Evaluation of some factors affecting taste perception

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Summary

The sense of taste is one of the most important human senses. Alteration in taste perception is crucial because it influences dietary habits and general health. In this study, we evaluated the influences of some physiological and external factors on taste perception such as gender, smoking, dietary habits and role of saliva in a group of young people. Twenty young subjects (mean age 25.2) were enrolled for the study. A whole-mouth, above threshold test and a spatial taste test were performed using four basic tastes (sweet, salty, sour, bitter). There was no significant difference in taste threshold concerning gender ($p > 0.10$), but a significant relation was found between the number of cigarettes per day and an increase in threshold for sweet taste ($p<0.10$). There was a significant relation between the frequency of salty food consumption and increase in threshold for bitter taste ($p < 0.10$). No significant difference was found between wet and dry mouth in spatial test ($p > 0.10$). This study suggests further researches, investigating various factors influencing taste perception.
Keywords: taste perception, gustatory function, smoking, dietary habits, saliva.

Introduction

The senses of taste and smell allow us to separate undesirable foods from those that are nutritious [1]. Both senses are strongly tied to primitive emotional and behavioural functions of our nervous system. Taste defines our ingestion of foods, beverages and medications [2]. Taste preferences mean simply that a person will choose certain types of foods in preference to others, and he/she automatically uses this to help control the type of diet eaten. Moreover, taste preferences often change in accord with the needs of the body for certain specific substances [1]. There are many pathophysiological conditions as well as daily habits that have close relation with the gustatory function. Taste perception is an important factor that affects the quality of life. Saliva plays a gastronomic role by solubilizing many of food components and acting as a medium for interaction, with the receptors of the taste cells. Reports dealing with the interaction of salivary function and taste preferences are contradictory. The aim of this study was to evaluate influences of various factors such as gender, smoking, nutritional habits and saliva function on taste perception in a group of young people.

Material and method

Twenty patients, admitted to Ankara University – Faculty of Dentistry for routine dental treatment, were enrolled for the study. All subjects taking part in the study were required to fulfill the following criteria: not be taking any medication, have good oral hygiene, not have any dental or systemic disease and history that could affect gustatory function [3], and not have any salivary gland disease. All measurements were recorded in the late morning or afternoon, at least one hour after each patient had finished eating or smoking.

To taste gustatory function, a whole-mouth, above threshold test and spatial test were carried out. For this test, sucrose (sweet), sodium chloride (salty), citric acid (sour) and quinine hydrochloride (bitter) solutions were used. Informed consent was obtained from all the participants.

Whole-mouth, above threshold taste test

For this test, the patient was instructed in the use of magnitude estimation to rate the intensity of each stimulator solution. Five concentration levels (in ½ log steps) of sodium chloride (0.01 mol/L – 1.0 mol/L), citric acid (0.32 mmol/L – 0.032 mol/L), quinine hydrochloride (0.01 mmol/L – 1.0 mmol/L) and sucrose (0.01 mol/L – 1.0 mol/L) were prepared in 5 ml samples, which the patient sipped and then expectorated. The solutions were given in increasing concentrations respectively. The patient was then asked to identify the quality (sweet, salty, sour, bitter, or tasteless) and intensity of each test solution. The threshold of each solution was determined.

Spatial (localized) taste test

I order to evaluating saliva role on taste, each patient was tested on localized taste function. This test consists of identifying the quality of each test stimulus and rating the stimulus on an intensity scale from 0 (no taste) to 9 (very strong taste). In each trial, the threshold concentration of each of the four compounds used in the whole-mouth taste test was painted with a cotton swab on one of four locations in the mouth: the right and left anterior and posterior-lateral surfaces of the tongue (within the receptive field of the chorda tympani-lingual nerve). This procedure was firstly applied when the mouth was physiologically wet. Then the mouth was dried thoroughly using a cotton swab and air pressure, then roller cottons were inserted bilaterally to parotid papilla and sublingual caruncle to prevent saliva flow from the salivary glands, after which the procedure was repeated.

To prevent any bias, the order in which each solution was to be taken was determined randomly. All tests were done in the same visit, and to minimize fatigue or inattention, all participants were allowed to take periodic rest breaks. Each patient was studied by only one observer.

Statistical analysis: Kruskal-Wallis test and Mann-Whitney U test were used and values ($p < 0.10$) were considered as significant.

Results

Twelve of the participants were female (60%) and 8 were male (40%). Age ranged 18 to 30 with a mean of 25.2. The scores of the whole-mouth, above threshold test for all parameters are shown in *Table 1*. There was no statistically significant difference between male and female subjects in the threshold for four basic tastes ($p > 0.10$). Five patients were non-smokers (25%), 4 were smoking 1-10 cigarettes/day (20%), 2 were smoking 10-15 cigarettes/day (10%), 5 were smoking 15-20 cigarettes/day (25%) and 4 were smoking 20-30 cigarettes/day (20%). There was a significant difference in threshold values for sweet taste between smokers and non-smokers ($p < 0.10$). As number of cigarettes smoked per day increased, increase in threshold for sweet taste was significant.

Concerning dietary habits, for sour food, 13 patients reported „rarely“ consumption (65%), 6 reported „sometimes“ (30%) and one reported „frequently“ consumption (5%). For salty food, 8 patients reported „rarely“ (40%), 10 reported „sometimes“ (50%) and 2 reported „frequently“ (10%). For spicy food, 11 patients reported „rarely“ (55%), 3 reported „sometimes“ (15%) and 6 reported „frequently“ (30%). For bitter food, 13 patients reported „rarely“ (65%), 4 reported „sometimes“ (20%) and 3 reported „frequently“ (15%). There was no significant difference in threshold values according to dietary habits ($p > 0.10$) except for salty food consumption. Significant increase was found in threshold for bitter taste parallel to frequency of salty food consumption ($p < 0.10$). There was not a significant difference between wet and dry mouth for the four basic tastes in spatial test (*Table 2*).

Table 1. *p* values for whole-mouth above threshold test

	Tested solution			
Factor	Sucrose	NaCl	Citric acid	Quinine hyd.
Gender	0.86	0.13	0.32	0.69
Smoking	**0.04**	**7**0.1	80.39	0.63
Sour food consumption	0.95	0.93	0.34	0.71
Spicy food consumption	0.87	0.24	0.27	0.37
Salty food consumption	0.67	0.30	0.12	**0.087**
Bitter food consumption	0.50	0.36	0.58	0.23

bold numbers: statistically significant

Table 2. *p* values for spatial taste test to investigate the role of saliva on taste function

	Tested solution			
Tested region	Sucrose	NaCl	Citric acid	Quininne hyd.
Right ant. tongue	0.34	0.21	0.24	0.62
Right post. tongue	0.13	0.14	0.33	0.92
Left ant. tongue	0.13	0.11	0.33	0.69
Left post. tongue	0.13	0.10	0.26	0.62

Discussion

Only a few studies investigated differences by age and sex in taste thresholds, measured at different loci in the mouth. Some of these studies found a difference in thresholds by age and sex whereas others did not. Different reported results may be due to different concentrations of the solutions and the techniques used for taste test and also the points stimulated in the mouth. Researchers whose results identified a difference in taste perception by sex, commonly indicated that detection and recognition of sour taste is higher in males than that in females [4, 5]. Our recent research findings indicated that there was a palatal deficit for sour and salty taste perception in elderly men compared to age-matched women (data not given). In this study, we did not find any difference in threshold for the four basic tastes in either sex. This may be attributable to physiological and hormonal differences between young and elderly people [6]. We only included young people in our study to rule out age effect on taste perception.

There are some other factors besides sex that can contribute to a change in taste perception. Some external factors that can affect the mouth have been suspected of or known to cause taste buds to decline in number. Smoking, for example, has been suspected of either inhibiting or destroying mouth ability to function properly. Hsu and Davis [7] found that smoking, along with certain diseases, could decrease gustatory sensitivity. Peterson et al. [8] and Yamauchi et al. [4] found higher thresholds among smokers, compared to non-smokers, for bitter taste only, and Jackson [9] reported that recognition of salty taste deteriorated among subjects who smoked at least 40 cigarettes per day. Sato et al. [5] found that taste threshold on the soft palate was higher for all four basic tastes among smokers of both sexes. They also concluded that impact of smoking on taste thresholds could develop first in the soft palate, probably due to the smaller number of taste buds in the soft palate. On the basis of different results, one may infer that even if smoking does have a negative effect on taste perception, the effect is probably slight and is most likely to affect bitter taste. In contrast, Moore et al. [10] and Fisher et al. [11] reported no significant difference between smokers and non-smokers. In this study, we found a significant difference in threshold for sweet taste between smokers and non-smokers. It is difficult to explain why smokers cannot perceive sweet as non-smokers can; therefore, we suggest further studies investigating the relation between different smoking habits (i.e. pipe smoking, reverse smoking, smokeless tobacco etc) and taste alteration.

Dietary habit is an important factor in taste function, in both negative and positive means. Healthy nutrition without excessive preference of any food, affects the taste function in a positive way. However, propensity to any kind of food may cause over consumption of that food which may give rise to systemic problems and side effects. As found in our study, people preferring salty foods lose perception of bitter taste. Preference of salty food may cause serious problems such as high blood pressure and renal diseases. Besides this, deficit in bitter taste may induce consumption of bitterer food, which is considered as a main factor for GIS complaints. Dietary habits of young people are worth considering, in order to decrease and prevent possible future systemic problems.

Spicy food consumption is a very common habit among Turkish people. It is considered as a tradition in Turkish cuisine almost in all regions of the country. Capsaicin, the active principle of hot peppers, has various effects on animals and the effects vary with the time of exposure. It has influence on a wide range of physiological processes, stretching far beyond those involved in creating its gustatory appeal

[12]. Recent studies showed that capsaicin is neurotoxic to the sensory neuron. It was found that capsaicin induces neurotoxicity in cultured dorsal root ganglion neurones [13,14]. It not only may cause sensory neuron degeneration but it can also cause duodenum cancer. Additionally, capsaicin is reported to have tumorigenic and mutagenic effects. However, it provides many therapeutic effects on many diseases like gastric ulcer, pain and arthritis [12,15,16]. Considering all reports on the neurotoxicity of capsaicin, eating hot spicy food may not be such a good idea, because of the possible result of nerve degeneration and carcinogenesis caused by capsaicin.

The terms „spicy" and „bitter" are generally confused and used in place of each other in daily speech. The receptors for bitter taste are mostly located in the posterior part of the tongue but we are not sure where the receptors for spicy taste are located. It is also difficult to determine whether the participants in this study were aware of the difference between „spicy food" and „bitter food".

Tasting ordinarily occurs in the presence of saliva and is mediated by sensory end organs that are chronically exposed to the fluids produced by major and minor salivary glands. The differentiation, growth and maintenance of taste buds depend on the presence of normal saliva [17]. As there is a mutual relationship between saliva flow and diet, food does not only influence salivary flow, but saliva can also affect sensory perception [18, 19]. Short-term reductions in salivary flow have been shown to have only little effect on taste perception, while long-term deficiency of saliva resulted in lower taste sensitivity and altered preferences [19]. Saliva is expected to be involved in our perception of taste, flavour and texture of foods. Mixing the saliva with food can have a diluting effect and it can influence flavour release. Saliva helps to dissolve and carry molecules that are perceived as one of the four or five basic tastes (including monosodium glutamate; umami) [20, 21]. However, there is not an agreement in the literature about the role of saliva on taste perception. Experimental studies have shown that removal of the major salivary glands as well as submandibular and sublingual salivary glands decreased preference for sodium chloride, potassium chloride, hydrochloric acid, and quinine sulphate [17]. Galili et al. [22] found that xerostomic rats showed a greater acceptance of salty and sour flavoured diets than do normal animals, whereas there was no difference in response to sweet or bitter flavoured diets. An explanation offered for the changes in taste preferences in xerostomic subjects is that saliva is essential for the maintenance of taste bud integrity. The duration of dryness of the mouth in our study is too short to come to a conclusion about preservation of taste bud integrity and taste alteration.

Sjöngren syndrome patients have been reported to have impaired taste detection and recognization thresholds [23]. Weiffenbach et al. [24] found an adequate to normal taste function in eight patients with no salivary function. Normal salivary gland function may not be necessary for the maintenance of normal taste perception. Although saliva is critical for complete oral comfort and function, it is not essential to the preservation of an intact taste system. Even in the chronic absence of saliva, the structures providing taste maintain their functional integrity. When the protection afforded by saliva is absent, taste system cells continue to be fully functional for a long time.

We tried to dry the mouth thoroughly but although it seems dry clinically it is not possible to make complete dryness on a molecular basis. In this study, in normal wet mouth and dry mouth, a significant change in the perception of the four basic taste solutions was not found. This may be attributable to presence of small amount of water molecules on taste receptors. On the basis of our results, we may infer that unless saliva is totally absent, even a small amount of saliva can provide sufficient taste perception.

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