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A test for the screening of taste function*

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SUMMARY

The overall aim of the present study was to investigate a new method for the screening of taste function in a clinical context. Instead of dripping liquids onto the tongue, thin edible wavers were used. One-hundred healthy subjects participated in the study (41 male, 59 female; mean age: 52 years; age range: 20-89 years). Supra-threshold taste stimuli were presented as flavoured wavers made from flour and water. Sequential testing was performed regionally on the anterior one-third of the tongue and as whole mouth testing. When comparing ratings for the 5 different wavers separately for regional and whole mouth testing, differences between qualities only emerged for regional testing. Women were found to have less difficulty in taste identification which was most pronounced for regional testing. No effects of the subjects' age were observed. In conclusion, the wavers were found to be easy to use; they have a shelf-life of 2 to 3 years and can be carried in the pocket. The results indicate that the wavers may be suited for the screening of gustatory function, especially in a clinical setting.

Key words: gustation, identification, thresholds

INTRODUCTION

Traditionally, assessment of taste function is performed by means of liquids that are brought onto the tongue (for review, see Frank et al., 1995). This form of stimulation requires a dispenser, most often some sort of pipette, that allows presentation of a defined quantity of liquid. The solutions used for testing have to be replaced frequently. While this procedure is no major concern in experimental research, the prerequisites for testing appear to be a major obstacle in the routine clinical evaluation of taste function. This leads, in turn, to the negligence of the sense of taste by neurologists, otorhinolaryngologists, and general practitioners. Thus, instead of systematic testing, many clinicians rely on the simple question whether the patient feels his/her sense of taste is altered.

To address this problem it appears necessary to provide the clinician with a taste screening system that can be used with the same ease as routine tests of the sense of smell (Doty et al., 1994; Kobal et al., 1996). Three major points are of importance: administration of the test-to-be-used has to be easy, the test should be of pocket-size, and it should have a long shelf-life.

Instead of dripping liquids onto the tongue it was thought to be more practical to use edible carriers of the taste. Similar ideas have been brought up by Dr. David G. Laing (personal communication), who used tablets with different flavours, and Furuta and co-workers, who used impregnated strips to investigate salty sensations (Nishimoto et al., 1996). Considering this it seemed to be ideal to utilize thin wavers that are used throughout Germany during the Christmas season for baking traditional-style cookies (so-called “Oblaten”). These thin wavers, made from flour and water, are virtually tasteless. When brought onto the tongue they immediately start to dissolve in the saliva; while they have very little mass (≤0.17 g per waver), one waver covers a surface of 6.6 cm^2. By adding NaCl, saccharin, quinine, and citric acid to the dough it was possible to produce wavers of different tastes. After chewing on them subjects do not have to spit them out but may swallow them.

The present study aimed to investigate some basic properties of this new procedure. Specifically, it aimed to investigate differences between taste function when applying stimuli to the tongue or the whole mouth. In addition, it should be tested if the current method is sensitive to gender-related differences in gustatory sensitivity (for review, see Doty, 1978).

MATERIAL AND METHODS

All experimental procedures were explained and demonstrated in full detail to the subjects. Written informed consent was

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obtained and the study was performed in accordance to the Declaration of Helsinki/Hong Kong.

Subjects

A total of 100 healthy subjects were included into the study (41 male, 59 female; mean age: 52 years; range: 20-89 years). None of the subjects reported gustatory dysfunction.

Protocol

Taste stimuli were presented as flavoured, thinly baked wavers made from flour and water; tasteless wavers were also used (Hoch, Miltenberg, Germany; Küchle, Günzburg, Germany). Four flavours were presented: sweet (saccharin, 4 g/l dough), sour (citric acid, 20 g/l dough), salty (sodium chloride, approximately 40 g/l dough) and bitter (quinine sulfate, 1 g/l dough). All wavers had a diameter of 29 mm, both average thickness and weight varied between the four flavours (saccharin: 1.10 mm, 16g mg; citric acid: 0.83 mm, 136 mg; quinine sulfate: 1.22 mm, 165 mg; sodium chloride: 0.94 mm, 162 mg). Their shelf-life is 2-3 years. During preliminary experiments these concentrations had been established to produce clear, supra-threshold taste sensations when put on the tongue.

The five types of wavers were applied to the subjects in a randomized fashion with an interval of approximately 1 min. They were instructed that the wavers might be either tasteless, or that they might taste like sweet, sour, salty, or bitter. First, the experimenter laid the wavers in the middle of the anterior one-third of the tongue. Subjects were instructed to keep the mouth open while they put the tongue out for approximately 5 s. After that, they had to indicate whether they perceived one of the possible four sensations or whether the waver was tasteless (forced choice). Then they put the tongue back into the mouth and chewed on the wavers for up to 10 s. Following that they again had to indicate the waver's flavour. Between presentation of the wavers subjects were free to sample low-sodium, non-carbonated mineral water. This procedure yielded correct or incorrect responses for regional or whole mouth testing.

Statistical analyses

Results were analysed by means of SPSS (version 6.1.3). Differences between taste qualities were analysed by means of Friedman 2-way ANOVAs (analysis of variance, repeated measurements). To investigate effects of both gender and age, scores were built separately for the two responses (regional *versus* whole mouth testing) which were 100% when subjects identified all flavours; if one response was incorrect, the score was 80%, and so on. These data were submitted to ANOVAs with between-subject factors "sex" or "age" and the within-subject factor "taste".

RESULTS

When comparing the ratings for the 5 different wavers separately for regional and whole mouth testing, differences between qualities only emerged for regional testing (df=4, X^2=35.9, p<0.0001). Here it was most difficult for the subjects to recognize bitter and sour (Figure 1). Tasteless wavers were recognized

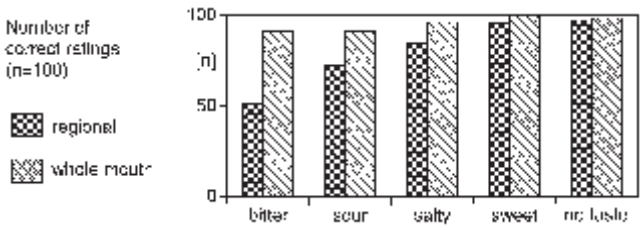

Figure 1. Comparison of the number of correct identifications obtained for regional testing, and whole mouth testing. A total of 100 subjects was investigated. Differences between taste qualities were most pronounced when stimuli were presented regionally. If subjects were only guessing, only 20 of the 100 subjects would have responded correctly.

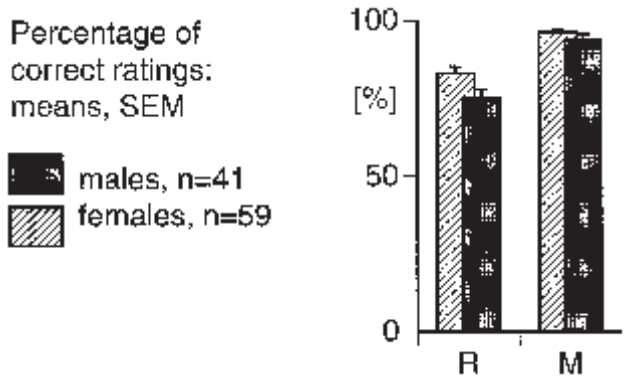

Figure 2. Differences between male (n=41) and female subjects (n=59) regarding the percentage of correct identifications for regional testing (R), and whole mouth testing (M). In general, women scored higher. Random performance would have produced a score of 20%.

best, which may be explained by a response bias towards a "null" identification. No significant differences were found for whole mouth testing (df=4, X^2=1.67).

When investigating differences between the two ratings separately for each flavour, the ANOVA revealed a significant difference for all qualities with the exception of tasteless wavers (bitter: df=1, X^2=40.0, p<0.0001; sour: df=1, X^2=19.0, p<0.0001; salty: df=1, X^2=12.0, p<0.001; sweet: df=1, X^2=5.0, p<0.05; tasteless: df=1, X^2=1.0, n.s.). Detection was always more difficult when stimuli were topically applied to the tongue.

Women were found to have less difficulty discriminating the 5 tastes. This was most pronounced for regional testing (factor "sex", F[1,98]=4.33, p<0.05; Figure 2). The missing significance of the interaction between factors "sex" and "taste" (F[1,98]=2.7, p=0.10) indicated that females were generally better to detect the tastes regardless whether the stimuli were applied to the tongue or to the whole mouth. Subjects above the age of 55 were found to have similar difficulty in both regional or whole mouth testing as the younger subjects (factor "age", F[1,98]=0.10, p=0.75).

DISCUSSION

The present results indicate that the wavers do show differences between regional and whole mouth testing. Differences between taste qualities were observed only when stimuli were applied to the anterior one-third of the tongue, but not after the subjects chewed on the wavers. This can be expected on the

basis of differences in the topographical distribution of taste receptors (Kiesow, 1894; Hänig, 1901). In line with the findings of Halpern and co-workers (Kelling and Halpern, 1987; Delwiche et al., 1996), approximately 50% of the subjects were able to clearly identify bitter in the anterior one-third of the tongue.

The data confirmed the observation that identification of taste qualities is better in females than in males which argues, in turn, for the test's validity (for review, see Doty, 1978). This difference was more pronounced for regional than for whole mouth testing which may indicate that topical testing is more sensitive for the assessment of subtle differences in gustatory perception (cf., Matsuda and Doty, 1995; Kroger et al., 1996). On the other hand, in many every-day encounters whole mouth testing seems to be of more relevance to "real-life" experiences, although it appears to be a less accurate measure of taste function (Frank et al., 1995). By means of the wavers it is possible to assess both functions at the same time. This specific feature may lead to a more detailed diagnosis of gustatory disorders.

The negative result on age-related changes to supra-threshold taste stimuli is not an isolated finding. It even led Schifferstein (1995) to state that "...changes in taste perception with age are confined to decreased sensitivity, whereas supra-threshold taste intensity remains unaffected." Other researchers have clearly demonstrated age-related effects on supra-threshold gustatory function, but "...the magnitude of the change in taste sensitivity [compared to olfactory sensitivity] is relatively small" (Mojet et al., 1996). Thus, although it is possible to discriminate between gender-related differences in gustatory perception by means of the wavers, further modifications of this technique may be necessary to detect age-related differences (e.g. the multiple, randomized administration of the wavers to individual quadrants of the tongue).

Taken together, the present results indicate that the wavers may be suited for the screening of gustatory function in a clinical setting. They are easy to use, have a shelf-life of 2-3 years, and can be carried in the pocket. Studies in patients with gustatory disorders will investigate whether the wavers provide valid data in a clinical context.

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