Selective Olfactory Loss May Affect Perception of Foods and Beverages

Charles J. Wysocki, Ph.D.
Monell Chemical Senses Center
April 4,2010

Summary

Whether they know it or not, every person has selective deficits in the sense of smell. These sensory “blindspots” in olfaction are termed specific anosmias. If an individual cannot smell the compound that provides the note that is critical to making the food or beverage outstanding for most people, what they are consuming may be thought of bland and they cannot understand why others are raving about the meal. Alternatively, if the specific anosmia is for a malodor that has developed in the food or beverage then the individual may not appropriately reject the meal as others in the group have done. Indeed, the meal may be superb to the person with the malodor specific anosmia. Unfortunately, as sensory testing expands, newly discovered specific anosmias, for both pleasant-smelling odorants and malodorants, are being discovered. From the producer’s perspective, sensory panelists should be screened for critical components, and consumers should be educated about the existence and prevalence of specific anosmias.

A new Asian—French fusion restaurant, OISHIINA, has opened in the city and the newspaper's food critic has given it the highest rating. You and a fairly large group of friends decide to pay a visit and hopefully enjoy a delicious Friday night meal. Upon being seated, the wait staff quickly provides the chef's newest, just created today, appetizer as a welcoming gift for your visit to the new restaurant—spiced seafood with pork and mushrooms. You sample the dish and note in amazement how pleasing it is to your palate; however, something you cannot understand, a few in the group have stopped eating after the first bite. You wonder what might be troubling them and inquire about their behavior. A self-confident poet, exhibiting his bravado, offers the following: "It tasted like stale urine smells." For the most part diners at the table are stunned, with the exception of those who rejected the food—they agreed with the poet.

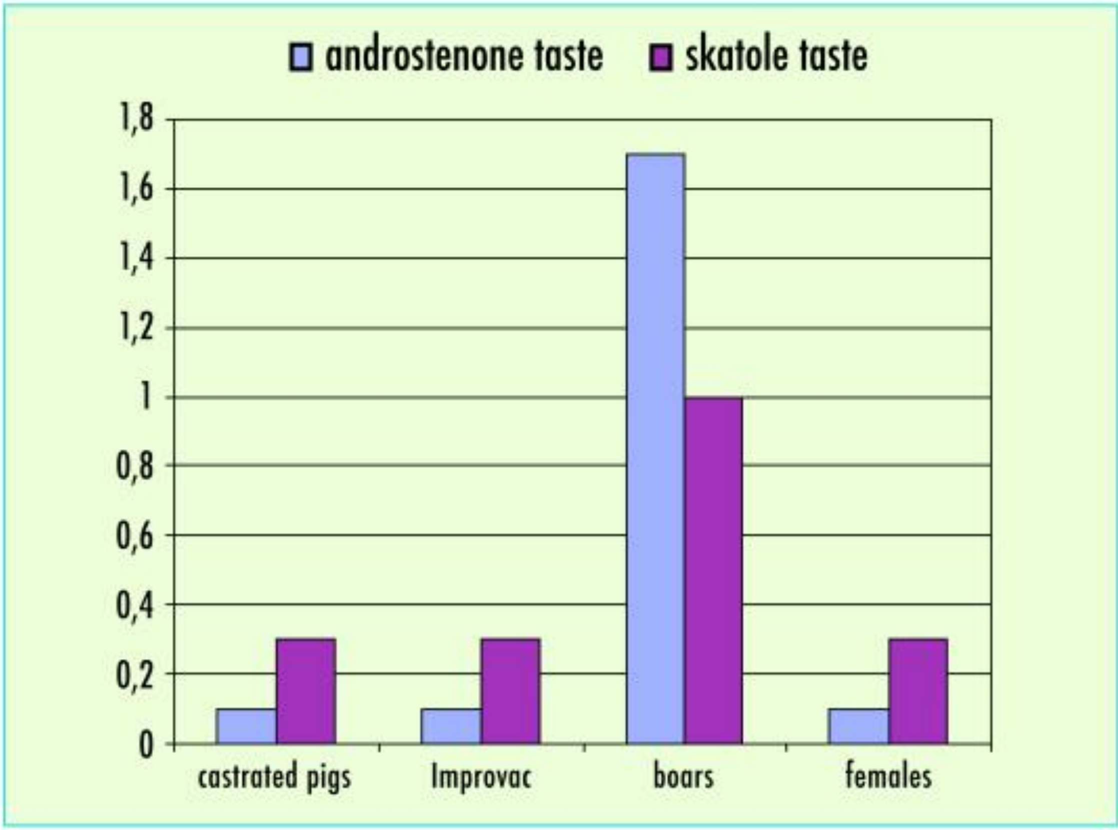
After some inquiries, the poet learns that the mushrooms were actually French truffles and recalls a vignette from his university course in sensory psychology: Truffles contain androstenone (Wysocki, Dorries & Beauchamp, 1989; Zhang & Firestein, 2007) and that there is considerable variation across humans in the ability to smell androstenone (Labows & Wysocki, 1984). Many people cannot smell androstenone. These people have a specific anosmia for the odorant; their sense of smell is otherwise intact but they lack the ability to smell this specific compound. Other people smell androstenone and experience a woody or floral odor. Still others are exquisitely sensitive to the odorant, smelling it in the range of ppb levels, and report a smell of stale urine. There's the answer to the group's varied response to the chef's gift.

The concept of specific anosmia was first introduced in the biomedical literature by Blakeslee (1918), who noted that some people could not smell the fragrance of certain varieties of verbena flowers. Guillot (1948), however, was the first to systematically study specific anosmias and noted eight different examples of such. Decades later, John Amoore commenced a lengthy career devoted, in most part, to discoveries of specific anomies as a path to categorizing odorants into primaries based upon specific anosmias—a quest that he believed would reveal underlying organization within human olfaction. He reviewed his career findings in Amoore & Steinle (1991). Paradoxically it was in 1991 that Linda Buck and Richard Axel published their landmark paper on the identification of olfactory receptor genes (Buck & Axel, 1991), for which they would receive a Nobel Prize in Physiology or Medicine in 2004.

Since the pivotal work of Dr. Amoore, specific anosmias have been identified in non-human species, viz., in inbred strains of mice, which offer excellent models for studying how genetics contributes to variability if odor perception (Griff & Reed, 1995; Price, 1977; Wysocki et al., 1977; Novikov et al., 2002). Furthermore, additional specific anosmias are being identified as research efforts that are focused upon understanding human variability in the perception of odors intensify (Wysocki et al., 2010). In 1991 Amoore & Steinle listed nine specific anosmias. Some of these include those to isovaleric acid, found in many cheeses, isobutyraldehyde, a prototypical malty odor found in beer, white bread and chocolate, trimethylamine, having a fishy odor, and l-carvone, smelling like spearmint (which differs from d-carvone, e.g., Clarin et al., 2010;). Other specific anosmias have been added to the list, including that to 3-methyl-2-hexenoic acid, having a strong underarm odor (Baydar, Petrzilka & Schott, 1992). More recently, a specific anosmia to ß-ionone, which "has a characteristic odor of violet, and it is also present in large amount in raspberries" has been identified (Plotto, Barnes & Goodner, 2006). Our laboratory reports at the 2010 AChemS meeting (Wysocki et al., 2010) newly identified specific anosmias for geosmin, having an earthy, musty odor, 3-hydroxy-3-methylhexanoic acid, another strong underarm odorant, 2-nonenal, a fatty odor thought to be associated with advancing age in men (Haze et al., 2001), but also found in beer (Santos et al., 2008) and buckwheat (Janes et al., 2008) and skatole, with its fecal odor (for a review of variability in the olfactory gene family see Niimura, 2012).

Each time these selective deficits are identified we are more able to contribute intelligent information relevant to why people ascribe to the Latin phrase *de gustibus non disputandum est* (there is no accounting for taste). I would argue that most people, including our ancestors, typically confuse taste (limited to sweet, sour, bitter, salty and umami) and smell (but that is for a future contribution).

Back to the chef's treat. Although the poet was correct about the truffles, he apparently forgot about the ancillary story that was told in his university class about androstenone and boar taint. Uncastrated boars have high levels of androstenone in the meat (see Fig. 1; Patterson, 1968). This and the specific anosmia associated with androstenone (Griffiths & Patterson, 1970) were noted decades ago. Early castration of the boar, however, significantly reduces levels of androstenone, as does immunization (Improvac in Fig. 1). The pork in the chef's gift was not from Japan, where most boars are castrated; rather, it too was imported from France, where ~71% of boars are immunized. Well, in this particular instance, for this particular pig, the immunization apparently was not effective. The chef, of course, knew full well that untreated boars develop "boar taint" from androstenone. He added the meat to the dish not detecting the androstenone in the pork for he too had a specific anosmia to androstenone.



Data on file (3b EU program). Pfizer Inc., New York, NY.

Figure 1. From http://www.thepigsite.com/articles/16/pig-meat-quality/2822/boar-taint-vaccine-improves-more-than-welfare (note the taste/smell confusion).

REFERENCES

Amoore, J.E. & Steinle, S. (1991) A graphic history of specific anosmia. In Wysocki, C.J. & Kare, M.R. (eds.) Chemical Senses: Volume 3 -- Genetics of Perception and Communication. New York: Marcel-Dekker, pp. 331-351.

Baydar, A.E., Petrzilka, M. & Schott, M-P. (1992) Perception of characteristic axillary odors. Perfumer and Flavorist, 17: 2-9.

Blakeslee, A.F. (1918) Unlike reaction of different individuals to fragrance in verbena flowers. Science, 48: 298-299.

Buck, L. & Axel, R. (1991) A novel multigene family may encode odorant receptors: a molecular basis for odor recognition. Cell, 65: 175-187 (for information about the Nobel Prize, see http://nobelprize.org/nobel_prizes/medicine/laureates/2004/press.html).

Clarin, T. , Sandhu, S, Apfelbach, R.(2010) Odor detection and odor discrimination in subadult and adult rats for two enantiomeric odorants supported by c-fos data Behavioural Brain Research, 206: 229–235.

Griff, I.C. & Reed, R.R. (1995) The genetic basis for specific anosmia to isovaleric acid in the mouse. Cell, 83: 407-414.

Griffiths, N.M. & Patterson, R.L.S. (1970) Human olfactory responses to 5a-androst-16-en-3-one—principal component of boar taint. Journal of Science of Food and Agriculture, 21: 4-6.

Guillot, M. (1948) Physiologie des sensations—anosmies partielles et odeurs fondamentales. Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, 226: 1307–1309.

Haze, S., Gozu, Y., Nakamura, S., Kohno, Y., Sawano, K., Ohta, H. & Yamazaki, K. (2001) 2-Nonenal newly found in human body odor tends to increase with aging. Journal of Investigative Dermatology, 116: 520–524.

Janes, D., Kantar, D., Kreft, S. & Prosen, H. (2008) Identification of buckwheat (Fagopyrum esculentum Moench) aroma compounds with GC-MS. Food Chemistry, doi:10.1016/j.foodchem.2008.05.048.

Labows, J.N. & Wysocki, C.J. (1984) Individual differences in odor perception. The Perfumer and Flavorist, 9: 21-26.

http://www.leffingwell.com/chirality/carvone.htm

Niimura Y. (2012) Olfactory receptor multigene family in vertebrates: from the viewpoint of evolutionary genomics. Current Genomics, 13: 103-114.

Novikov, S. N., Troitskaya, V. T. Gladysheva, O.S. & Churakov, G.A. (2002) Specific Anosmia to Isovaleric Acid in Laboratory C57BL/6 Mice: Recessive Inheritance. Doklady Biological Sciences, 387: 1-6.

Patterson, R.L.S. (1968) 5a-Androst-16-ene-3-one: Compound responsible for taint in boar fat. Journal of Science of Food and Agriculture, 19: 31-38.

Plotto, A., Barnes, K. & Goodner, K. (2006) Enhancement of fruit and fruit product flavor quality using analytical/sensory methods. Journal of Food Science, 71: S401-406.

Price, S. (1977) Specific anosmia to geraniol in mice. Neuroscience Letters, 4: 49-50.

Santos, J.R., Carneiro, J.R. Guido, L.F. Almeida, P.J. Rodrigues, J.A. & Barros, A.A. (2008). Determination of E-2-nonenal by high-performance liquid chromatography with UV detection - Assay for the evaluation of beer ageing. Journal of Chromatography A, 985: 395–402.

Wysocki, C.J., Louie, J., Oriolo, L., Au, A., Strojan, E., Emura, M. & Lankin, M. (2010) Newly discovered specific anosmias. Chemical Senses, 31: A54.

Wysocki, C.J., Whitney, G. & Tucker, D. (1977) Specific anosmia in the laboratory mouse. Behavior Genetics, 7: 171 188.

Zhang, X. & Firestein, S. (2007) Nose thyself: individuality in the human olfactory genome. Genome Biology, 8: 230 doi, 10.1186/gb-2007-8-11-230.