Anterior Tongue Shows Greater Fine Roughness Acuity than Finger

Karli Van Simaeys, Brittany Miles, Christopher Simons

Department of Food Science and Technology, The Ohio State University, Columbus, OH 43210.

INTRODUCTION

While the systems of texture perception on the dermis have been well-researched, there is not much information about texture perception in the oral cavity. Structures, transduction mechanisms, and knowledge about comparative sensitivity do not exist for most textures on most oral surfaces. What knowledge we do have is limited to a few, higher-level studies. Almost no comparative evaluation between the oral cavity and the epidermis has been conducted.

The mechanism for fine surface roughness perception in the fingertips has been partially explained. Bensmaia and Hollins (2003) found that Pacinian corpuscles were responsible for fine surface roughness detection (<100μm) on the fingertips. However, these corpuscle structures have not been seen in the tongue[2]. This leads us to believe that if fine surface roughness perception by the tongue is occurring then either the Pacinian corpuscles may actually be present, or there is some other structure that allows us to perform this task.

Our study seeks to establish a detection threshold for lingual roughness sensitivity and compare it to the sensitivity of the fingertips. In doing so, we hope to determine which surface shows a greater roughness sensitivity and discrimination ability. Based on the oral cavity's independence from visual cues (a dominant part of texture sensation in the fingers), we hypothesized that the tongue would show a greater roughness sensitivity and tactile acuity than the fingers, as its tactile discrimination ability is exclusively responsible for many aspects of texture identification in the mouth[3,4,5].

OBJECTIVE

To establish detection thresholds for fine roughness perception on the anterior tongue versus the fingertip in an effort to learn more about the mechanisms of surface roughness perception in the oral cavity.

MATERIALS & METHODS

Stimuli

- Stainless steel coupons mechanically roughened to surface roughness levels from 0.177 to 0.44μm (as measured by optical profilometry)
- Stimuli presented to panelists using rubberized clamps prevent potential temperature cues
- Panelists also wore parafilm-covered goggles to prevent stimuli recognition based on visual information

Panelists

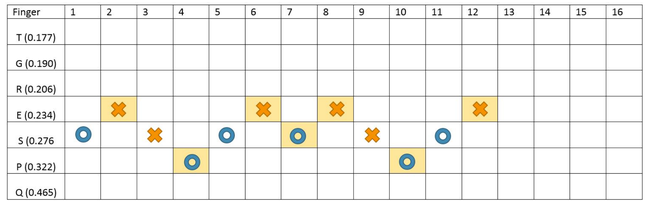
- 31 subjects (18F, 13M) between the ages of 18-30
- Excluded smokers and individfuals with noticeable surface deformations or calluses on the tongue or finger tip
- Self excluded if based on frequent engagement in any "callus forming" hobbies or professions

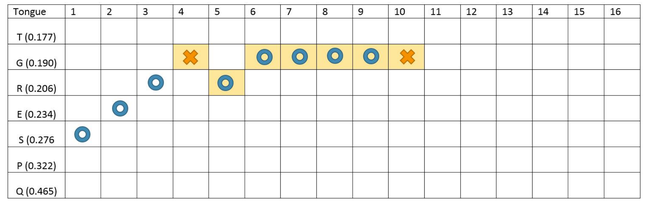
The roughest coupon, Q (pictured left) and the least rough coupon, T (pictured right).

MATERIALS & METHODS (cont.)

Roughness Evaluation

- Presented with a pair of metal stimuli and were asked which one they perceived to be rougher. They were always presented the smoothest stimuli, T, and another, rougher stimuli
- If correct, panelists were given the next less rough stimuli and the smoothest stimuli to compare
- If incorrect, they were given the next rougher stimuli and the smoothest stimuli to compare
- To prevent effects due to licking or rubbing pattern panelists were asked evaluate stimuli by licking or rubbing them in a circular motion





Completed staircase for both the tongue and the finger. Blue circles indicate a correct response and orange crosses indicate an incorrect response. Highlighted boxes denote a recorded reversal.

Data Analysis

- Reversals consisted of a correct response then an incorrect one or vice versa
- In the event a panelist correctly selected the rougher stimuli for the least different pair or incorrectly selected the smoother stimuli for the least different pair marked it was also marked as a reversal
- Repeated until seven reversals were achieved. The mean of the seven reversals were then calculated to find the detection threshold for both tongue and finger

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RESULTS AND DISCUSSION

Average Detection Threshold

- On average, panelists showed a very **significantly lower detection threshold for the tongue versus the fingers** (p<0.001, Figure 1)
- The fingers had an average detection threshold of 0.289 ± 0.018 μm, while the tongue had an average detection threshold of 0.216 ± 0.004 μm.

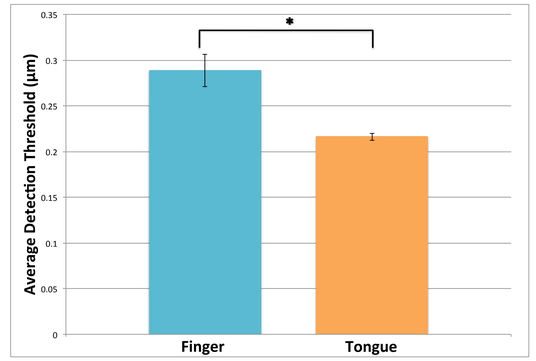

Figure 1: Average Roughness Detection Threshold for the Finger vs the Tongue.

Binomial Statistics

- Analysis using binomial statistics, also showed that **a significant number of panelists had greater acuity with their tongue than with their finger** (p = 0.021, Figure 2)
- 21 participants showed greater acuity with the tongue, while 8 were better with their fingers. One panelist received the same score for both locations.

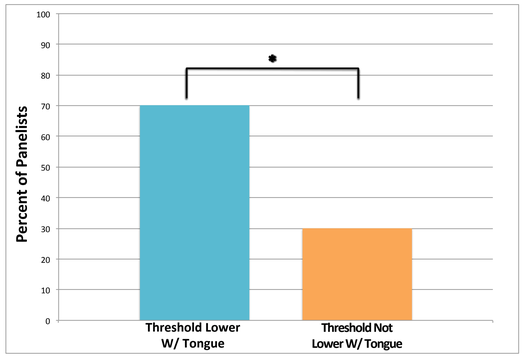

Figure 2: Proportion of population showing greater acuity with the tongue versus not with the tongue

CONCLUSIONS

- Results support the hypothesis **that the tongue has a greater ability to perceive fine-scale surface roughness than the finger tips**
- This suggests that **mechanosensitive nerve endings sensitive to fine surface roughness** (potentially Pacinian corpuscles) **are found in the tongue**
- Potential future studies include identification of specific neural structures responsible for transduction as well as similar comparative sensitivity studies looking at comparisons using different stimuli or between different oral tissues