

The Perfect Meal

The multisensory science of
food and dining

Charles Spence & Betina Piqueras-Fiszman

Foreword by Heston Blumenthal



WILEY Blackwell

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“This book offers insights into all the wonderful sensory elements that make up our memories of a dining experience. For the last two decades the culinary world has been obsessed with modernist cooking and the role science can play in the kitchen. Nowadays more and more chefs are realising that science also has a place at the table; that a dining experience is made up of far more than just good food and that by understanding how we use our senses to interact with and appreciate food we may be able to further enhance our guest's dining experience. This book looks at many topics which will become increasingly relevant to both chefs and society as a whole in the coming years.”

Jozef Youseff, chef and author of *Molecular Gastronomy at Home* (www.kitchen-theory.com)

“Whether your idea of a good night is the local café or the latest Michelin-starred restaurant, it is unlikely that you'll be unaware of the cultural phenomenon that restaurant food has become in recent years. The secrets of chefs—amateur and celebrity—have been laid bare in myriad weighty books and glossy TV programmes. *The Perfect Meal* goes beyond the exotic ingredients and creative insights of the chef and into the realm of the diner's psychology. Using an accessible writing style that neither talks down to the reader nor dumbs down the science, the authors take us into the relatively unexplored world of the dining context: the gastrophysics of the visual, acoustic, tactile—not to mention taste and smell—influences that we are exposed to in every dining experience. This is a new approach to thinking about dining that will appeal to and inform anyone who has ever been convinced to buy a cookbook by its illustrations or who persists, despite failure in trying to make a reservation at The Fat Duck.”

John Prescott, Ph.D, author of *Taste Matters: Why We Eat the Foods We Do*

“In striving for a hypothetical level of delicious perfection we are forced to look beyond culinary technique and ingredients. Focussing on the brain's interpretation of our eating experience, pioneers Spence and Piqueras-Fiszman acknowledge the interdisciplinary nature of gastronomy, rendering a complex area of study both digestible and applicable.

This valuable input furthers the development of co-evolving disciplines; the scientific study of our brains, and the relentless creativity, experimentation and intuition so important in producing a truly great meal.”

Ben Reade, Gastronome and Head of Culinary Research and Development at Nordic Food Lab

“Not many people are as ready to realise the importance of the senses, not only in cooking but in eating, as Charles Spence and Betina Piqueras-Fiszman. ‘The senses as the starting point for creating’ was one of the most important creative methods of elBulli and one of the pillars of our cooking.

This book demonstrates beyond doubt that gastronomy is the most complex creative discipline that exists. Therefore, I invite you to enjoy the secrets of the fascinating world of the senses from Charles' and Betina's hand, something which is fundamental to enjoy gastronomy.”

Ferran Adrià, elBullifoundation

The Perfect Meal

The Multisensory Science of Food and Dining

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Foreword

The day I fell down the enchanting rabbit hole into the magical wonderland of the senses and began exploring their influence on our culinary likes and dislikes, I encountered a great deal of scepticism and resistance from chefs, diners, and food writers alike. In their eyes, the only thing of real importance was the food on the plate. The idea that the senses might influence our perception of flavour and help generate the pleasure and emotion that can accompany a meal was dismissed by some as nonsense, that reduced cooking and eating to mathematical formulae devoid of emotion. How wrong they were!

Although I only realised it later, my interest in the interplay of the senses and their influence on cuisine must stem from the event that originally made me want to be a chef when I was just 16 years old: a meal on the terrace of a three-star Michelin restaurant in Provence where the smell of the lavender bushes, the sound of the cicadas and the visual splendour of the setting almost seemed to eclipse the food and sent me down the rabbit hole. However, I date my conscious realisation of the culinary importance of the senses to 1997, when I created a dish that featured a crab-flavoured ice cream. The notion of a crab ice cream put some people off because ice cream is sweet, right? This association prevented them from enjoying a savoury version. However, I discovered that if I simply changed the name from 'crab ice cream' to 'frozen crab bisque', most people totally got it— even though it was the same ice cream! The idea that the actual name of a dish could change its whole context and enjoyment was, for me, a total eye opener. (As mentioned in the pages that follow, this dish was the inspiration for a paper from Sussex University on how the name of a dish can even change its perceived saltiness)

From then on, I researched whatever I could find on the incredible complexity of multisensory flavour perception, and began developing dishes that drew on what I was discovering. At the start of 2004, I unveiled my multisensory approach to cooking at one of the world's foremost gastronomic congresses in a presentation entitled 'Eating is a multisensory experience', and the rest, as they say, is history.

I first met Charles back in 2002 through a mutual friend and mentor of mine, Professor Tony Blake. I still have vivid memories of my first visit to his Crossmodal Research Laboratory in Oxford. He showed me the fascinating Sonic Chips experiment described in Chapter 6, and the idea that sound could radically affect our perception and enjoyment of food started my mind racing, like a kid in a sweet shop. I returned to Bray, got hold of a sound box, and started trying things out for myself.

Since then, Charles and I have worked together on a number of sonic experiments. For one of them we fed test-participants (actually members of the audience at the Art and the Senses conference held in Oxford in 2006) a scoop of bacon and egg ice cream. One group of participants ate the ice cream while listening to the sounds of bacon sizzling in the pan. The others tasted the ice cream while listening to the sounds of chickens clucking in the farmyard. In each case the sound appeared to intensify the relevant flavour. In another experiment, we fed participants oysters while listening either to the sound of the sea (think waves crashing gently on the beach), or to the sounds of farmyard animals, after which we asked them to rate how pleasant the oysters tasted. (Listening to the sound of the sea resulted in people rating the oyster as tasting significantly more enjoyable, but no more salty when compared to the farmyard soundtrack. Such results giving further support to the notion that sound can indeed influence our emotional response to food.) It was this last experiment (the results you'll find described within the pages that follow) that inspired what is now a classic on the menu at The Fat

Duck, “Sound of the Sea”, in which seafood, seaweed and edible “sand” are used to create what looks like the edge of the seashore, all of which is accompanied by an iPod and earphones so that the diner can hear the sounds of the waves lapping up against the shore while eating.

There are all sorts of other sensory questions that Charles and I have explored over the years, like whether listening to a low-pitched sound while eating a bitter, crunchy caramel would emphasize bitterness and whether listening to a sharp sound while tasting an acidulated toffee sauce would accentuate its acidity. We even investigated whether listening to a synaesthetically soft sound could enhance the richer, sweeter notes of the sauce. We've used jellies and *pâtes de fruit* in which the colour misleads you into expecting, say, a particular fruit when it is in fact a vegetable (i.e., blackcurrant that is in reality beetroot; lime that is fennel and pumpkin that tastes like apricot... adding fruit acids can flip the mind's interpretation of the colour of a food to blackcurrant) in order to probe the ways in which the senses can nudge us to a different place in terms of our perception of flavour. The senses of sight and taste have nudged the vegetable to a fruit of the same colour, leaving the smell saying little about the matter. And we've pursued ideas based on the early research from Köhler on sound symbolism in which people were shown a pair of two-dimensional shapes, a spiky one and an amoeba-like one, and asked which of the two was a “kiki” and which a “bouba”. Despite both names being meaningless nonsense words, there was an overwhelming conviction that bouba was the rounded amoeba shape and kiki the pointed one. We tried this out with various foods and discovered that a similar correspondence between flavour and sound seemed to exist: for example, milk chocolate – even when brittle from a stint in the fridge – was generally considered more “bouba” while dark chocolate, even in the form of a light and airy mousse, was overwhelmingly “kiki”.

As will by now be apparent, Charles has been one of my biggest inspirations. He is one of the world's leading researchers in the field of multisensory perception and together with Betina they have opened up new ways of experiencing food by focusing on everything that surrounds it. So it's very exciting that they have turned their ground-breaking fundamental research into a book so that you, too, can be inspired in much the same way that I have been – and still am. The pages that follow will open your eyes to new worlds and new ideas. Charles and Betina are the perfect guides for such a journey given their wide-ranging curiosity, great clarity of thought, and lively minds that are forever spotting connections that illuminate how the world of food and drink really works. If you're at all interested in food and the effect it has on our bodies and, more significantly, on our minds, then *The Perfect Meal* can't fail to entertain, inform and ultimately to dazzle.

Heston Blumenthal
The Fat Duck

Preface

Why is it that what you like I detest? How can it be that what we touch affects what we taste? Can people be nudged towards healthier food choices simply by incorporating a few psychological illusions and neuroscience insights into their cuisine? These are just a few of the intriguing questions that we address in the pages that follow. This book aims to provide the reader with the facts and figures needed to grasp what is it that makes them perceive and experience the food (one of life's greatest pleasures!) in the way that they do and how to improve upon it. Each of the chapters covers a number of the key factors that influence the diner's experience. Our interests lay in understanding from the fancy meals nowadays being served in modernist restaurants through to the family meal served in the comfort of our own home. Throughout, we highlight what we see as some of the most intriguing possible future trends when it comes to food and multisensory dining.

Our goal in writing this book has been to bring together and critically evaluate the large body of empirical research that has emerged in recent years documenting the profound effect that each one of our senses has on our perception and enjoyment of food. The focus, though, is not on the neuroscience of flavour, but rather on all of the other (non-food) factors that influence our overall multisensory experience of food. We outline the transition in research practice from the more traditional approaches to the study of flavour perception founded in the field of sensory science through to the emergence of a number of novel methods to understanding the diner's experience based on areas of research as diverse as cognitive and decisional neuroscience, marketing, design, and psychology. When taken together, these new ways of thinking about people's response to food give rise to a neuroscience-inspired approach to multisensory design. In this book, we describe all this exciting research in an accessible style for the general readership.

In this volume, we use both the latest research as well as relevant historical examples to illustrate how much more there is to the diner's experience than merely what is sitting there on the plate (if indeed there is a plate – nowadays you can't always be too sure). Indeed, there are researchers out there who are convinced that as much as half of the pleasure in a plate of food (or meal) actually comes from the “everything else”! In the pages that follow, we will highlight what we see as the most relevant and exciting findings to have emerged from the latest studies to have been conducted by sensory scientists, psychologists, neuroscientists, oenologists, and even economists, investigating how important each and every element of the meal (focusing especially on those cues that are extrinsic to the food itself) is to the diner's overall experience. This, then, is “*the new science of the table*” that we want to share our own passion for with the reader: A new field of research that is referred to as gastrophysics.

Many of the chefs whom we have had the good fortune to speak to over the years, and this includes a number with Michelin-stars under their belts (or should that be toques), are convinced that the meal is all, and only, about sourcing the right ingredients, preparing them correctly, and how the food is ultimately presented on the plate. Oftentimes, these chefs spend so much time thinking about the food itself that they forget to give adequate consideration to the *mise-en-scene*, for example, paying no attention to the music that happens to be playing in the background. As we will see later, such oversights can have a much greater impact on our dining experiences than might be expected.

Who is this book for? It is primarily aimed at all those people out there who are interested in food and the factors that influence our experience of it. That includes those working in the world of food, or writing about it, that is, the chefs, cooks, marketers, large food companies, research scientists,

gourmets, and food lovers (or “foodies”), or simply the curious lay reader, who wants to know more about the key drivers underlying our experience of food. This book highlights a number of the most important influences that distinguish the wonderful, perhaps even that once-in-a-lifetime ‘perfect meal’ from the mundane fare of everyday life. We illustrate the central themes with dishes taken from the tables of some of the world's top restaurants. That said, it is our firm belief that many of the insights can easily be adapted to enhance the home dining experience as well.

Health researchers involved in trying to tackle the current global obesity crisis should also find a number of the findings summarized here to be relevant: So, for example, we provide numerous suggestions concerning ways in which the diner's mind can be tricked into thinking that more food has been consumed than is actually the case. We will also highlight a number of most innovative methods for making food taste sweeter which don't rely on adding a grain of sugar to our pudding. How? The tips here include everything from changing the colour of the plate to adding a little digital seasoning in the form of some sweet-sounding music. This book also contains a number of actionable insights for those working with the aging and hospital populations, where profound nutritional problems abound and are likely to increase unless we do something about it.

Many wonderfully creative minds have accompanied us on the journey that was writing this book. Our special thanks go to Heston Blumenthal and all of the research team at The Fat Duck in Bray for their ongoing interest and support at the frontiers of scientific and creative cuisine. We would also like to thank the many other chefs and culinary artists that we have had the great good fortune to collaborate or share all manner of outlandish ideas with: So, in no particular order our heartfelt thanks go out to Denis Martin (Restaurant Denis Martin); Ben Reade (Nordic Food Lab); Jozef Youssef (Kitchen Theory); Charles Michel (401B), Caroline Hobkinson (Stirring with Knives); Louise Bloor (Fragrant Supper Club); María José San Román (Monastrell Restaurant); Sriram Aylur (The Quilon Restaurant); Wylie Dufresne (WD~50); Blanch & Shock; Bompas & Parr: the chefs at Casa Mia in Bristol; and the Institut Paul Bocuse. We have also benefited greatly from the support of those working in the food science industry, particular thanks going to Francis McGlone, Tony Blake, Barry Smith, John Prescott, Rupert Ponsonby, Michael Bom Frøst, Line Holler Mielby, Ophelia Deroy; and Susana Fiszman. You have inspired us greatly and this book has been possible thanks to your generosity of spirit and ideas.

We would also like to thank all our contributors for having provided us with their images. They range from professional photographers through science researchers, to designers and architecture agencies and all share a passion and curiosity for food and eating experiences. We are also grateful to all those friends and family who have been kind enough to review some of the material that follows; Barbara and Thierry, thank you so much for going beyond the line of duty. Needless to say, the blame for any remaining inaccuracies lies squarely with us.

So, without further ado, let the meal begin...

Chapter 1

Introducing the Perfect Meal

“Once at least in the life of every human, whether he be brute or trembling daffodil, comes a moment of complete gastronomic satisfaction. It is, I am sure, as much a matter of spirit as of body. Everything is right; nothing jars. There is a kind of harmony, with every sensation and emotion melted into one chord of well-being.”

(Fisher 2005, p. 325)

1.1 Introduction

This is a book about the perfect meal and how to get it, or at least how to get closer to it: not in the sense of the chef travelling to the furthest corners of the globe in the search for the über-unusual and extreme of culinary delights (Bourdain 2002)¹; nor in the behavioural economist's sense of trying to optimize the benefits, while minimizing the costs, of the financial transaction that is dining out (Cowen 2012); and nor does this book offer a chef's guide to, or search for, perfection as seen through the lens of molecular gastronomy or (better said) modernist cuisine (Blumenthal 2007; see also Rayner 2008). Rather, this is a book about how the latest insights from a diverse range of fields of research that include experimental psychology, design, neuroscience, sensory marketing, behavioural economics and the culinary and sensory sciences can, and in some cases already are, being used by a number of the world's top chefs in order to deliver multisensory dining experiences that are more sensational, more enjoyable and consequently more memorable than anything that has ever gone before.

“What is ‘real’? How do you define ‘real’? If you are talking about what you can feel, what you can smell, what you can taste and see then ‘real’ is simply electrical signals interpreted by your brain.”

(Morpheus in *The Matrix*; see Haden 2005, p. 354)

Here we are talking about experiences that are based on the emerging insights concerning the mind of the diner and not just on the whims and intuitions of the chef, or increasingly the culinary team, beavering away behind the scenes in many of the world's top restaurants (Spence 2013). It is our contention that, in the years to come, the search for the perfect meal will be facilitated as much by knowing about the mind of the diner and what makes it tick as it will by gaining further insights into the physiology of the human flavour system or by sourcing the most seasonal of ingredients and knowing how best to prepare (and present) them on the plate (Pollan 2006). The revolutionary new approach to the science of the perfect meal that we wish to showcase here is called ‘gastrophysics’. Before immersing ourselves in it, let's take a look back over the evolution of gastronomic movements and trends that has led to our current culinary practices and food knowledge.

1.2 A brief history of culinary movements

Over the last half century or so there have been a couple of major culinary movements that have left their indelible mark on the way in which we think about food today. The first of these was *Nouvelle Cuisine* which emerged in France during the 1960s. In the early 1990s, molecular gastronomy arrived

with a bang (often literally). Let's take a brief look at these movements in order to get a better sense of the culinary landscape in which we find ourselves today.

“Periods of gastronomic change are inevitably periods of gastronomic controversy. When there is no controversy, there is no inventiveness, because controversy of course doesn't appear if there is no tension between tradition and innovation, or the other way, between innovation and academic conventions.”

(Revel 1985, on the introduction of the *Nouvelle Cuisine*)

1.2.1 Nouvelle Cuisine

The term itself dates from the 1730s–1740s when French writers used it to describe a break with the traditional way of cooking and presenting foods (Hyman and Hyman 1999). However, the culinary movement that now bears the name really took on a life of its own in the 1960s when the French food critics Christian Millau and Henri Gault used the term to describe the new culinary style that was then just starting to make its appearance in the kitchens of some of France's top chefs. Nowadays, the term *nouvelle cuisine* is used to refer to the use of seasonal ingredients with a focus on natural flavours, light textures (e.g. sauces that have not been thickened by the addition of flour and fat) together with a visual aesthetic that focuses on a presentation that is both simple and elegant (see Chapter 4). The French chefs who were instrumental in developing this new type of cuisine, including Paul Bocuse and Jean and Pierre Troisgros, were undoubtedly influenced by the minimalist Japanese style that placed value on serving smaller portions. Indeed, the opening of the first French culinary school in Japan in 1960 by chef Shizuo Tsuji resulted in a much greater cultural exchange between Japanese and leading French chefs, including Paul Bocuse and Alain Chapel. The latter also embraced the use of ingredients sourced from many different parts of the world. In fact, this is also why it was so natural for *nouvelle cuisine* to morph seamlessly into ‘fusion’ food.

“Really, the concern with how the food looked can be traced back to the emergence of nouvelle cuisine. The pictures of these dishes have set themselves in the mind of the public. Nouvelle cuisine was essentially photogenic ... Think of the glorious coloured photographs of these dishes, which have become eponymous with the purveying of recipes.”

(Halligan 1990, p. 121)

It was precisely this emphasis on the visual appearance of food that led Alexander Cockburn, in a 1977 article that appeared in the *New York Review of Books*, to introduce the term ‘gastroporn’.² This term, which has now made it into the Collins English Dictionary, is defined as ‘the representation of food in a highly sensual manner’. It should therefore be noted that even food writing can qualify for this epithet.

1.2.2 The rise of molecular gastronomy

There can be no doubt that the fusion of the physical sciences with culinary artistry has fundamentally changed the fine dining landscape over the last couple of decades or so (Belasco 2006; Roosth 2013) and has been enthusiastically covered in the press under the title of ‘molecular gastronomy’. This revolutionary new approach to cuisine is one that has attracted a phenomenal amount of media interest from pretty much every corner of the developed world (see Barham *et al.* 2010). The term itself was first coined by the Oxford-based Hungarian physicist Nicholas Kurti (who back in 1969 gave a presentation at the Royal Institute in London entitled *The Physicist in the Kitchen*; see Kurti 1969; Kurti and Kurti 1988). Particularly influential here was also a paper that Kurti wrote together with the

French physical chemist Hervé This in the popular science magazine *Scientific American* (Kurti and This-Benckhard 1994a, b).

But what exactly is molecular gastronomy? McGee (1984) talks in terms of “*the scientific study of deliciousness*”. Perhaps a more precise, albeit less grammatical, definition comes from Roosth (2013, p. 4) who describes it as “*a food movement whose practitioners – chemists who study food and chefs who apply their results – define [sic] as the application of the scientific method and laboratory apparatuses [sic] to further cooking.*”

Nowadays, there is certainly a bewildering array of new techniques and ingredients, some natural, others much more artificial/processed,³ available to the budding modernist chef, no matter whether operating in the restaurant or home environment (e.g. see Blumenthal 2008; Myhrvold and Young 2011; Youssef 2013). Harold McGee, the brilliant North American author on kitchen science, has written a number of influential books in which he explores the science underpinning the practice of molecular gastronomy (McGee 1984; 1990). There he investigates such things as culinary proverbs, sayings and old wives' tales. He has done more than perhaps anyone else to explore the physics and chemistry that lie behind a host of everyday culinary phenomena such as, for example, the Maillard reaction (McGee 1990).⁴

Fortunately for us there are already many great chefs and eminent scientists, not to mention flavour houses, working on the physics and chemistry of flavour (e.g. Barham 2000; Alícia and elBullitaller 2006; Konings 2009; Barham *et al.* 2010; Chartier 2012; Humphries 2012). We are therefore not going to cover these aspects of molecular gastronomy in any detail in this book (see McGee 1990; This 2005, 2012, 2013, for detailed coverage of this theme). We will, however, be taking a closer look at some of the most intriguing dishes to have emerged from these modernist kitchens over the last couple of decades. We will discuss some of the legendary dishes from the elBulli restaurant in Spain and The Fat Duck in Bray (UK). We're going to dissect a number of the dishes from the Chicago School of Restaurants; think Grant Achatz's Alinea and Homaro Cantu's Moto. We'll also be taking a look at a few of the dishes championed by those innovative new restaurants that have sprung up across Spain in recent years (part of *la nueva cocina* movement; Lubow 2003; Steinberger 2010). However, our interest in discussing many of these amazing dishes will not be the culinary magic underlying the preparation of the ingredients on the plate, but rather to try and understand some of the key psychological and neuroscientific principles that lie behind the wonderful experience of eating them. And having got a handle on these fundamental insights, the challenge will then be to demonstrate how they can be used in everyday life, for example, to provide tips to help any one of us eat a little more healthily without having to compromise on the sensory pleasure of the experience.

1.2.3 Molecular gastronomy or modernist cuisine?

A number of the chefs with whom we collaborate most closely have something of a love/hate relationship with the term ‘molecular gastronomy’ (e.g. Blumenthal and McGee 2006; McGee 2006; Rayner 2006; Blumenthal 2008; Gopnik 2011). In fact, many of those working in the field would much rather have you refer to what they do as ‘modernist cuisine’. There are a number of reasons behind this terminological debate that are perhaps worth mentioning here. First, many chefs object to the term ‘molecular gastronomy’ because they feel that what has been happening in the kitchen in recent years is about so much more than merely playing with molecules, films, foams (or *espumas* as the Spanish like to call them) and gels, etc. In the pages that follow, you'll see this is a view with which we most wholeheartedly agree.

What is more, many of those working in this area are also sensitive to the criticism that what they deliver can be seen as nothing more than a form of elitist cuisine. This notion, at least to those who worry about such things, is strengthened by the term ‘gastronomy’.⁵ As Heston Blumenthal put it in an interview back in 2006:

“Molecular makes it sound complicated ... and gastronomy makes it sound elitist... We may use modern thickeners, sugar substitutes, enzymes, liquid nitrogen, sous vide, dehydration and other non-traditional means but these do not define our cooking. They are a few of the many tools that we are fortunate to have available as we strive to make delicious and stimulating dishes”

(Rayner 2006)

The preference among many of those practitioners working in the kitchen is therefore for the more inclusive and less overtly chemical label of ‘modernist cuisine’.

What with so much baggage associated with the term ‘molecular gastronomy’, it should perhaps come as little surprise that Myhrvold and Young (2011), in what *The Independent* newspaper described as “the most spectacular cookbook the world has ever seen” (Walsh 2011, p. 11), chose to title their 3000-page masterpiece *Modernist Cuisine*. This 5-volume shelf-filler is undoubtedly a veritable feast for the eyes, detailing with absolutely stunning photography pretty much every tool and technique of the new art and science of the table (those with an addiction to gastroporn take note). That said, ‘molecular gastronomy’ would appear to be the term that has stuck in the public consciousness. Indeed, a quick search on Google Scholar on 24 August 2013 brought up 1080 hits for the term ‘molecular gastronomy’ as compared to just 123 for ‘modernist cuisine’. Furthermore, many other up-and-coming young chefs such as Josef Youssef (who like many others trained for a while in the kitchens of The Fat Duck) appear to have no qualms about using the term ‘molecular’ (as Youssef himself does in the title for his new book; see Youssef 2013).

Deciding on the right name for this global culinary movement would seem to be a debate that is going to run and run. As such, we trust that you will forgive us for using the two terms fairly interchangeably in this book, although we also acknowledge the fact that ‘molecular gastronomy’ fails to capture many of the most important innovations that have permeated the research kitchens of some of the world's top restaurants over the last few years (see also McGee 2006; Schira 2011).⁶

In the pages that follow, we will repeatedly see how many of the most interesting things that have been going on recently in the world's top restaurants are about so much more than merely innovative food chemistry (especially in the area of novel gelling agents such as methylcellulose, xanthan gum and alginate) and kitchen technology (here we are thinking of devices such as the RotoVap, Pacojet, Thermomix and Gastrovac). Rather, the table of the future will likely involve the delivery of marketable (and hence branded)⁷ multisensory dining experiences: experiences that are as much about theatrical performance, entertainment and, increasingly, interaction as they are about the delivery of nutritious and filling food to the hungry and soon-to-be rather poorer diner (Berghaus 2001). In addition, as far as we can tell, technology is also going to be an ubiquitous feature of our fine (and possibly also home) dining in the years to come.

“They work on extracting the essence of the ingredient, and they play with the sense and textures,” Remolina says. *“All the senses are involved. Now food is a show.”*

(Park 2013 interviewing Remolina)

Of course, not everyone is convinced by the turn that so many top-end dining experiences are taking (e.g. Gill 2007; Poole 2012). And that's fine too (to be expected, even; see the earlier quote from

Revel). As we hope to show in the pages that follow, even if you plan never to set foot in a modernist restaurant, there are still insights to be gained from studying the food that is being served in such venues nowadays – insights that can be applied no matter your favourite food or style of cuisine. Even the slowest of slow food (see Petrini 2007) still has to be served somewhere, and will most likely be eaten with the aid of some sort of cutlery. It is crucial to remember, then, that the atmosphere affects what we think about the food no matter where we happen to be or what we happen to be eating (slow food or modernist cuisine). The same applies when we start to think about the cutlery, the company and even the naming of the dishes that we order. The key point to note here is that while our growing understanding of the new sciences of the table may well be best advanced by looking at what is being served at the top modernist restaurants, the insights that will be uncovered there can hopefully be applied wherever we happen to eat and no matter what we happen to be eating.

1.2.4 On the rise of the celebrity chef

While nouvelle cuisine and molecular gastronomy have swept the world stage, another profound change in the balance of power within the restaurant sector has also taken place. Traditionally, all of the activity in a fancy restaurant would revolve around the front of house. Just think back to the time when the omnipotent restaurateur would meet and greet his guests by name as they arrived, wielding the power to decide who would get to sit at the best tables (Steinberger 2010). Meanwhile, the anonymous chef would normally keep a low profile out back doing exactly as he or she was told. In fact, should the chef in one of these restaurants change, the diner might well not know about it; even if they did, they likely wouldn't care too much. However, the last couple of decades have seen a fundamental shift of power from the front of house to the back (which is no longer always to be found out back).

The rise of the glass-screened kitchen, which has become such a signature feature of so many restaurants nowadays, can be seen as an architectural acknowledgement of this transition. For those who have had the opportunity to dine there, think of the glass-screened kitchen that forms the centrepiece of Heston Blumenthal's Dinner restaurant in the Mandarin Oriental Hotel in London. There is simply no way that the diner can get to their table without catching an eyeful of the action taking place in the kitchen (including all of those pineapples slowly spit-roasting). It is certainly hard to imagine that there has ever been a time previously when anyone would have thought it worthwhile to beam the action live from the kitchen direct to the diners' table (as Daniel Facen now does in his Italian restaurant; see Schira 2011). And never before has the celebrity chef been guaranteed to pack out stadium after stadium (as happened to Heston Blumenthal during his recent tour of Australia) while talking about and demonstrating the latest culinary creations from their kitchens.

1.3 The search for novelty and surprise

Before taking a look at the relevant science underlying the field of gastrophysics, it is perhaps worth dwelling for a moment on the search for novelty that is such a signature feature of so much of contemporary cuisine (and that includes, obviously, *nouvelle cuisine* but also modernist cuisine). This search very often seems as if it were a recent phenomenon. However, Beaugé (2012) makes the case that diners have actually been interested in all that is new for well over a century now. As proof, just take the following: “*It is an exceedingly common mania among people of inordinate wealth to exact incessantly new or so-called new dishes ... Novelty! It is the prevailing cry; it is imperiously demanded by everyone. ... What feats of ingenuity have we not been forced to perform, at times, in order to meet our customer's wishes? Personally, I have ceased counting the nights spent in the*

attempt to discover new combinations.” While this might well sound like something that came from the keyboard of one of today's overworked celebrity chefs, the words were actually penned more than a century ago by Auguste Escoffier, head cook of the Paris Ritz and London Savoy (Escoffier 1907, p. vii).

The key point, then, is that we shouldn't think of the search for novelty as being a late twentieth century phenomenon. The desire, at least at the top end of cuisine, has been with us for a very long time. That said, an argument can be made that there probably hasn't been a time previously when the appetite for anything and everything new was quite as strong as it is today, nor found across such a broad section of the dining public. But where exactly does this overriding search for novelty, for the unusual, for the surprising and for the latest ‘new thing’ come from? According to Baumann (1996, pp. 116–121), contemporary dining can be seen in terms of the post-modern ‘consuming body’: the modernist diner as the receiver of sensations. In fact, in his book *Life in Fragments*, Baumann stresses how we currently live in a period of uncertainty: we live in a world where we are unsure if what we are getting is really the best of all possible sensations. The problem for the diner, then, is that it simply isn't possible to measure those sensations and experiences objectively in order to know whether or not they really are the very best.⁸

“Novel or strange edibles are no longer scorned but prized, dinner-party fare is judged according to its surprise value.”

(MacClancy 1992, p. 209)

This uncertainty, then, leads the diner – and the modernist chef preparing the food for that diner – to search for the new products and improved food experiences that just might live up to the promise of delivering heightened sensory pleasures at the table (Baumann, 1996, pp. 116–117, as cited in Sutton 2001, pp. 117-119).⁹ Notice here how novelty comes in many forms: from sourcing the most unusual and/or exotic of ingredients or outré vegetables from the very furthest corners of the globe (MacClancy 1992; Baumann 1996, p. 121; Sutton 2001; Bourdain 2002); from presenting familiar ingredients and flavours in formats that are entirely unfamiliar (see Chapter 7); or from the introduction of unusual new elements into the dining experience, be it technology at the dining table (Chapter 10), dining-in-the-dark (Chapter 8) or the addition of elements of theatre or magic to the gastronomic proceedings (Chapter 11). We believe that the delivery of novel culinary experiences that diners find both satisfying and multisensorially stimulating is increasingly going to be facilitated by our rapidly growing knowledge about how the diner's brain integrates the various sensory and conceptual elements in a dish, by understanding that taste and flavour resides in the mind (and not the mouth) and, of course, by taking this science to the table. As Gill (2007, p. 119) notes “...*taste is something that happens in your head and not, as you might imagine, on your tongue.*” Marion Halligan (1990, p. 209) makes a similar point: “*Chefs, whose livelihood is others' eating, know that the best food begins in the mind*”... to which we would like to add that that is where the best food experiences end up as well!

At the same time, however, it is worth remembering that the search for novelty can have some unexpected consequences. Although we may be willing to try anything once (Abrahams 1984, p. 23), as least if we happen to be a neophile (Rozin 1999), much of contemporary cuisine cannot really be described as comfort food (Rayner 2008, p. 193; Stuckey 2012, p. 65). What is undoubtedly also the case is that culinary surprise never tastes as sweet the second time around. In fact, we may find ourselves in the bizarre position of having a truly wonderful meal at the hands of a modernist chef (who knows, perhaps even *the* perfect meal), while at the same time having absolutely no desire to want to repeat the experience ever again (cf. Stuckey 2012, on this theme). Take the following from a

recent review of the London eatery Restaurant Story:

“Still, Sellers is a serious talent, and his achievement in launching a restaurant this fine at the age of 26 is worth celebrating. Like a good book, Restaurant Story left me feeling stimulated, satisfied and wanting to tell my friends about it. It also left me with a suspicion that, much as I'd enjoyed it, I would probably never need to return.”

(MacLeod 2013)

1.3.1 The taste of expectation

Expectations are a key point when talking about novelty and surprise. It has been demonstrated that, generally speaking, we tend to like food and drink more if they meet our expectations than if they do not (see Peterson and Ross 1972; Pinson 1986; Lee *et al.* 2006; but see also Garber *et al.* 2000). Whenever we eat and drink in fact, even before we have taken the first mouthful, our brains will have made a prediction about the likely taste/flavour of that which we are about to ingest (Small 2012). They will also have made a judgment call about how much we are going to like the experience (this is known as hedonic expectancy; Cardello and Sawyer 1992; Woods *et al.* 2011). Note also that the appearance sets up expectations regarding the likely satiating properties of a food too, which can also impact on a diner's subsequent feelings of satiety (Brunstrom and Wilkinson 2007; Brunstrom *et al.* 2010).

“A great deal of the pleasure of food is expectation.”

(Gill 2011, p. 13)

Food scientists have demonstrated that when a food or beverage item fails to meet our expectations we are likely to evaluate it, both immediately and for a long time thereafter, more negatively than if our expectations had been met (e.g. Cardello 1994; Deliza and MacFie 1996; Schifferstein 2001; Raudenbush *et al.* 2002; Deliza *et al.* 2003; Zellner *et al.* 2004; Yeomans *et al.* 2008). It turns out that we may be especially sensitive to disconfirmed expectation when it comes to our experience of food and drink, since these are the stimuli that we actually take into our mouths (Koza *et al.* 2005). As such, we need to take special care to avoid the risk of poisoning (see Chapter 7). Such findings are once again of fundamental importance to the modernist chef who may well be thinking about deliberately confounding his or her diners' expectations. Take the following example to illustrate the point: when Heston Blumenthal and his colleagues served a savoury ice-cream that looked like sweet strawberry to unsuspecting diners in the setting of the laboratory, those who hadn't been forewarned that it might be salty rather than sweet liked the dish far less both at the time and when tested several weeks thereafter than those who had been told (by the name of the dish) to expect a savoury flavour. In fact, simply giving the dish the name 'Food 386' helped to prepare diners for surprise, to expect the unexpected and so keep their mind open to new experiences. Just how many great-tasting dishes have been spoiled, one wonders, by the failure to get the name of the dish right (see Chapter 3 on the wonderful world of food naming).

“I watched the Blonde get her first course, a neat timbale of salmon hash, beet-cured salmon and sweet dill dressing (what's beet-cured salmon, please?). Her pretty face was a picture of serene expectation. Then, a moment later, it was as if she were [sic] sitting still, but her head were [sic] travelling at Mach three. She let out a small, strangulated mew and coughed: ‘Cat food.’ What, it's like cat food? ‘No, it is cat food. It's Rory Bremner beethinied salmon doing such a good impression of cat food, it's uncanny’.”

(Gill 2007, p. 108)

Of course, any self-respecting modernist chef wouldn't climb very far up the international San Pellegrino rankings if they were to listen to advice such as ‘We really do think that you shouldn't surprise your diners! Laboratory-based research unequivocally suggests that people just don't like it.’ This is one of the key areas where the results of laboratory research differ from what happens in many Michelin-starred restaurants. Now, when it comes to surprising the diner (which often involves trying to disconfirm or confound their expectations), this is something that the modernist chef excels at (in a positive way). Indeed, to be surprised is something that many diners have now come to expect when dining at one of the modernist temples to haute cuisine (Rayner 2008). However, our enjoyment of surprise, especially when it comes to food and drink – that is, the stuff that goes into our mouths and that we may swallow and which, as was just mentioned, has the potential to poison us – is going to be very much context dependent.

While surprise can undoubtedly be a very enjoyable and exciting experience if the diner knows that they are safe in the hands of one of the growing number of culinary artists who has specifically designed the experience to be ‘just so’, it can be far less pleasant when dining at a friend's house or if you find yourself taking part in a culinary experiment in the context of the research laboratory. Understanding the role of expectations in our dining experiences is therefore going to be absolutely crucial to approaching the perfect meal, as we will see in Chapter 7.

“Standing in Ferran Adrià's kitchen at elBulli, it is easy to believe that you have slipped down the rabbit hole. Adrià, who would have been the caterer of choice for the Mad Hatter, invents food that provokes all the senses, including the sense of disbelief. His success is almost as amazing as his food.”

(Lubow 2003)

1.3.2 Food as theatre: the multisensory experience economy meets cuisine

In the pages that follow, we are going to see how the new art of the table is increasingly as much about the theatre of the overall experience as it is about the taste of the food on the plate (in a way, building on Pine and Gilmore's 1998, 1999 influential work on ‘the experience economy’; see also Kotler 1997; Hanefors and Mossberg 2003). At this point in history and for the foreseeable future, should we be lucky enough to stumble across it or search it out (as one of the growing number of food tourists; Boniface 2003; Hall *et al.* 2003; Rayner 2008), the perfect meal will likely involve some combination of great (and probably novel) culinary sensations together with a healthy dose of theatre/story-telling in what will be a truly immersive multisensory dining experience (Blumenthal 2013).

“It is food as theatre.”

(Elizabeth Carter, Good Food Guide editor, cited in BBC News story ‘Fat Duck wins award despite scare’)

1.4 The brain on flavour

At this stage in the proceedings, it should be clear that the perfect meal involves so much more than merely how the food on the plate tastes. As such, it suddenly becomes clear that we need to draw on a whole new range of scientific disciplines/insights in order to really understand what is going on in the diner's mind in response to the all-new multisensory experiences that they find themselves exposed to.

Now, it isn't strictly true to say that scientists have *not* been studying the experience of flavour; they have. More often than not however, this study is carried out in a very basic way typically at the behest of one of the large food or drink companies (Meiselman 2013). The results that emerge from such

research may well have been of interest to the company who wants to know how to reduce the salt in their breakfast cereal without the consumer detecting it (Stuckey 2012), or else answering a company queries about exactly how much fish meal you can feed a chicken before the average supermarket consumer will taste it in the breast meat.¹⁰ However, while such research is undoubtedly worthy, it fails to address many of the most pressing questions about how to deliver the most stimulating and memorable multisensory dining experiences with which we are concerned in this book. We are fortunate here that our understanding of how the brain experiences flavour have benefited greatly from the recent emergence of a new field of research that goes by the name of ‘neurogastronomy’.

1.4.1 Neurogastronomy

Neurogastronomy – the study of the complex brain processes that give rise to the flavours that we all experience when eating or drinking – really emerged as a scientific discipline in the first years of the twenty-first century. The term itself was first coined by Gordon Shepherd, a distinguished professor at Yale School of Medicine (Shepherd 2006, 2012). We certainly believe that a number of the studies that have investigated which parts of the brain light up when a participant, lying in the brain scanner, is fed something or other (often some liquid or purified foodstuff delivered by means of a tube inserted into their mouth) have generated some fascinating results (e.g. St-Onge *et al.* 2005). Neuroimaging studies have, for example, enabled researchers to understand why exactly it is that people think that a drink tastes better when they have been told that it costs more (Plassman *et al.* 2008; Spence 2010). They have also highlighted the way in which different brands of soft drink (e.g. Coke vs Pepsi) can end up recruiting different brain networks (McClure *et al.* 2004; see also Kühn and Gallinat 2013).

Neuroimaging has also been used to investigate whether wine experts use more of their brain when tasting than the rest of us do; the answer, it turns out, depends on which study you read (Castriota-Scanderbeg *et al.* 2005; Pazart *et al.* 2011). Furthermore, surprising though it may seem, more of our brain lights up when we merely think about (or anticipate) food than when we actually get to taste it (O’Doherty *et al.* 2002; see also Pelchat *et al.* 2004).¹¹ Researchers have even started to delve into the question of which parts of the brain become more active when we decide whether or not we would like to taste a particular novel combination of ingredients (i.e. something that we have never eaten or come across before; Van der Laan *et al.* 2011; Barron *et al.* 2013). For example, do you think that you would like the taste of a raspberry and avocado smoothie? Or how about a green tea jelly, or beetroot custard? Only future research will tell whether today’s modernist chefs exhibit increased neural activation in areas such as the medial prefrontal cortex (mPFC) that have been shown to light up when we perform such a task, given all the practice they have undoubtedly had in terms of imagining weird and wonderful combinations of ingredients with which to assault their diners’ senses (Maguire *et al.* 2000).

It turns out that food really is one of the most effective stimuli in terms of modulating brain activity. This is especially true if we happen to be hungry. For example, in one neuroimaging study, a 24% increase in whole brain metabolism was observed when a group of hungry participants were shown, and allowed to smell, their favourite foods (e.g. a bacon, egg, cheese sandwich or cinnamon buns; see Wang *et al.* 2004). This is a massive change in brain activity in what is by far the body’s most blood-thirsty organ (e.g. Wrangham 2010; Allen 2012), especially when compared to the 1–2% signal changes that are typically reported in the literature.¹²

“... on a day-to-day basis, from the moment we are born until the moment we die, there is nothing that concerns us more than food.”

At this point, we can only speculate as to whether there might be a link between the profound neural and physiological changes that can be triggered when a person looks at (and/or smells) an appetizing plate of food and the recent growth of gastroporn.¹³ Indeed, the growing importance of the visual appearance of food, a trend that as we have seen already was really promoted by the emergence of the nouvelle cuisine movement, seems to make perfect sense once it is realized that ‘eye appeal’ really is half the meal (or as Apicius, the first century Roman gourmet is purported to have said: “*The first taste is always with the eyes*”).¹⁴ Given just how important the sight of food is, we are clearly going to need to learn as much as we can about the visual aesthetics of plating (see Chapter 4).

In fact, one of the most fascinating examples of the way in which our brain controls our food behaviours actually comes not from neuroimaging research but rather from neuropsychology (that is, from the study of patients suffering from brain damage). Take the bizarre case of those patients afflicted by Gourmand Syndrome (Regard and Landis 1997; Steingarten 2002). This is a rare neurological condition in which a stroke (one that typically affects the insula) results in an individual suddenly acquiring a profound and all-consuming interest in fine food! This can sometimes happen to those who previously expressed no interest in food whatsoever (i.e. those would eat to live rather than vice versa). Seemingly overnight, these patients develop an overriding passion for fine gastronomic cuisine. Such curious examples left Jeffrey Steingarten (2002), the famous North American food critic, to ponder: “*With nearly every bite I take, in the back of my mind there looms the same nagging question: Who is having all the fun? Is it my brain or is it really me?*”

1.4.2 Do neurogastronomists make great-tasting food?

Given the importance of the brain to multisensory flavour perception, one question that would likely spring to mind here is whether you are likely to have your perfect meal while sitting in a restaurant serviced by a chef practicing neurogastronomy. This is no longer a purely hypothetical question. For while he may not have come up with the term, the credit for first combining culinary science with brain science should probably go to Miguel Sánchez Romera, a friend of Ferran Adrià. For a while, Sánchez Romera combined two careers, one as a neurologist by day and the other as a practicing chef by night. Somehow, he even found time to write the intriguing book *La Cocina de los Sentidos* in which he combines his two passions (Sánchez Romera 2003). He eventually closed his Spanish restaurant situated close to Barcelona, L'Esguard de Sant Andreu de Llavaneres, and moved to New York City's Chelsea district to open another one named Romera (McLaughlin 2011). Miraculously, it looks like the restaurant has managed to survive the excoriating review it received from Frank Bruni in *The New York Times* (Bruni 2011).

“Its chef, Miguel Sánchez Romera, is a doctor who worked for years as a neurologist. He has coined a whole new genre for his cooking, which favors squishy textures, kaleidoscopic mosaics of vegetable powders, and a wedding's worth of edible flowers. He calls it neurogastronomy, which “embodies a holistic approach to food by means of a thoughtful study of the organoleptic properties of each ingredient,” or so says the restaurant's Web site. Organoleptic means ‘perceived by a sense organ’. I looked it up.”

(Frank Bruni on Romero, one of the world's first neurogastronomy restaurants in Chelsea, New York City; Bruni 2011)

Of course, it is unlikely that the neurogastronomy movement will lose momentum simply because of the activities of any one of its practitioners (or because of a negative review, no matter how bad it might be). We would, however, argue that this example helps to illustrate the more fundamental point

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