Oral Digestion Contributes to the Hedonic Appeal of Sugar in Mice

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Introduction

• Previous research from our lab showed that sugar-experienced mice lacking a key channel for “sweet” taste transduction (TRPM5-) and their wild type counterparts (TRPM5+) lick more avidly for glucose and maltose than naive C57BL6J (B6) mice.1

• In sweet sensitive B6 mice, the acquired preference for glucose taste is abolished after glucokinase (GCK) has been virogenetically knockdown (KD).2 However, whether this same mechanism contributes to the preference of maltose in mice is unknown.

• In the taste cells, α-glucosidases (enzyme which cleave complex sugars to monosaccharides) are expressed.3 Therefore, we hypothesized that the digestive enzyme, maltase glucoamylase (MGAM) rapidly cleaves maltose to free glucose, which effectively generate more ligands nearby glucosensors.

In this experiment, we aim to investigate whether two enzymes involved in glucose assimilation, glucokinase (GCK) and maltase-glucoamylase (MGAM), which are also localized in taste cells, are required to express a preference for the taste of maltose.

Methods

1. Do sweet sensitive and subsensitive mice express different levels of GCK and MGAM in the taste papillae?

<table>
<thead>
<tr>
<th>Experimental Subjects and Procedures</th>
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<th>Conditions</th>
<th>Sugar Exposure Groups</th>
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<td>5 Sugar Exposed</td>
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<td>Mouse 4</td>
<td>9 Sugar naive</td>
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Procedures: Sugar exposure (vs naive), Brief Access Test, Tissue Harvest, and RT-qPCR.

Day 1 Day 2 Day 3 Day 4 Day 5 Day 6 Single Access Sugar Exposure

• 24-hour access session
• 1 solodays for 18 days
• Randomized order
• Only source of fluid
• Food restricted to 85% body mass

Naive mice were food restricted to 85% body mass and had water as their fluid source.

2. Does reduced GCK in the taste fields reduce the appeal of maltose compared to sucrose?

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Procedures: Sugar Exposure, Glucose versus Fructose Brief Access Test, 50% (vs scramble) KD, Maltose vs Fructose Brief Access Test, Tissue Harvest, RT-qPCR.

Post-KD Test | Stimuli | Parameters

Maltose versus Sucrose Brief Access Test

0.316 M Maltose, 0.56 M, 1.1 M maltose

0.316 M, 0.08 M, 1.1 M sucrose, deQ

Estimate mice loss per 24 hr. Study mice harvested and GCK expressed in taste fields.

3. Does reduced MGAM in the taste fields reduce the appeal of maltose compared to sucrose?

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Procedures: Sugar Exposure, Glucose versus Fructose Brief Access Test, Maltose (vs scramble) KD, Maltose vs Fructose Brief Access Test, Tissue Harvest, RT-qPCR.

Post-exposure Brief Access Test

Virogenetic GCK or MGAM knockdown (KD)

2 µl of vector was infused onto the fungiform and circumvallate taste papillae

Post-exposure Brief Access Test

Results

Sweet-sensitive (B6 and TRPM5+) mice have more GCK in the taste buds than do the sweet-sub-sensitive (TRPM5-) mice. Yet, B6 mice have less MGAM in the taste buds than TRPM5+ and TRPM5- mice.

Expected Results

Sweet-sensitive (TRPM5+) mice with deficient lingual GCK lick significantly less for maltose in a brief access taste test.

Discussion

• Sweet-subsensitive mice (TRPM5-deficient) have diminished sweet receptor gene expression (Tas1r3) or GCK in the taste papillae coupled with greater expression of a gene that encodes for the main enzyme involved in maltose digestion (Mgam). Sweet-sensitive B6 mice, on the other hand, express less peri-taste Mgam.

• Knockdown of GCK in the major taste fields decreases the hedonic appeal of maltose in sugar-exposed sweet-sensitive mice.

• These findings raise the interesting possibility that sweet-subsensitive mice have an increased capacity to rapidly digest complex saccharides, effectively generating more ligands to engage diffuse sweet receptors and/or glucosensors at the level of the taste bud.

• Knockdown of MGAM in the major taste fields is predicted to reduce licking avidity for maltose in sugar exposed TRPM5+ sweet-sensitive mice.

• The results will provide the first evidence that two key metabolic enzymes (glucokinase and maltase-glucoamylase) act within the taste buds to bolster signals that drive complex sugar ingestion.

References & Acknowledgement


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