Sensory Evaluation

A Practical Handbook

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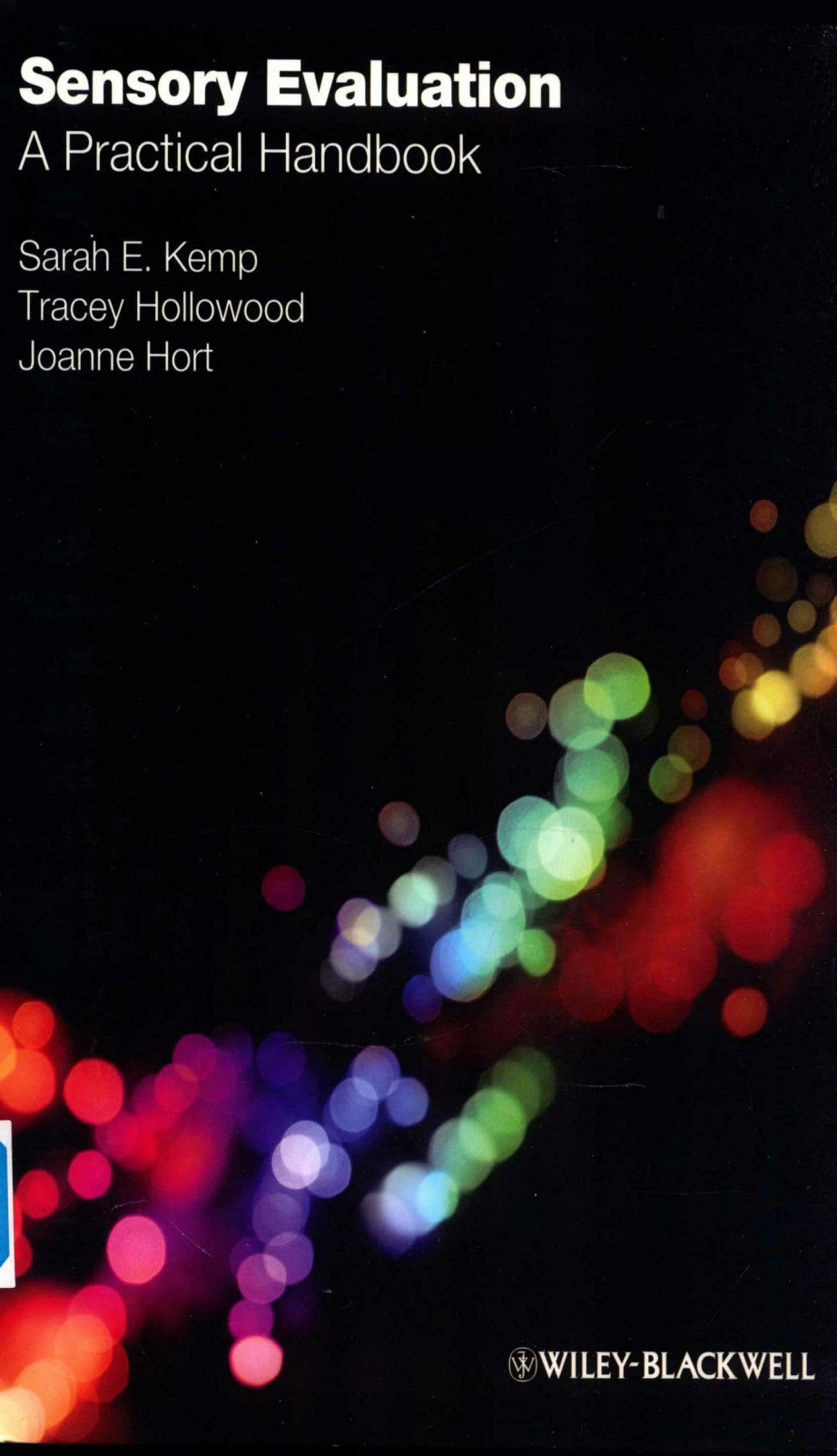

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Sensory Evaluation

A practical handbook

To George, Elizabeth, George and William
To Mike, Holly and Socks
To Campbell, Emma and Lara

Preface

This book is an affordable sensory science textbook focused on the practical aspects of sensory testing on a broad range of products. It is presented in a simple 'how to' style for use by industry and academia as a step-by-step guide on how to carry out a range of sensory tests. It is intended as a companion volume to a larger, more detailed sensory science textbook covering theoretical aspects, advanced techniques and applications of sensory evaluation. The inspiration for this book is the excellent *Laboratory Methods for Sensory Evaluation of Food* by Elizabeth Larmont first published in 1967 and revised in 1977 and 1991 (Poste *et al.*, 1991). It is now out of print; but at the time of publication, it was popular for its practical, easy-to-read style, coupled with good use of examples and illustrations. The authors have fond memories of using the book during their formative years in sensory science.

Between them, the authors have over 50 years of industrial and academic experience in sensory science and have published widely in the field. All three authors are founder committee members of The Institute of Food Science and Technology's Professional Food Sensory Group (IFST PFSG).

There are many good sensory textbooks on the market. The generalist sensory science texts are very comprehensive, but are often written in a research style, or with large sections of unbroken text which renders them unsuitable for use as a simple training/teaching aid or as a quick practical guide. They are also expensive/unaffordable in developing countries and difficult to understand for readers who have English as a second language. In addition, more and more specialised sensory texts are now available which tend to focus on theory and application in a narrow field, rather than general practice. There is a tendency for sensory textbooks to focus on food and beverage applications, often to the exclusion of other product categories.

The objectives of this book are as follows:

- To provide a practical guide and laboratory manual on how to carry out sensory evaluation techniques.

- To reach sensory practitioners, as well as sensory scientists, by using a simple, easy-to-read, easy-to-use format.
- To cover a broad range of product applications, including food, beverages, personal care and household products.
- To be inexpensive and available to a wide audience who would not usually be able to afford to purchase standard sensory textbooks, including students, technicians and practitioners in developing countries.
- To cover the IFST PFSG accreditation scheme at foundation and intermediate levels.

The very simple, practical, easy-to-use style of this book, coupled with its affordability, makes it suitable as a training manual, reference text, teaching aid and course book. Key audiences include sensory practitioners, junior sensory staff, sensory students and sensory trainers. It is applicable across a broad range of industries and to those with limited budgets.

The style of the book is easy-to-follow 'instructions' with simple explanations of how and why to do testing in a particular way, rather than detailed theory and underlying science of techniques. It is laid out in logical sequence. Examples and illustrations are used throughout. Practical tips and hints in the form of dos and don'ts are included in each section.

The book begins with an introductory chapter that gives an overview of sensory evaluation and a second chapter on sensory perception. The third chapter outlines how to plan a sensory project. The fourth chapter focuses on requirements for sensory testing. Important elements of this chapter are professional conduct and good laboratory practice. These often receive scant coverage, but are becoming increasingly important as novel ingredients and processes continue to be developed (e.g. ingredients from genetically modified origin), and as products are increasingly tested in markets with regulations that are different from those in the markets for which they were designed. No matter how informal the sensory assessment is, it is essential that safe and ethical practices are used. The fifth chapter covers sensory test methods. Methods for statistical analysis are given throughout this chapter, rather than as a stand-alone section, to make the translation to practice easier. Case studies are used to illustrate methods. The sixth chapter covers elements necessary to complete a sensory project. Also included are appendices, glossary, references and index.

The authors hope that you enjoy using this book and that it helps bring success in your sensory endeavours.

Sarah E. Kemp
Tracey Hollowood
Joanne Hort

Author biographies

Sarah Elizabeth Kemp, *BSc (Hons), PhD, CSci, FIFST*, is a sensory and consumer science professional with more than 20 years of experience in academia and industry. Dr Kemp gained a BSc in Food Technology in 1986 and a PhD in Taste Chemistry in 1989 from the Food Science and Technology Department at Reading University, UK. In 1990, she did a postdoctoral research fellowship on sensory analysis at the Monell Chemical Senses Center in Philadelphia, USA. Dr Kemp has held numerous positions in the industry, including Manager of Sensory Psychology in the Fragrance Division of Givaudan-Roure in New Jersey, USA, Director of European Consumer and Marketing Research in the Fragrance Division at Givaudan-Roure, France, Product Area Leader and Sensory Science Leader in Foods Consumer Science at Unilever Research Colworth, UK, Former Head of Global Sensory and Consumer Guidance at Cadbury Schweppes, UK, and Director of Sensory and Consumer Services at Reading Scientific Services Ltd, UK. Dr Kemp has also set up and run her own consultancy service, Kemps Research Solutions Ltd. She has written numerous scientific articles in the field of sensory evaluation, has provided sensory training courses, including lecturing on the European Masters Course in Food Science, and has worked with bodies developing standards in sensory evaluation, such as the American Society for Testing and Materials. She is a founder member of the Professional Food Sensory Group of the Institute of Food Science and Technology, and a member of several other professional bodies, including the Sensory Evaluation Division of the Institute of Food Technologists, the Consumer and Sensory Research Technical Interest Group of the Society of Chemical Industry and the Association for Chemoreception Sciences.

Tracey Hollowood, *BSc (Hons), PhD, MIFST*, is currently Associate Director of Sensory and Consumer Research for Sensory Dimensions, UK. She has over 15 years of experience in academia and industry; she worked

at Nottingham University for 10 years during which time she achieved her doctorate investigating perceptual taste–texture–aroma interactions. She established the United Kingdom's first Post Graduate Certificate in Sensory Science, and designed and managed the university's prestigious Sensory Science Centre. Her research has focused on psychophysical studies, interactions in sensory modalities and fundamental method development. She has over 20 peer-reviewed publications; has given numerous oral presentations and workshops; and has participated in the organisation of seven international symposia, including International Symposium of Taste 2000 and Pangborn Sensory Science Symposium 2005. She is the current Chair of the Institute of Food Science and Technology (IFST), Midland Branch and the Professional Food Sensory Group (PFSG).

Joanne Hort, *BEd (Hons), PhD, MIFST*, is Associate Professor in Sensory Science in the Division of Food Sciences at the University of Nottingham. Initially, she studied Food Technology and began her career in teaching. However, she returned to the university to receive her doctorate concerning the modelling of the sensory attributes of cheese from analytical and instrumental measures in 1998. As a lecturer at Sheffield Hallam University, she carried out sensory consultancy for local industry, developed a sensory program at undergraduate level and oversaw the installation of new sensory facilities before being appointed as Lecturer in Sensory Science at the University of Nottingham in 2002. She has since established the University of Nottingham Sensory Science Centre, which is renowned for both its sensory training and research into flavour perception. She delivers sensory courses at both undergraduate and postgraduate levels and is the Course Director for the Postgraduate Certificate in Sensory Science. Her research interests focus on the multimodal aspects of flavour perception and she has published several articles in this area, together with oral presentations and posters at international symposia. She is a founder member of the Professional Food Sensory Group of the Institute of Food Science and Technology and was on the organising committee of the 6th International Pangborn Symposium in the United Kingdom in 2005.

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Contents

1 Introduction

It is estimated that 75% of new products fail within their first year on the supermarket shelf (Buisson 1995) and that, as a consequence, considerable resource invested in product development is squandered (Deschamps and Nayak 1996). Sensory attributes, whether the flavour of coffee, the smell of an air freshener, the texture of fabric or even the sound of a car door closing, are key determinants of product delivery including quality, functional and emotional benefits. Thus, a considerable proportion of product failure can be attributed to a mismatch between sensory properties and consumer needs or expectations. When integrated within the product development process, sensory and consumer testing allows cost-effective delivery of acceptable products to consumers and thus reduces the risk of failure (Lawless and Heymann 1998).

1.1 What is sensory evaluation?

Sensory evaluation is often described using the definition of Institute of Food Technology – a scientific method used to evoke, measure, analyse and interpret those responses to products as perceived through the senses of sight, smell, touch, taste and hearing (Anonymous 1975).

Since its emergence in the 1940s, however, sensory evaluation has developed as an exciting, dynamic, constantly evolving discipline that is now recognised as a scientific field in its own right.

The sensory professional is routinely confronted with problems which call upon an extensive skill set drawn from a range of disciplines, e.g. biological sciences, psychology, experimental design and statistics and will often be required to work with other specialists from these areas. Additional challenges are presented by working with a human 'measuring instrument' that is highly variable.

Sensory evaluation can be divided into two categories of testing: objective and subjective. In objective testing, the sensory attributes of

a product are evaluated by a selected or trained panel. In subjective testing, the reactions of consumers to the sensory properties of products are measured. The power of sensory evaluation is realised when these two elements are combined to reveal insights into the way in which sensory properties drive consumer acceptance and emotional benefits. Linking sensory properties to physical, chemical, formulation and/or process variables then enables the product to be designed to deliver optimum or appropriate consumer benefits.

1.2 What is the role of sensory evaluation?

The role of sensory evaluation has changed considerably over the years. Initially, it was a service provider supplying data, but now its role is, in partnership with R&D and marketing, to provide insights to help guide development and commercial strategy.

From product conception to post-launch monitoring, sensory professionals can be called upon to inform decision-making during the stages of a product's life cycle. Sensory and consumer testing can also provide insights into human behaviour and perception at a more fundamental level.

In the early stages of product development, consumer and sensory testing can help identify the important sensory attributes driving acceptability across a product category. It can identify sensory-based target consumer segments, analyse competitor products and evaluate new concepts.

Combining data from sensory and instrumental testing may provide insights into the chemical and physical properties, driving sensory attributes. Where significant correlations exist with sensory data, it may be possible to dispense with the use of a sensory panel, in favour of a more cost-effective instrumental test, e.g. in quality testing.

Sensory testing can determine the impact of scaling up kitchen and/or pilot samples to large-scale production and is invaluable in determining whether raw ingredient changes or modifications to the production process, e.g. for cost reduction or change of supplier, will impact on sensory quality and/or product acceptability.

In terms of quality assurance, it can be used as part of a QA programme on raw materials. In addition, sensory testing can set consumer acceptability limits for sensory specifications used during quality testing. For those products susceptible to taints, sensory testing can ensure substandard products are not released onto the market. For many products, the sensory properties deteriorate ahead of microbial quality and so, in tandem with microbial tests, sensory testing can be used to determine shelf life and product variability through the supply chain.

From a marketing perspective, sensory and consumer testing can inform understanding concerning product preferences and acceptability. It can provide the data to support marketing claims such as 'best ever', 'new creamier', and 'most preferred'. It can also ensure that sensory properties work in synergy with brand communication and advertising.

Sensory and consumer testing is widely employed in the research arena. It is used at a more fundamental level to investigate new technologies to aid product development and to understand consumer behaviour. Furthermore, multidisciplinary investigations linking sensory testing with, for example instrumental analyses, brain-imaging techniques, psychophysical tests and genomics provide a wider understanding of the mechanisms involved in sensory perception and the variations that exist within the population.

1.3 What drives successful sensory testing?

Successful sensory testing is driven by setting clear objectives, developing robust experimental strategy and design, applying appropriate statistical techniques, adhering to good ethical practice and successfully delivering actionable insights that are used to inform decision-making. Appropriate training is crucial to ensure that the sensory professional has the necessary technical capability and interpersonal skills.

The aim of this book is to provide new and current sensory professionals with a firm foundation in the above principles in a practical, easy to follow format.

2 Sensory perception

2.1 The human senses

Sensory properties are perceived when our sensory organs interact with stimuli in the world around us. Consequently, it is important for sensory professionals to have some understanding of the biological mechanisms involved in perception. A basic outline of each sensory system is given in the following sections. *For more detailed information on the human senses, see Goldstein (2006).*

2.1.1 Vision

The appearance of any object is determined by the sense of vision. Light waves reflected by an object enter the eye and fall on the retina. The retina contains receptor cells, known as rods and cones, which convert this light energy into neural impulses that travel via the optic nerve to the brain. Cones are responsive to different wavelengths of light relating to 'colour'. Rods respond positively to white light and relay information concerning the lightness of the colour. The brain interprets these signals and we perceive the appearance (colour, shape, size, translucency, surface texture, etc.) of the object.

2.1.2 Gustation

The sense of taste involves the perception of non-volatile substances which, when dissolved in water, oil or saliva, are detected by taste receptors in the taste buds located on the surface of the tongue and other areas of the mouth or throat. The resulting sensations can be divided into five different taste qualities – salty, sweet, sour, bitter and umami. Examples of compounds that elicit particular tastes are given as follows:

- Salty substances: sodium chloride, potassium chloride
- Sweet substances: sucrose, glucose, aspartame
- Sour substances: citric acid, phosphoric acid
- Bitter substances: quinine, caffeine
- Umami substance: monosodium glutamate.

It is a myth that only certain areas of the tongue are sensitive to particular tastes. In fact, different areas of the tongue can be responsive to all the taste qualities; however, some areas are more sensitive than others.

2.1.3 Olfaction

Volatile molecules are sensed by olfactory receptors on the millions of hair-like cilia that cover the nasal epithelium (located in the roof of the nasal cavity). Consequently, for something to have an odour or aroma, volatile molecules must be transported in air to the nose. Volatile molecules enter the nose orthonasally during breathing/sniffing, or retronasally via the back of the throat during eating. There are around 17,000 different volatile compounds. A particular odour may be made up of several volatile compounds, but sometimes particular volatiles (character-impact compounds) can be associated with a particular smell, e.g. iso-amyl acetate and banana/pear drops. Individuals may perceive and/or describe single compounds differently, e.g. hexenol can be described as grass, green, unripe. Similarly, an odour quality may be perceived and/or described in different compounds, e.g. minty is used to describe both menthol and carvone.

2.1.4 Touch (somesthesis, kinesthesis and chemesthesis)

Somesthesis: The skin, including the lips, tongue and surfaces of the oral cavity, contains many different tactile receptors that can detect sensations related to contact/touch, e.g. force, particle size and heat.

Kinesthesis: Nerve fibres in the muscles, tendons and joints sense tension and relaxation in the muscles, allowing the perception of attributes such as heaviness and hardness.

Chemesthesis: Some chemical substances can stimulate the trigeminal nerves situated in the skin, mouth and nose to give hot, burning, tingling, cooling or astringent sensations, e.g. piperine in pepper, capsaicin in chilli pepper, carbon dioxide in fizzy drinks, coolants in showers gel, warming compounds in muscle rubs and tannins in wine. When sensed in the oral cavity, they form part of what are collectively known as mouth-feel attributes.

Texture perception is complex. Attributes of food texture can be divided into three categories: (i) mechanical, e.g. hardness and chewiness; (ii) geometric, e.g. graininess and crumbliness and (iii) mouth-feel, e.g. oiliness and moistness. These are generally described as being perceived during three phases: Initial phase (first bite), masticatory phase (chewing) and residual phase (after swallowing).