compared to the NaCl group, the LiCl group significantly avoided the linoleic acid.

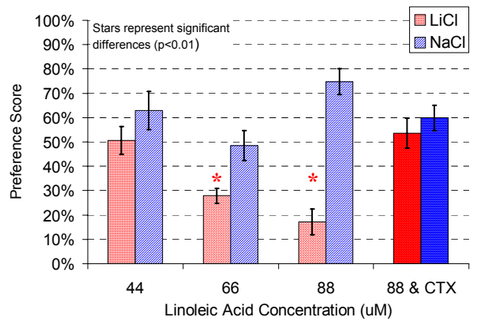
The Role of the Chorda Tympani Nerve in the Detection of Linoleic Acid





	Left Pores	Left FP	Right Pores	Right FP	Total Pores	Total FP	% FP w/ Pores	SE %:
CTX	7.22	61.56	8.67	57.44	15.89	119.00	11.9%	3.6%
Sham	66.8	74.5	69.8	77.4	136.6	151.9	89.5%	1.8%

Results



- In a conditioned taste aversion test, rats could successfully detect and avoid linoleic acid at concentrations equal to or greater than 66μM.
- Rats not exposed to an aversive stimulus (NaCl-injection) preferred 88μM linoleic acid to a control solution in a 2-bottle test.
- Following bilateral transection of the chorda tympani nerve, rats could not successfully detect and avoid 88μM linoleic acid.

Conclusions

1. Rats can taste linoleic acid, a free fatty acid component of corn oil.
2. The chorda tympani nerve transmits gustatory information that is necessary in order to form a conditioned taste aversion to linoleic acid.

Future areas of interest include:

- the detection abilities of rats for other free fatty acids such as palmitic and oleic acid
- the role of linoleic acid in modulating the intake of other tastants
- neural coding for the detection of linoleic acid in the chorda tympani nerve
- the applicability of this rodent model to human detection and perception of free fatty acids

Acknowledgements

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