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INVITED MEDICAL REVIEW

Taste dysfunction: a practical guide for oral medicine

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Dental practitioners are often the first clinicians to be presented with complaints about changes in taste. This raises a problem in terms of appropriate evaluative response. It is a difficult issue both because of the common confusion between smell and taste problems (with smell being the more vulnerable sense and contributing substantially to the flavor of food that most patients equate with 'taste'), and because of the lack of widely accepted standardized techniques to assess true taste function. This brief review provides a summary of some of the problems associated with assessing taste function in a clinical setting and of patient management options available to the practitioner of oral medicine.

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Introduction

Taste (or gustation) has long been regarded as a minor sense, less important even than its chemosensory cousin, smell (or olfaction). It provides information about only a limited number of stimulus qualities (sweet, salty, sour, bitter, umami, and possibly fat and a few others), and has received much less medical and clinical research attention than smell because, as elaborated below, it is relatively invulnerable to significant disruption. However, taste's apparent simplicity and stability may be seen as speaking to its critical role as the gatekeeper of the body, protecting humans and other animals from consuming dangerous substances and encouraging consumption of nutritious ones (Cowart, 2005). Thus, when disruptions do occur, they can have a substantial impact on nutriture and quality of life (Mattes *et al*, 1990; Mattes and Cowart, 1994; Cowart, 2005; Cowart *et al*, 2007).

Dental practitioners are often the first clinicians to be presented with complaints about changes in taste. This raises a problem in terms of appropriate evaluative response. Taste complaints generally take one of two forms. Either the patient complains of diminished or lost taste perception (hypogeusia or ageusia) or of the presence of a persistent, unpleasant taste sensation (phantogeusia), frequently in conjunction with distortions in taste quality (dysgeusia) and/or burning mouth symptoms (BMS). The first thing that must be determined in the case of diminished perception is whether the complaint reflects a true taste loss or a smell loss that impacts on food flavor perception.

Taste *vs* smell: relative vulnerabilities

It was recognized well over a 100 years ago that true taste loss is rare, whereas loss of smell is more common (Mackenzie, 1884). Studies from modern chemosensory clinics have confirmed this observation (e.g., Goodspeed *et al*, 1987; Deems *et al*, 1991; Cowart *et al*, 1997; Pribitkin *et al*, 2003). For example, both the University of Pennsylvania Smell & Taste Clinic and the Monell-Jefferson Taste & Smell Clinic have reported that while close to 70% of patients presenting with a complaint of taste loss evidenced smell loss, fewer than 10% evidenced measurable taste loss (Deems *et al*, 1991; Cowart *et al*, 1997).

Consideration of the anatomies of the olfactory and gustatory systems makes the reason for this obvious. Olfaction depends on a single cranial nerve (I), while multiple branches of three cranial nerves (VII, IX, and X) carry gustatory information. Moreover, the olfactory nerve is located in a vulnerable position in that its axons must pass through the cribriform plate of the ethmoid bone prior to dissemination on the surface of the olfactory bulb. As a consequence, they are subject to the coup contra coup forces associated with head injury that can lead to tearing or severing of the axonal processes (Costanzo and Zasler, 1991).

Moreover, olfactory receptors are highly localized in a small patch of tissue high in the nasal cavity, rendering them vulnerable to changes in nasal patency or airflow patterns that might limit the access of stimulus molecules. In contrast, taste receptors are found on a large portion of the tongue dorsum, as well as on the soft palate, larynx, pharynx, and epiglottis.

Finally, both systems are subject to a barrage of potentially toxic chemical stimuli, although both have regenerative capacity. However, in the case of the

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olfactory system, in which the receptor cells are primary neurons, this requires reinnervation of the olfactory bulb. In contrast, receptor cells in the gustatory system are modified epithelial cells that, although they have some neuronal characteristics, can turn over more rapidly (Mackay-Sim and Kittel, 1991; Lindemann, 2001).

Nature and assessment of taste dysfunction

As noted, taste loss is relatively rare, despite the frequency of patient complaint. A more common true taste disorder is a distortion in taste perception, most often taking the form of a persistent unpleasant taste in the oral cavity (phantoguesia), sometimes accompanied by burning sensations (burning sensations may also occur in isolation; for useful reviews of BMS *per se* see Forman and Settle, 1990a,b; Patton *et al*, 2007). Primary distortions in the perceived qualities of taste stimuli (e.g., sweet stimuli eliciting a bitter taste) may also occur rarely, but are not well-documented in clinical settings.

Taste loss can be assessed via chemical (threshold or suprathreshold) or electrogustometric measures (see Frank *et al*, 2003). Because of both the (largely) independent innervation of taste receptor fields in the oral cavity (tongue/palate/pharynx, left/right, and anterior/posterior tongue) and the unique receptors for the basic tastes as well as unique taste receptor cells that express them (Lindemann, 2001; Yarmolinsky *et al*, 2009), taste loss can, in principle, be both regional and quality specific. In fact, correlations among measures of threshold sensitivity for different substances are significantly lower for tastes than for smells (Cowart *et al*, 1997). This complicates full objective assessment, making it impossible for the dental practitioner, and even difficult for specialized clinics. Clinical centers in the United States have relied primarily on whole-mouth assessments of responses to the four traditional basic tastes (sweet, salty, sour, and bitter) supplemented with regional testing. However, testing is idiosyncratic, and widely accepted norms have not been developed. Although quality identification has proven to be a useful tool in the clinical assessment of olfactory function, its use in taste assessment is limited by common taste quality confusions in the general population (particularly sour-bitter, but also sour-salty and salty-bitter). Nonetheless, a test using taste identification of chemical stimuli presented via taste strips on the anterior tongue has recently been proposed as a diagnostic tool in taste dysfunction (Landis *et al*, 2009). However, the proposed measure does not distinguish either quality specific losses or spatial losses other than anterior tongue right/left. It is also unclear if the measure can identify anything other than ageusia, and there has been no attempt to relate diagnostic results to those obtained via whole-mouth testing. Thus, the clinical utility of the measure is still in question.

In contrast to the logistical difficulties associated with the preparation and storage of chemical stimuli for testing, electrogustrometric measurement offers a seemingly simple solution for taste testing. However, it is limited in terms of quality specificity (Frank *et al*, 2003), and has not been widely used in the U.S. as a primary diagnostic tool, so again norms are lacking (Cowart *et al*, 1997).

Assessment of phantogeusia, the more common true taste complaint, is even more problematic. Although sometimes these complaints seem to arise from regional losses in taste sensitivity (e.g., Bull, 1965; Kveton and Bartoshuk, 1994), they often are not associated with measurable changes in basic taste function (Cowart *et al*, 1997). In short, there are no specific measurement techniques to objectively validate or quantify phantom taste complaints. The clinician should bear in mind, however, that this is not the patient's fault, and does not invalidate his/her complaint.

Etiologies

Detailed reports of the etiologic factors contributing to taste dysfunction in patients seen in chemosensory clinics are not available. More often than not, there appear to be no clear precipitating events or identifiable underlying pathology (Cowart *et al*, 1997). The bases of general taste losses are simply not known (Pribitkin *et al*, 2003). Head trauma and upper respiratory viral infections may in some cases contribute to these (as well as to taste distortions and phantoms) but the underlying pathophysiology is still not completely understood (Costanzo and Zasler, 1991; Leopold *et al*, 1991).

Based on the sheer number of clinical reports in the literature (see Rollin, 1978; Schiffman, 1983, 1991; Mott and Leopold, 1991; Schiffman and Zervakis, 2002), it can be argued that the single most common etiologic factor contributing to taste dysfunction is medication usage. This may be the result of the direct impact of medications on taste receptor function or of residual tastes associated with either the drug's presence in saliva or in the blood, since tastes can be perceived intravascularly (Bradley, 1973) [a phenomenon that has been used to assess both blood circulation time (Fishberg *et al*, 1933) and taste dysfunction (Matsuyama and Tomita, 1986)].

The principal nutrient deficiency that has been associated with taste loss is zinc. The evidence for this in the U.S. derives largely from a single-blind trial of the efficacy of zinc supplementation in the reversal of hypogeusia (Schechter *et al*, 1972). However, a subsequent double-blind trial showed no significant difference between the effects of zinc and placebo (Henkin *et al*, 1976). Some controlled studies of documented zinc deficiency in specific disease states do indicate it may be associated with taste loss that reverses with zinc supplementation (e.g., Atkin-Thor *et al*, 1978; Weisman *et al*, 1979; Majahan *et al*, 1980), although the mechanisms by which zinc affects gustatory function are still uncertain. Overall, it seems unlikely that zinc deficiency underlies many cases of hypogeusia in the U.S.

Poor oral hygiene, periodontal disease or changes in oral hygiene regimens are obvious potential sources of phantogeusias. In particular, the overgrowth of oral

Candida, which may be associated with xerostomia, with the use of dentures, antibiotics or corticosteroids, or with immunological deficiencies or diabetes, may give rise to phantom taste and oral burning sensations even in the absence of objective manifestation, that is, without clinically evident thrush or angular cheilitis (Forman and Settle, 1990a; Osaki *et al*, 2000).

Gastroesophageal reflux disease (GERD) can produce apparent 'phantom' taste sensations, which may be intermittent or persistent and are most often described as sour (Mantani *et al*, 2005; Moshkowitz *et al*, 2007). This is also often associated with dental erosion, particularly of the posterior teeth (Ali *et al*, 2002).

Two common surgical procedures, one of particular relevance to the dental practitioner, may result in damage to the chorda tympani (CT) nerve, which mediates taste perception on the anterior tongue, leading to complaints of both loss and phantoms. First, the CT passes through the middle ear, between the malleus and the incus, and middle ear surgery may require stretching or severing it, resulting in the loss or diminution of taste sensation on one or both (if the surgery is bilateral) anterior quadrants of the tongue (Bull, 1965; Chilla *et al*, 1982; Grant *et al*, 1989). In addition, the CT joins the lingual branch of the mandibular nerve as it travels toward the lateral border of the floor of the oral cavity, and the joined nerve lies against the medial surface of the mandible in the area of the third molar, where it is vulnerable to damage during third molar extraction (Blackburn and Bramley, 1989; Shafer *et al*, 1999), again resulting in localized taste dysfunction. [Much more rarely, CT-lingual damage may result from mandibular block analgesia, perhaps particularly inferior alveolar nerve block (Paxton *et al*, 1994; Hotta *et al*, 2002; Hillerup and Jensen, 2006).]

Interestingly, while patients are often aware of some diminution in taste in cases of bilateral chorda tympani section, they rarely report a loss following unilateral damage (Bull, 1965; Grant *et al*, 1989). On the other hand, reports of phantogeusia following surgical damage to the CT, whether unilateral or bilateral, appear to be common (Moon and Pullen, 1963; Bull, 1965). Taste phantoms may also be induced experimentally by anesthetization of the CT (Yanagisawa *et al*, 1998). Central inhibitory interactions between input from the CT and glossopharyngeal nerve (which mediates taste perception on the posterior tongue) have been proposed as a mechanism to explain both the limited impact on whole-mouth taste perception and the occurrence of taste phantoms when CT input is disrupted; that is, a release from inhibition may lead to enhanced glossopharyngeal response (Kveton and Bartoshuk, 1994; Lehman *et al*, 1995; Yanagisawa *et al*, 1998).

Phantogeusias may also be associated with depression, although the bases for and significance of this symptom in depressed patients are unclear (Miller and Naylor, 1989). It should be borne in mind that psychological morbidity associated with persistent unpleasant tastes, and/or BMS, may be the result and not the cause of the symptoms (Hendler, 1984; Grushka *et al*, 1987; van der Ploeg *et al*, 1987).

Finally, aging or factors associated with aging may render individuals more vulnerable to taste dysfunction. In the healthy elderly, age-related changes in taste are less pronounced than in smell (e.g., Stevens *et al*, 1984; Cowart, 1989) and have frequently been reported to be quality or compound specific (e.g., Weiffenbach *et al*, 1982; Cowart, 1989; Murphy and Gilmore, 1989; Cowart *et al*, 1994). Nonetheless, in a chemosensory clinic population, Cowart *et al* (1997) found that elderly patients (≥65 years) were significantly more likely than young or middle-aged patients to report phantogeusia and to evidence diminished taste. Similar age relationships were not seen in reports of phantom smells or measured smell loss.

Practical guidelines for assessment and referral

A patient complaining of diminished taste perception should first be assessed for olfactory function using one of the standardized tests that are now commercially available (e.g., Doty *et al*, 1984; Kobal *et al*, 2000; Bromley and Doty, 2010). If the patient is found to have an olfactory problem, he/she should be referred to an otorhinolaryngologist sub-specializing in diseases of the nose and sinuses. It may be informative to ask patients specifically about their ability to perceive basic tastes (e.g., sweet, salty, sour, and bitter; Gent *et al*, 1987), although responses indicating that those are diminished have low positive predictive value for measured taste dysfunction (Soter *et al*, 2008), and may reflect the synergy between smell and taste sensations in complex foods rather than an actual diminution in gustatory sensitivity *per se* (see Small and Prescott, 2005).

In cases of phantom taste complaints, it is essential to rule out oral health problems that may contribute to these. A thorough oral exam should be performed, including assessment of possible abnormalities in the microbial flora of the oral cavity. An empirical trial with oral antifungal agents, for example, clotrimazole troches, may be appropriate (Forman and Settle, 1990a).

A detailed consideration of changes in medications and oral health procedures (e.g., types of toothpaste and oral rinses used) should also be undertaken. In addition, referral to a gastroenterologist should be considered to rule out the possible contribution of GERD to the persistent taste, particularly when there is evidence of dental erosion.

In cases in which there is a suspicion of iatrogenic damage to the CT, microsurgical repair may be possible (Zuniga *et al*, 1994). However, the efficacy of this intervention is variable (Robinson *et al*, 2004).

The practitioner should also be sensitive to the patient's psychological state. Depression may be the result of a taste problem or contribute to a taste complaint. In either case, referral for psychological counseling should be considered, although not as a first step.

Finally, the patient should be reassured that although persistent taste symptoms are difficult to live with, taste is a resilient system. For example, it appears that taste loss after traumatic head injury is more likely to recover than smell loss (Costanzo and Zasler, 1991). In addition,

two-thirds of patients with dysgeusias have been reported to experience spontaneous resolution of symptoms within an average of 10 months (Deems *et al*, 1996).

Conclusion

Taste complaints present a number of difficulties to the oral medicine practitioner, not the least of which is obtaining an objective assessment of the nature and degree of dysfunction. It is important to recognize that, even if it is not practical to measure them, these symptoms have real-world bases that while not necessarily congruent with the specifics of the patient complaint, can impact significantly on nutriture and quality of life. Thus, clinicians should be attuned to these issues, and be prepared to make appropriate evaluations and referrals.

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