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Research Report

Rapid quantitative assessment of fungiform papillae density in the human tongue

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Abstract

Fungiform papillae density, which can be used in a variety of circumstances as an indicator of taste function [L.M. Bartoshuk, V.B. Duffy, I.J. Miller, PTC/PROP tasting: anatomy, psychophysics and sex effects, Physiol. Behav. 56 (1994) 1165–117; I.J. Miller, F.E. Reedy, Variation in human taste bud density and taste intensity perception, Physiol. Behav. 47 (1990) 1213–1219; J.R. Zuniga, N. Chen, C.L. Phillips, Chemosensory and somatosensory regeneration after lingual nerve repair in humans, J. Oral Maxillofac. Surg. 55 (1997) 2–13], was measured on the dorsal surface of the anterior tongue of living humans using a digital camera and a videomicroscope. Both procedures provided similar results, with the camera providing a more rapid, portable and flexible imaging procedure. Subsequently, the camera was successfully used to identify small regions of the anterior tongue which provide reliable measures of fungiform papillae density that correlate highly with the total number of fungiform papillae on the anterior tongue.

Theme: Development and regeneration
Topic: Sensory systems

Keywords: Fungiform papillae; Papillae density; Humans; Digital camera; Videomicroscopy

1. Introduction

High numbers of fungiform papillae on the anterior dorsal surface of the tongue are commonly found in people who are classified as supertasters of the bitter substance PROP compared to moderate and non-tasters [1,8], while degeneration or loss of taste following medications or neural damage is accompanied by a decrease in the number of papillae found in individuals [11,15]. Measurement of papillae number or density, therefore, can provide information about taste function. Counts of these papillae in living tissue have been achieved using non-invasive videomicroscopy [7–9,11]. However, although the videomicroscope is an excellent tool for this purpose, its use is limited to the research laboratory. Currently, there is a need for a more portable system that allows filming of fungiform papillae of subjects at their bedside and outpatient clinics in hospitals to gain an insight to taste function and of substantial numbers of children in schools in studies of the development of taste [10]. Another disadvantage of the videomicroscope is that it requires 30–60 min to obtain high quality images from an individual to allow counting of papillae. This time period is unacceptable to patients in pain or uncomfortable from clinical treatments or to young children with their limited attention span. As regards other portable devices for measuring papillae density [3,12,13], none provide the flexibility of the digital camera. Accordingly, as an alternative method for obtaining images of taste papillae, in Part 1 here, we have investigated the use of a digital camera.

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Following validation of the digital camera as a suitable tool for measuring fungiform papillae density, in Part 2 of the study, the aim was to use the camera to locate the region(s) of the anterior tongue which provide the most reliable location for determining papillae density and that give the highest correlation with the total number of papillae on the anterior tongue. The reason for wanting to define such a region is that a number of studies have reported using a single small region of the anterior tongue to provide an indicator of the total number of papillae in this area, however, none have demonstrated that the small region they have used is the most reliable indicator [1,8,14]. Accordingly, by establishing such a location, we proposed that this would provide a reliable and rapid method for assessment of taste function in studies of human responses to PROP and degeneration/regeneration of taste papillae during treatment with medications and diseases which affect taste function.

2. Part 1

2.1. Aim

To determine if a digital camera can be used as a reliable tool for measuring fungiform papillae density in humans.

2.2. Methods

The subjects were 9 children aged 8–9 years (mean: 8.7 years) and 7 adults aged 25–38 years (mean: 31.0 years), from local suburbs, who were examined in a University microscopy laboratory. Prior to commencing measurements, subjects rinsed their mouth with deionized water (Milli-Ro-6 Plus System, conductivity 0.9 μS). Their tongue was dried with a filter paper by the experimenter, and a 6 mm diameter circular piece of filter paper (Whatman's No. 1) [4] that contained a blue food dye (Robert's Brilliant Blue FCF133) was placed on the tip of the anterior part of the left side of the tongue closest to the midline (Fig. 1A) for 3 s. On removal of the filter paper, the tongue was again dried. In the procedure used with the digital camera, to minimize head movement during filming, a subject supported their head by placing their arms on a table and held their head with their hands such that their chin protruded forward. The subject then protruded their tongue and held it steady with their lips (Fig. 1A). A 10 mm × 3 mm wide piece of filter paper placed on the right side of the anterior tongue provided a scale to calculate the magnification of each image (Fig. 1A). Following this, 3–5 images of the stained area were recorded with a Nikon Coolpix 4500

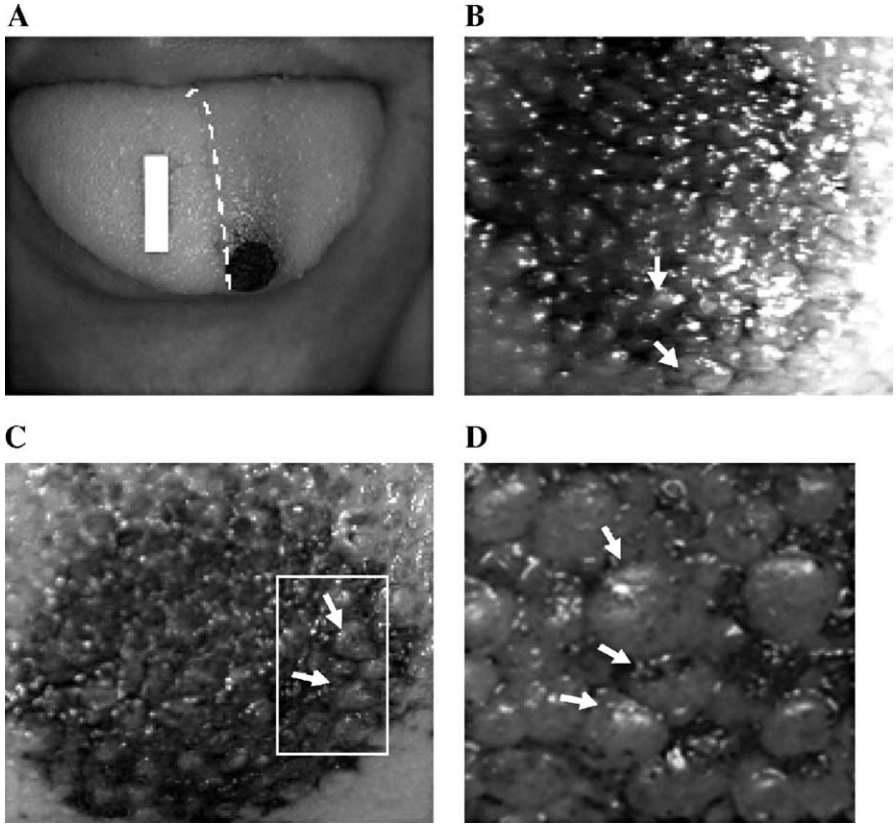

Fig. 1. (A–D) Fungiform papillae in a human tongue. (A) Tongue with midline highlighted with a white line and showing the 6 mm diameter stained area where papilla counts were conducted and the 10 mm scale. (B, C) Images of the stained area obtained with the videomicroscope and digital camera, respectively. (D) Inset in (C) viewed at the highest magnification used with the camera (×22.5) to count papillae. Arrows indicate typical fungiform papillae.