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Introduction to Sensory Techniques

1.1 INTRODUCTION

This introduction is in three parts. The first part lists some reasons why sensory tests are performed and briefly traces the history of their development. The second part introduces the basic approach of modern sensory analysis, which is to treat the panelists as measuring instruments. As such, they are highly variable and very prone to bias, but they are the only instruments that will measure what needs to be measured; therefore, the variability must be minimized and the bias must be controlled by making full use of the best existing techniques in psychology and psychophysics. In the third part, a demonstration is provided of how these techniques are applied with the aid of seven practical steps.

1.2 DEVELOPMENT OF SENSORY TESTING

Sensory tests, of course, have been conducted for as long as there have been human beings evaluating the goodness and badness of food, water, weapons, shelters, and everything else that can be used and consumed.

The rise of trading inspired slightly more formal sensory testing. A buyer, hoping that a part would represent the whole, would test a small sample of a shipload. Sellers began to set their prices on the basis of an assessment of the quality of goods. With time, ritualistic schemes of grading wine, tea, coffee, butter, fish, and meat developed, some of which survive to this day.

Grading gave rise to the professional taster and consultant to the budding industries of foods, beverages, and cosmetics in the early 1900s. Literature was developed that used the term *organoleptic testing* (Pfenninger, 1979) to denote the supposedly objective measurement of sensory attributes. In reality, tests were often subjective, tasters too few, and interpretations open to prejudice.

Pangborn (1964) traces the history of systematic "sensory" analysis that is based on wartime efforts to provide acceptable food to American forces (Dove, 1946, 1947) and on the development of the triangle test in Scandinavia (Bengtsson and Helm, 1946; Helm and Trolle, 1946). A major role in the development of sensory testing was played by the

Food Science Department at the University of California at Davis, resulting in the book by Amerine et al. (1965).

Scientists have only recently developed sensory testing as a formalized, structured, and codified methodology, and they continue to develop new methods and refine existing ones. The current state of sensory techniques is recorded in the dedicated journals *Chemical Senses*, *Journal of Sensory Studies*, *Journal of Texture Studies*, *Food Quality*, and *Journal of Cosmetic Studies*; in the proceedings of the Pangborn Symposia (triennial) and the International Sensometrics Group (biannual), both usually published as individual papers in the journal *Food Quality & Preference*; and the proceedings of the Weurman Symposia (triennial, but published in book form, e.g., Martens et al., 1987; Bessière and Thomas, 1990). Sensory papers presented to the Institute of Food Technologists (IFT) are usually published in the IFT's *Journal of Food Science* or *Food Technology*. Papers presented at the Society of Sensory Professionals are typically published in the *Journal of Sensory Studies*.

The methods that have been developed serve economic interests. Sensory testing can develop a level of acceptability for a commodity or help determine the value of a commodity. Sensory testing evaluates alternative courses to select the one that optimizes value for money. The principal uses of sensory techniques are in quality control, product development, and research. They find application not only in the characterization and evaluation of foods and beverages but also in other fields such as household products, environmental odors, personal hygiene products, diagnosis of illnesses, testing of pure chemicals, and so on. The primary function of sensory testing is to conduct valid and reliable tests that provide data on the basis of which sound decisions can be made.

1.3 HUMAN SUBJECTS AS INSTRUMENTS

Dependable sensory analysis is based on the skill of the sensory analyst in optimizing the four factors of such analysis, which we all recognize because they are the ones that govern any measurement (Pfenninger, 1979).

1. *Definition of the problem*: We must define precisely what it is we wish to measure; important as this is in "hard" science, it is much more so with senses and feelings.
2. *Test design*: Not only must the design leave no room for subjectivity and take into account the known sources of bias, but it also must minimize the amount of testing required to produce the desired accuracy of results. Test controls for subjects, site, samples, and sensory methods must be in place (Civille and Oftedal 2012).
3. *Instrumentation*: The test subjects must be selected and trained to give a reproducible verdict; the analyst must work with them until he/she knows their sensitivity and bias in the given situation.
4. *Interpretation of results*: Using statistics, the analyst chooses the correct null hypothesis and the correct alternative hypothesis and draws only those conclusions that are warranted by the results.

Tasters, as measuring instruments, are (1) quite variable over time, (2) very variable among themselves, and (3) highly prone to bias. To account adequately for these shortcomings requires (1) that measurements be repeated, (2) that enough subjects (often 20–50) are

made available so that verdicts are representative, and (3) that the sensory analyst respects the many rules and pitfalls that govern panel attitudes (see Chapter 4). Subjects vary innately in sensitivity by a factor of 2–10 or more (Meilgaard and Reid, 1979; Pangborn, 1981) and should not be interchanged halfway through a project. Subjects must be selected for sensitivity and must be trained and retrained (see Chapter 9) until they fully understand the task at hand. The annals of sensory testing are replete with results that are unreliable because many of the panelists did not understand the questions and/or the terminology used in the test, did not recognize the tactile and fragrance parameters in the products, or did not feel comfortable with the mechanics of the test or the numerical expressions used.

For these reasons and others, it is very important for the sensory analyst to be actively involved in the development of the scales and the terminology/lexicons used to measure the panelists' responses. A good scale requires much study, must be based on a thorough understanding of the physical and chemical factors that govern the sensory variable in question, and requires several reference points and thorough training of the panel on that scale. It is unreasonable to expect that even an experienced panelist would possess the necessary knowledge and skill to develop a lexicon that is consistently accurate and precise. Only through the direct involvement of a knowledgeable sensory professional in the development of scales can one obtain descriptive analyses, for example, that will mean the same in 6 months' time as they do today.

1.3.1 Chain of Sensory Perception

When sensory analysts study the relationship between a given physical stimulus and the subject's response, the outcome is often regarded as a one-step process. In fact, there are at least three steps in the process: The stimulus hits the sense organ and is converted to a nerve signal that travels to the brain. With previous experiences in memory, the brain then interprets, organizes, and integrates the incoming sensations into perceptions. Finally, a response is formulated based on the subject's perceptions (Schiffman, 1996).

In dealing with the fact that humans often yield varied responses to the same stimulus, sensory professionals need to understand that differences between two people's verdicts can be caused either by a difference in the sensation they receive because their sense organs differ in sensitivity or by a difference in their mental treatment of the sensation, for example, because of a lack of knowledge of the particular odor, taste, and so on, or because of lack of training in expressing what they sense in words and numbers. Through training and the use of references, sensory professionals can attempt to shape the mental process so that subjects move toward showing the same response to a given stimulus.

A commendable critical review of the psychophysical measurement of human olfactory function (with 214 references) can be found in Chapter 10 of Doty and Laing (2003).

1.4 CONDUCTING A SENSORY STUDY

The best products are developed in organizations where the sensory professional is more than the provider of a specialized testing service. Only through a process of total involvement can he or she be in the position of knowing what tests are necessary and appropriate

at every point during the life of a research project. The sensory professional (like the statistician) must take an active role in developing the research program, collaborating with the other involved parties on the development of the experimental designs that ultimately will be used to answer the questions posed. Erhardt (1978) divides the role of the sensory analyst into the following seven practical tasks:

1. Determine the project objective. Defining the needs of the project leader is the most important requirement for conducting the correct test. Were the samples submitted as a product improvement, to permit cost reduction or ingredient substitution, or as a match of a competitor's product? Is one sample expected to be similar or different from others, preferred or at parity, variable in one or more attributes? If this critical step is not carried out, the sensory analyst is unlikely to use the appropriate test or to interpret the data correctly.
2. Determine the test objective. Once the objective of the project can be clearly stated, the sensory analyst and the project leader can determine the test objective: overall difference, attribute difference, relative preference, acceptability, and so on. Avoid attempting to answer too many questions in a single test. A good idea is for the sensory analyst and project leader to record in writing, before the test is initiated, the project objective, the test objective, the specifics of the test, the set of samples, and a brief statement of how the test results will be used.
3. Screen the samples. During the discussion of project and test objectives, the sensory analyst should examine all of the sensory properties of the samples to be tested. This enables the sensory analyst to choose test methods that take into account any sensory biases introduced by the samples. For example, visual cues (color, thickness, sheen) may influence overall difference responses, such as those provided in a triangle test, for example, to measure differences due to sweetness of sucrose versus aspartame. In such a case, an attribute test would be more appropriate. In addition, product screening provides information on possible terms to be included in the score sheet.
4. Design the test. After defining the project and test objectives and screening the samples, the sensory analyst can proceed to design the test. This involves selection of the test technique (see Chapter 6 for general guidelines; see Chapters 7, 8, 9, 11, 12, 13, 17, and 18 for specific guidelines for different sensory techniques); selecting and training panelists (see Chapter 10); designing the accompanying score sheet (ballot, questionnaire); specifying the criteria for sample preparation and presentation (see Chapter 3); and determining how the data will be analyzed (see Chapters 13 and 14). Care must be taken, in each step, to adhere to the principles of statistical design of experiments to ensure that the most sensitive evaluation of the test objective is attained.
5. Conduct the test. Even when technicians are used to carry out the test, the sensory analyst is responsible for ensuring that all the requirements of the test design are met.
6. Analyze the data. Because the procedure for analysis of the data was determined at the test design stage, the necessary expertise and statistical programs, if used, will be ready to begin data analysis as soon as the study is completed. The data

should be analyzed for the main treatment effect (test objective) as well as other test variables, such as order of presentation, time of day, different days, and/or subject variables such as age, sex, geographic area, and so on (see Chapters 14 and 15).

7. Interpret and report results. The initial clear statement of the project and test objectives will enable the sensory analyst to review the results, express them in terms of the stated objectives, and make any recommendations for action that may be warranted. The latter should be stated clearly and concisely in a written report that also summarizes the data, identifies the samples, and states the number and qualification of subjects (see Chapter 16).

The main purpose of this book is to help the sensory analyst develop the methodology, subject pool, facilities, and test controls required to conduct analytical sensory tests with trained and/or experienced tasters. In addition, Chapters 13 and 19 discuss the organization of consumer tests, that is, the use of naïve consumers (nonanalytical) for large-scale evaluations, which are structured to represent the population of the product market. The role of sensory evaluation in the development of advertising claims is also addressed.

The role of sensory evaluation and quality is to provide valid and reliable information to research and development (R&D), production, and marketing in order for management to make sound business decisions about the perceived sensory properties of products. The ultimate goal of any sensory program should attempt to find the most cost-effective and efficient method with which to obtain the most sensory information. When possible, internal laboratory difference or descriptive techniques are used in place of more expensive and time-consuming consumer tests to develop cost-effective sensory analysis. Further cost savings may be realized by correlating as many sensory properties as possible with instrumental, physical, or chemical analyses. In some cases, it may be possible to replace a part of routine sensory testing with cheaper and quicker instrumental techniques.

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