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About the Author

Professor Charles Spence is the world expert in multisensory perception and experience design, having spent over 20 years researching how people perceive the world around them at the Crossmodal Research Laboratory at Oxford University. He has consulted for many multinational companies, including Unilever, PepsiCo and Nestlé, advising on various aspects of multisensory design, packaging, and branding.

To Babis, for keeping faith

Illustrations

1. Introduction

From the moment we are born until the last breath we take, sensation is fundamental to our existence. Everything we perceive, experience and know comes to us through our senses. As Francis Galton, Charles Darwin's half-cousin, noted in 1883, 'The only information that reaches us concerning outward events appears to pass through the avenue of our senses; and the more perceptive the senses are of difference, the larger is the field upon which our judgement and intelligence can act.'[1]

Yet, paradoxically, what many of us complain about is sensory overload. We are all tired of being bombarded by too much noise, too much information, and too many distractions.[2] Just think about how much multitasking you do these days. According to a 2015 report by the business consultancy Accenture, 87 per cent of us use multiple media devices at the same time.[3] And the problem is only getting worse, with the world apparently getting faster, faster.[4] Look closely, though, and it soon becomes apparent that it is mostly our higher rational senses, namely, our hearing and vision, that can communicate large amounts of information and which are easily targeted by technology, that are being overstimulated. It is much harder to find anyone complaining about having to deal with too many smells,[fn1] too much touch, or else an overabundance of taste. It is, in other words, all a matter of getting the sensory balance right.[5]

North American researcher Tiffany Field, from the Touch Research Institute and Miller School of Medicine in Miami, has been arguing for years that most of us are 'touch hungry', and that this may be leading to a range of negative outcomes for our health and well-being. The skin, by far the largest organ we sense with, accounts for something like 16–18 per cent of our body mass.[6] In recent years, researchers have discovered that the hairy skin – that is, all the skin on your body except for the palms of your hands and the soles of your feet – is packed with sensory receptors that like – no, that *need* – to be gently stroked.[7] Such warm interpersonal touch conveys a wide range of benefits for our social, cognitive and emotional well-being; interpersonal touch between couples is so powerful that it can even help to relieve physical pain. The stress-buffering social support provided by frequent hugging also reduces one's susceptibility to upper respiratory tract infection and illness.[8] And if you don't have anyone to cuddle, don't worry; there are now professional huggers who, for a fee, will give you one. So, neglect your biggest sense at your peril. The Covid-19 pandemic set many of us thinking how we might deliver the touch that we all so urgently need from afar. We will return in the final chapter to the question of how technology may be used to deliver this interpersonal touch at a distance.

It has been estimated that more than a billion people will be over sixty years of age by the year 2025. Many older people complain about a lack of stimulation because no one wants to touch them since they have become, they say, physically unattractive.

Aging takes its toll on all our senses, though the decline starts at different ages for each of them. Fortunately, we have hearing aids and glasses to ameliorate the deterioration of sight and sound but, crucially, there is as yet nothing that can be done to restore our more emotional senses of touch, smell and taste. Consequently, the elderly are in very real danger of suffering 'sensory underload'.[9]

If you ask which of their senses they would miss the most, most people immediately say their sight. However, the data from quality-of-life indicators and suicide rates indicate that those who have lost their sense of smell are actually often much worse off. After all, many of those losing vision later in life can still picture their loved ones when hearing their voices. This can help to soften the blow of sensory loss, at least for a while. But when we lose the ability to smell, there really is nothing left of that sense. Few amongst us inhabit a world of remembered smells that is anything like as rich as in the mentally imagined world that we can conjure before our mind's-eye.[10]

Over the last quarter of a century or so, I have been lucky enough to work with many of the world's largest companies translating the emerging science of the senses into implementable strategies to help promote health and well-being, not to mention profitability (obviously). This includes everyone from Johnson & Johnson to Unilever, from Asahi to the VF Corporation, and from Dulux to Durex.[11] In the pages that follow, I want to share with you what I have learned.

I have spent many years working with paediatricians to highlight the importance of ensuring a balanced mix of multisensory stimulation for the optimal social, emotional and cognitive development of babies.[12] I have helped car manufacturers to sensehack driving, and so make our roads safer.[13] (I will tell you more about what I found out in the chapter on Commuting.) I also work closely with many of the world's largest beauty, fragrance, home and personal care and sexual health companies trying to figure out how multisensory attraction really works.[fn2] (Don't worry, I'll pass on some of my top tips in the Dating chapter.)[14] I have also consulted extensively for many high-street brands and mall owners across the globe, devising new ways to entice you to spend money at their 'emporia of the senses'. (We will learn more about this in the Shopping chapter.) These, then, are just a few of the secrets of the senses that I will be sharing with you.

So what exactly is sensehacking? It can be defined as using the power of the senses, and sensory stimulation, to help improve our social, cognitive and emotional well-being. It is only by recognizing the unique capacities of every one of our senses, and by acknowledging the predictable ways in which they interact to guide our feelings and behaviours, that we can hope to hack our own sensory experience most effectively. By so doing, we can all start to improve the quality of life of those we care about, starting with ourselves. No matter whether you want to feel more relaxed or more alert; no matter whether you want to be more productive or less stressed at work; no matter whether you want to sleep better, figure out how to look your best, or else get the most out of your workout at the gym; the science of sensehacking is here to help you to achieve your goals and aspirations.

The chapters in this book are organized around the key activities of daily life, and a number of the most frequently encountered everyday environments in which we are likely to find ourselves, at least if your life is anything like mine. We start at your front door, in the aptly named Home chapter. We will take a look inside the living room, the kitchen and the bathroom in order to see how each of our senses can be hacked to make our homes more hospitable and more habitable, not to mention easier to sell. We then move on to look at the benefits of nature in the Garden chapter. Next, in the Bedroom chapter, we take a look at how to sensehack our sleep by playing with

perception, in literally every sense. This is a particularly important issue, since so many of us currently complain about problems getting enough sleep, and an especially worrying one, given the stats concerning how bad for our health and well-being missing out on sleep is. Having covered the home environment, I move on to work, sensehacking Commuting and the multisensory design of the Workplace. Finally, leisure is covered in chapters on Shopping, Healthcare, Exercise and Sport, and Dating. In each case, we will take a look at some of the most effective sense hacks that have been demonstrated to make us spend more, exercise harder, look better, and recover from disease or injury more quickly.

In the concluding chapter I will recap some of the key issues and insights around the themes of sensory overload, sensory underload, sensory balance, multisensory congruency and the technology-mediated sensorium in which we find ourselves increasingly often. As a Professor of Experimental Psychology at Oxford University, my insights and recommendations are based firmly on hard science from peer-reviewed academic research, as opposed to the often unsubstantiated claims from various lifestyle gurus, feng shui 'experts', interior designers and trends futurologists so often found in this genre, so you are in safe hands.

Interior design for the multisensory mind

Getting the multisensory atmosphere right in the places where we live and work really matters, especially once you realize that those of us living in an urban environment, which is now the majority of the world's population, spend 95 per cent of our time indoors. As we will see in several of the subsequent chapters, this results in a sensory imbalance that is having a negative effect on our well-being. Spending so much of our time indoors not only can all too easily restrict our access to natural light but also means that many of us are being exposed to more airborne pollutants in poorly ventilated office buildings than is good for us. As we will see in the Workplace chapter, there is mounting evidence that spending so much time indoors, as is currently the case for many of us, may be leading to problems such as sick building syndrome and seasonal affective disorder, the latter affecting something like 6 per cent of the population in the UK who suffer from insufficient natural light in the dark winter months. Given the move towards open-plan offices in recent years, we will also look at what you can do to make sure that the sensory attributes of the working environment help, rather than hinder, your productivity and creative output. Many of the world's largest paint, lighting and fragrance companies have long been interested in trying to design multisensory interiors that allow us to achieve our goals, whatever they might be.[15]

Over the years, I have consulted for gyms and a range of other sporting organizations, helping people to get the most out of their exercise and fitness regimes by engaging the power of the senses to help motivate, energize and distract. We will take a closer look at this in the Exercise and Sport chapter. Gaining a competitive advantage, be it on the sports field or in one's love life, requires us all to make the most of whatever our senses have to offer. A number of innovative individuals and organizations are already making themselves healthier, wealthier and wiser by using the latest insights from the world of sensehacking. What is more, they are doing all this without the side effects that are usually associated with pharmacological interventions – what some refer to as 'cosmetic neuroscience'.[16] So what are you waiting for?

Familiarity breeds liking. Did you know that simply by exposing you to something, I can increase your liking for it? This is known as the 'mere exposure effect', and it works no matter whether we are aware of having been exposed or not.[17] Mere exposure presumably explains why it is that some of us like to eat chillies while others prefer to listen to the Red Hot Chili Peppers. It also helps to explain why it is that newborn babies turn their heads toward the aromas of the foods that their mothers consumed during pregnancy. Have you heard of 'foetal soap syndrome'? Don't worry, it's not as bad as it sounds. The term was introduced in the 1980s by doctors who noticed that some newborn babies preferred the voices of popular soap stars at the time (think Kylie Minogue and Jason Donovan in *Neighbours* if you're old enough) to the dulcet tones of their own mothers. It turned out that the babies had not only been tasting what their mothers had been eating but also listening to what they had been listening to.[18] Such insights and observations are leading some to wonder just how early in life the senses can be hacked.

While the majority of our responses to the multisensory stimuli that surround us are learned, it is always important to bear in mind that we evolved within a particular niche. This means that those stimuli once important for our survival seem to have retained a special status. For instance, it turns out that spiders and snakes can capture our attention and make us feel anxious, even from a very young age.[19] And, as we will see in the Home chapter, the latest evidence suggests that we also tend to set our central-heating thermostat to imitate the climatic conditions in the Ethiopian highlands where we evolved many millennia ago.

The more of your senses that are stimulated by nature, the better. Furthermore, being attentive to all that the environment has to offer our senses, rather than passing mindlessly through your surroundings, can magnify this benefit still further. Time and again in the chapters to come we will see how capturing some aspect of nature, often mediated by technology, can have a positive impact, no matter whether we happen to be at work, exercising, out shopping or at play. In order to know how best to hack our senses, no matter whether it is with the aim of enhancing our own well-being, or else perhaps nudging us to buy more whenever we go out shopping, it surely has to make sense first to try to understand the evolutionary niche in which our senses developed. Or, to adapt the famous line from geneticist and evolutionist Theodosius Dobzhansky, nothing in psychology makes sense except in the light of evolution.[20] For instance, in the Garden chapter, we will see how important those small green spaces outside the home are in providing us with a dose of the nature effect.

We also have a hard-wired, or evolved, preference for smiles over frowns, no matter whether we see them on other people's faces or on clock faces. There are stimuli that we appear to be evolutionarily prepared either to like or to loathe. Successful design and marketing often makes use of such subtle, and not so subtle, triggers to nudge us consumers by means of the latest in sensory marketing, as we will see in the Shopping chapter.[21] Have you, for instance, ever noticed, or wondered why it is, that analogue watches in ads nearly always show the time as ten minutes past ten? In fact, according to the results of one analysis, ninety-seven of the one hundred bestselling men's dress watches on Amazon.com, showed this time. The position of the hands at 10.10 makes it seem like it is smiling, and when researchers in Germany assessed this experimentally, they found that people prefer those watches that 'smile' at them.[22]

Why is 8.20 a downer? Which clock face is smiling at you? Which watch looks sad? This is just one example of anthropomorphism in product design.

Those who market timepieces long ago realized that simply by setting the time to 10.10 on an analogue watch they could make us feel more favourably about what they were offering us.[fn3] Such a simple sense hack really shouldn't influence our choice – after all, the precision of a watch's timekeeping is not signalled by the time it shows – but the evidence suggests that it most certainly does. What is more, having recognized the importance of such evolutionary triggers, one can then design everything from product packaging to computers and cars, safe in the knowledge that they will be appreciated that little bit more by consumers because they play on specific evolutionary affordances. For instance, designers have shown that arranging the USB slots on the front of your computer, or the visual design of cars, so that they look, anthropomorphically, like they are smiling can also help to create a better, more appealing impression too. Once you know what to look out for, it will suddenly become apparent just how many companies are already hacking your senses. For instance, look closely and I bet you will be amazed to see how many brands are smiling at us these days, everyone from Amazon to Argos.[23]

Intriguingly, however, watches did not always smile. The majority of adverts from the 1920s and 1930s displayed watches set to 8.20 (frowning). Hence, while making one's product smile might seem obvious today (at least to the intuitive marketers and designers of this world), such evolutionarily inspired solutions were often stumbled upon by accident. And while some have, rightly in my view, wanted to question the ethics of sensory marketing and consumer neuroscience, in this strange twenty-first century, when global pandemics and lockdowns are apt to devastate the global economy without warning, I would argue that never has there been an era when sensehacking was more important. Sensehacking is what we need to remain well and balanced.[24]

Some examples of brands that have incorporated a smile into their logo.

Indeed, during the deepest pre-Covid-19 recession, the Great Depression that followed the Wall Street Crash of 1929, 'consumer engineering', or 'humaneering', was regarded by some as a key element in terms of helping to reinvigorate the world economy. This novel approach to consumer psychology was all about getting the subtle sensory cues in product design right.[25] In a way, then, consumer engineering can be seen as last century's precursor to today's sensehacking. However, in order to hack them most effectively we first need to recognize that our senses do not work independently but talk to each other all the time. And it is only by understanding the key rules governing how the senses interact to deliver our multisensory perception of the world around us, and all the objects within, that we can really begin to optimize the multisensory cues and environments to help deliver the outcomes we all desire.

Sensory crosstalk

When I first started teaching in Oxford almost a quarter of a century ago, there was one professor studying vision and another studying hearing. Even though these two individuals worked together closely (both physically and metaphorically), they had

fallen out and not spoken to one another for years. The truly surprising thing to me, though, was that neither of them appeared concerned at this lack of communication. They simply did not realize what they were missing out on. Implicit in their attitude was the traditional view of perception, whereby the senses were considered as entirely separate systems. This is, after all, just how they appear to us on the outside: we have eyes to see, ears to hear, a nose to smell, a tongue with which to taste, and skin to feel the world around us.

But how much do your senses interact? The answer to this question is critical, both in terms of determining how we experience the world around us and how that experience makes us feel. The science shows that our senses connect far more than we ever imagined. In practice, this means it is possible to change what we hear simply by altering what we see, while manipulating the way something sounds can affect what it feels like. And simply by adding the right scent, it is possible to bias our impression of whatever is before our eyes, as the wily marketers know only too well. Any one of us can also use the tricks, or sense hacks, associated with multisensory perception, to our own advantage.

In the chapters that follow, we will come across many such surprising examples of crosstalk between the senses. For instance, in the Dating chapter, we will see that how attractive, not to mention how youthful, you *look* to others is partly determined by your choice of fragrance (i.e. how you *smell*). We will also see how the agreeable sensation of a loving caress can be ruined by a bad smell while being enhanced by a good one.[26] In the Home chapter, we will discover how you can make your washing feel softer and look whiter, simply by adding the right scent. We will also see how our perception of the bitterness of coffee turns out to be influenced as much by the harshness of the noise made by the coffee machine as by your choice of beans and roast. And, in the Commuting chapter, we will see how your perception of the quality of a car is subtly, not to say subliminally, influenced by the psychoacoustically engineered sound of solidity made by its doors when you close them, hence priming notions of security. If you drive an upmarket model, then the chances are that the throaty roar of the engine that you so admire has actually been synthesized to sound a certain way too. All that before we get to the recommendations to add value to an older model using nothing more than a dash of 'new-car smell'.

While big business has been hacking our senses for decades,[27] there is nothing to stop the rest of us from using sensehacking to help us to eat less without feeling hungry. Wouldn't you want to know if it turned out that you could use 'warm' lighting and/or paint colours to help reduce your heating costs? We can all get more out of life by hacking our senses. This book is going to show you *how* to do it, and *why* it works. Sensehacking provides one of the most effective means of helping us to eat less, live longer and enjoy ourselves more along the way. We can all use music, soundscapes, scents and colours to become more productive, to relax and sleep better and to improve perception when necessary.[28]

Sensehacking is built on the growing awareness of just how connected our senses are, and how fundamental the right balance of sensory stimulation is to our health, productivity and well-being. This is true no matter whether we happen to be at home, in the office, at the gym, out shopping or even receiving healthcare. Integrating the senses is fundamental and, what is more, may even help to improve the quality of life too. In fact, correctly balanced multisensory stimulation is already being used in some clinical settings to help alleviate pain and aid in the recovery of hospital patients. We will come across a number of remarkable examples of such sensehacking in the

Healthcare chapter, such as how patients who listen to music not only require less pain relief but may even recover faster too.

The merging of the senses

No creature that has more than one sense keeps them separate. Just think about it for a moment. It would be catastrophic if one sense pulled in one direction while another pulled in the opposite direction. There is simply no way of resolving such a conflict unless the senses communicate. Our perception and behaviour are controlled by the activity of many millions of multisensory neurons connecting the five main senses of sight, sound, smell, touch and taste. The key question is what rules the brain actually uses to combine the inputs from the different senses. For it is only by understanding how multisensory perception works that we will be ready to start hacking our senses efficiently. In the Home and Dating chapters we will come across many examples of how sights, sounds, smells and even feelings combine to deliver the extraordinary, as well as the mostly mundane, multisensory experiences of everyday life. But what are the rules governing multisensory perception? Well, the good news is that there are only three key rules that you need to know about for now.

1) Sensory dominance: Hearing what you see

Very often, one of our senses will dominate the others in terms of dictating what we perceive. For instance, just think about how the actor's voice always seems to come from their lips on the cinema screen. This despite the fact that the voices actually emerge from loudspeakers hidden away somewhere else in the auditorium. In this case, our brain uses the evidence before our eyes to infer where the sounds belong. The 'ventriloquism effect', as it is known, has been used in stage shows, not to mention by mystics, for millennia. This makes sense inasmuch as our eyes typically do a much better job of telling us where something is than our ears. During human development, our brains learn to rely on the most dependable, or accurate, sense, thus helping us to deal with the 'blooming, buzzing confusion'[fn4] that greets us all at birth.[29] While some researchers have wanted to explain vision's dominance in purely mathematical (specifically Bayesian) terms, there remains some intriguing evidence suggesting that there is a more deep-seated reliance on, or attention to, whatever is before our eyes, that the mathematicians have not yet been able to explain.[30] This is where the anthropologists, historians, artists and possibly even sociologists can help us to contextualize the hierarchy of the senses that we currently find ourselves with, and enable us to probe whether it is the right one for us personally, not to mention for the societies in which we live.[31]

Imagine watching a person's lips articulating the syllable 'ga' while at the same time hearing them utter the syllable 'ba'. What would you perceive? Most people hear the speaker saying 'da'.[32] You can try this illusion, known as the McGurk effect, for yourself. There are plenty of great examples online. Very often our brains combine the various sensory inputs automatically, and without letting us know quite what is going on. Sometimes, even when you know exactly what is happening, and that your senses are tricking you (as in the McGurk effect), it is still impossible to stop yourself from hearing something different when the lip movements you see change their tune. Exactly the same thing happens when red dye is added to a white wine and the experts suddenly start smelling what they take to be red, or rosé, wine aromas.[33] The question

of which sense dominates when they get conflicting messages is one that we will return to throughout the book.

2) Superadditivity: or when 1 + 1 = 3

Have you ever noticed just how much easier it can be to hear what someone is saying at a noisy cocktail party if you just put your glasses on?[fn5] Many researchers believe that this provides an everyday example of superadditivity. This is the idea that individually weak sensory inputs may sometimes combine to give rise to a multisensory experience that is much richer than would be predicted simply by the sum of the individual parts. As we will see in the Shopping chapter, marketers have become very excited by the possibility that they can enhance sales simply by getting the combination of in-store sounds, scents and colours right.

3) Sensory incongruence

Do you remember the last time you watched a badly dubbed foreign movie, say, or else a satellite broadcast where the voice became desynchronized from the lips? The visual image may be crystal clear, the voice quality second to none, but if the senses do not quite match up temporally, the experience can all too easily be ruined. Sub-additivity, the third of the key rules governing multisensory perception, is often the result when incongruent sensory impressions are combined. In fact, the outcome can all too easily end up being worse than would have been expected from the best of the individual inputs. Incongruent combinations of sensory stimuli are typically hard to process, meaning that they are negatively valenced; in other words, we do not like them much.[fn6] When the owner of the store or shopping mall starts playing the sounds of the jungle, or forest, over the loudspeakers, is that congruent? This just one of the questions that we will return to in the chapters that follow.

The science of sensehacking

By avoiding sensory overload, sensory imbalance and sensory conflict, every one of us has the sensory tools at our disposal to help us live healthier, happier and more fulfilling lives by building on the emerging scientific understanding of the synergy between the senses. That requires us to recognize the cultural construction of the senses, acknowledge the inherently multisensory nature of mind and also be sensitive to the individual differences in the sensory worlds we all both inhabit and desire. This is the multisensory science of sensehacking. Now let's see how it is done.

2. Home

Let's start at the entrance. Have you ever wondered about the slightly strange scent that greets your nostrils as soon as you open your front door on returning from holiday? In fact, this smell is always there, it is just that we all adapt to it since we are continually exposed to it. It is only when we return after a long trip away that we suddenly realize what our own home actually smells like. Everyone's home has its own distinctive building odour (or BO, for short), as you've probably noticed, and your own abode is, of course, no different. Because we spend much of our time there, it becomes so familiar that we do not necessarily perceive it as a visitor would. All too often, we miss what is, quite literally in this case, right under our noses.[1]

But what effect does constant exposure to that smell have on your household? After all, the ambient scents that surround us can affect our mood and well-being, not to mention how alert or relaxed we feel.[2] And just because you are not aware of it certainly does not mean that you are immune to scent's influence upon you. Indeed, smells that we don't notice can sometimes affect us more than those that we do. Worryingly, there is also evidence to suggest that the airborne mould and other unidentified low-level odorants in people's homes may be responsible, at least in part, for the debilitating condition known as sick building syndrome, whereby the building in which you work and/or live can actually make you ill.[3]

Baudelaire once described the smell of a room as 'the soul of the apartment',[4] and I am sure that you have heard the advice to brew some coffee, bake some bread or a cake and/or put out some fresh flowers when prospective buyers view your home. The smell of vanilla is apparently particularly popular with North American real-estate brokers. Now, while it is actually surprisingly hard to find any concrete evidence showing that such a strategy works, this has not stopped others from going even further when it comes to scenting homes they are trying to sell. Indeed, according to one press report, we should all forget about the smell of coffee and fresh bread, because the perfect smell to sell a new home actually consists of a mixture of white tea and fig. Once again, though, no evidence was provided to back up this particular claim. At the same time, however, the smell of cigarette smoke and pets – and here we are talking cats and dogs, not goldfish – can be particularly off-putting, potentially reducing sale prices by as much as 10 per cent according to the CEO of one Florida estate agency.[5]

In 2018 the lucky owners of one high-end apartment commissioned synaesthetic[fn1] scent-designer Dawn Goldsworthy to create a bespoke scent especially for the $29 million new condo that they had just bought in Sunny Isles Beach, Miami. The idea was for this fragrance to be dispersed via the apartment's air-conditioning system, thus giving their property a truly unique olfactory identity. While such a strategy is obviously beyond the reach of all but the super-rich, there is certainly nothing to stop

the rest of us from scenting our homes more frugally, be it with flowers, pot pourri or perhaps one of those battery-powered scent-dispensers. Scented candles are another option, although some commentators have started to raise concerns about their air-polluting effects, so burn them at your peril.

Many florists now offer 'well-being bouquets' – flower arrangements that not only look great but also give off scents that can exert a positive influence on our mood and our health.[6] So, no matter whether you're trying to sell your home or just giving it a spring clean, thinking more carefully about the scent that pervades the space might be a good idea. It certainly makes sense when one considers all the evidence showing that aromatherapy can influence our mood, our alertness and even our sense of well-being. Similarly, the presence of a pleasant fragrance such as warm bread, roast coffee or citrus can even increase our prosocial behaviour, be it measured in terms of helping others when they drop something or else tidying up after ourselves when we finish eating.[7]

The effects of ambient aroma appear to be more psychological than pharmacological in nature, meaning that they result from associative learning.[8] So, for example, it is likely to be the psychological associations we have that explain why the smell of heliotropin is so calming to so many of us. The scent of this South American flower is one of the key volatiles in Johnson's baby powder. The smell probably triggers reassuring memories and associations of early childhood, even if we cannot quite place it when coming across it out of context as adults. Meanwhile, some older people take a dislike to the scent of certain flowers because it reminds them of what lies ahead for us all: death and funerals. More generally, our response to ambient scent may well be determined by whether we happen to like the smell or not, whether we believe it to be artificial or natural, and how intense, or overpowering, we find it, although the published studies in this field are often statistically underpowered, meaning that it is hard to draw any firm conclusions from them.[9]

Designing for the multisensory mind

Years ago, the modernist Swiss architect Le Corbusier made the intriguing claim that architectural forms 'work physiologically upon our senses'.[10] The latest findings from the emerging field of research lying at the intersection of cognitive neuroscience and architecture have started to provide some robust empirical support for such a claim.[11] For instance, the researchers in one study had their participants perform a social stress test in virtual reality. The psychologists' favourite stress test, known as the Trier Social Stress Test (or TSST for short), after the city in Germany where it was developed, involves having people give a short speech in front of a panel of listeners who show no emotion whatsoever. The panellists are usually real people, but in this case virtual characters were used instead. The researchers documented an increase in the level of salivary cortisol, which is a physiological marker of stress, in those who undertook the stress test in an enclosed virtual environment as compared with those who performed the task in a virtual room that gave the appearance of being more open. In this case, the suggestion was that the more open room provided a better opportunity for escape.[12]

For what it is worth, entering a home that smells bad can trigger a desire to escape too. People rate rooms as brighter, clearer and fresher if there is a low level of ambient fragrance present – even if they are unaware of the scent. What is more, rooms are experienced as larger when a pleasant scent is present. It has even been suggested that

Readers of a certain age might recall the almost obligatory avocado and/or chocolate-coloured bathroom suites of the 1970s. What were people thinking? This is just one memorable example of how the most desirable colours for our homes are often determined more by trends or fashion than by any functional claims for the physiological effects that colour may have on us. Whenever I see such a colour scheme in a retro-styled or unmodernized home today, I find it hard to imagine why people once flocked to install them.[fn4] Nowadays, the big paint companies employ trend experts to come up with the most desirable new-season colour names to keep their offerings sounding fresh and to make their paints seem contemporary. We should perhaps all be thankful that they have yet to conjure up a winning new name for this particularly unsavoury pair of colours, one that makes us fall in love with them all over again.

Le Corbusier hinted at an almost moral angle to the use of colour, or rather to its absence, when writing in 1923, 'Demand bare walls in your bedroom, your living room and your dining room ... Once you have put ripolin [whitewash] on your walls you will be master of yourself. And you will want to be precise, to be accurate, to think clearly.' Here Le Corbusier seems to have been using white for its purifying value, as a sort of architectural sanitizer, much as men in the eighteenth century would have worn a white shirt instead of washing their bodies.[fn5] I do, though, wonder what the great architect would have made of German painter Johannes Itten's claim, 'Colour is life; for a world without colours appears to us as dead.'[26]

People make more errors when proofreading in a white room than in one that is either red or blue, thus seemingly contradicting Le Corbusier's suggestions. Elsewhere, meanwhile, in a study of almost 1,000 workers from different countries, those who found themselves in a room with some colour tended to be in a better mood than those working in a room without any.[27]

A large Italian study published in 2018 investigated the impact of interior colour on psychological functioning in 443 students living in university halls of residence just outside Pisa. The corridors, kitchens, living areas, and part of the residents' rooms in six identical buildings were painted in six different colours and the students' impressions were collected a little over a year later. The most popular colour was blue,[fn6] followed by green, violet, orange, yellow and red. The preference for blue was much stronger amongst the male students than amongst the females, while the sex difference was reversed for those living in the violet-coloured building. Those living in the blue building also reported that they found it easier to study than those inhabiting rooms of any other colour.[28]

The colour of emotion

What colour paint should you put on the walls of your home? Your choice really matters, given that the colour of the rooms inside which we spend so much of our time has been shown to exert a significant impact on our mood and well-being, with effects being linked to the hue (red, blue, green etc.), saturation (i.e. chroma, the purity or vividness of colour) and brightness (referring to the dark or light nature) of the colour. One of my favourite illustrations of this comes from famous Italian movie director Michelangelo Antonioni, who once painted the canteen a bright red with the idea of getting his actors into the right frame of mind prior to filming some tense scenes. This simple change to the environment apparently proved so effective that within a few weeks fights had started breaking out amongst the canteen's regular diners. Consistent with such an anecdotal observation, laboratory-based research has documented a

measurable increase in arousal, as measured by what is called the galvanic skin response (basically, a measure of how much you sweat), after no more than a minute's exposure to red light as compared to light of other colours.[29]

The colour of walls and/or lighting has been shown to bias our mood, emotion and arousal. It has even been suggested that our internal clocks run just that little bit faster under red lighting than under blue. Consider how for centuries performers waiting to go on stage used to wait in a 'green room' that was literally green. Indeed, it is just this ability of colour to sensehack our emotions that might lie behind room lighting's influence on the perceived taste and enjoyment of food and drink. So, for example, the authors of one study demonstrating an effect of the colour of the ambient lighting on the taste of wine suggested that 'if a colour induces a positive mood or emotion [...] then the same wine tasted in this positive mood is liked better than when in a negative mood'. The colour scheme in a room can, then, perhaps be considered in much the same way that we think about the background music. For there too, it has been shown that the more we like the music, the more we appear to like whatever we are tasting.[30] The colour of the ambient lighting also influences our perception of the brightness of the lighting as well as the ambient temperature, which brings us nicely on to the question of ...

Why do we like our homes to be as warm as Africa?

The mean temperature, not to mention the regularity and consistency of indoor heating, has increased dramatically since the nineteenth century, with night-time averages continuing to rise well into the modern era. For instance, the mean indoor dwelling winter temperature increased by as much as 1.3°C (2.3°F) per decade from 1978 through to 1996.[fn7] More than 85 per cent of homes in the US have air conditioning, further helping homeowners to control the ambient indoor temperature.[31] So the question that you have to ask yourself, given how many of us now have so much control over our indoor climates, is why we all seem to like our homes to be as warm as Africa? These days, most of us set our homes to a fairly uniform 17–23°C (63–73°F). At least that was the result of a study in which researchers collected indoor climate data from the homes of thirty-seven 'citizen scientists' across the United States over the course of the year. These data were then compared with global terrestrial climate data looking for the closest match.

Remarkably, no matter whether the citizen scientist's home was in Hawaii or Alaska, the chilly north of Washington State or the humid south of the Florida Everglades, the average indoor temperature and humidity across the course of the year that matched most closely turned out to be the mild outdoor conditions of west central Kenya or Ethiopia, where human life is first thought to have evolved. What such results have been taken to suggest is that we set our own home environments to mimic that of our prehistoric ancestors. According to Mark Maslin, an academic from University College London, these results highlight the enduring effects of 5 million years of evolution in East Africa.[32]

A kitchen for the senses

The kitchen is one of the spaces in the home that has perhaps changed its form and function more than any other over the last century and a half. In Victorian times, it would typically have been hidden well out of sight. However, concern about food smells percolating through the home was something that people worried about even

then. In 1880 the architect J. J. Stevenson wrote that, 'unless the kitchen itself is ventilated so that all smells and vapours pass immediately away, they are sure to get into the house, greeting us with their sickly odour in the halls and passages, and finding their way to the topmost bedroom, notwithstanding all contrivances of swing doors and crooked passages'. Le Corbusier's solution to this problem at the Villa Savoye, a modernist villa situated in Poissy, on the outskirts of Paris, that the Swiss architect designed together with his cousin Pierre Jeanneret, was to put the kitchen on the roof. The idea was that this would help avoid the home filling with cooking aromas at mealtimes.[33] Dispelling cooking odours was just the sort of luxury that people could start to worry about after the widespread introduction of flushing toilets (actually invented in 1596) in the middle of the nineteenth century.[34]

Nowadays, the kitchen/dining room has become the common living space where many of us spend much of our waking time while at home. Thus we are being increasingly often exposed to food cues in the home, both olfactory and visual. This may be inadvertently nudging us toward eating and drinking more than we otherwise might.[35] Do not despair, though, for the creative designers at NozNoz have come up with an inventive, if bizarre, solution to tackle this particular problem. According to the instructions, all you have to do is to insert their patented rubber seals discreetly into your nostrils in order to block out all the homely food aromas that might otherwise be tempting you. *Voilà!* Problem solved. The results of a small preliminary study (not peer-reviewed as far as I can tell) suggested that wearing these inserts developed by the Rabin Medical Center in Israel could lead to a doubling in weight loss in dieters under fifty years of age. Over the three months of the trial, overweight individuals wearing the inserts apparently lost an average of 18lb (8.2kg; 7.7 per cent of body mass), as compared to 9.8lb (4.5kg) in the other group. I wait with bated breath to see whether this particular solution catches on – though something tells me that it perhaps will not. The good news, though, is this may not be the only sense hack that has been suggested to suppress our appetites.

The NozNoz, one potentially effective means of sensehacking your sense of smell in order to avoid all of those tempting food aromas that so often surround us.

Is Baker-Miller pink really an appetite suppressant?

According to Kendall Jenner, painting your walls Baker-Miller pink acts as an appetite suppressant.[fn8] Jenner, the half-sister of Kim Kardashian, is currently one of the world's biggest Instagram stars (with more than 75 million followers last time I checked). When she painted her living-room walls in this colour after seeing an exhibition in which a pink Schauss Kitchen had been displayed it was big news, at least for the Instagram generation. However, before rushing out to stock up on this most unappetizing shade of bubblegum pink, it is worth noting, once again, that there is simply no support for this suggestion, intriguing though it undoubtedly sounds.

It is not that the visual system does not hold certain wavelengths of light in special regard, for it most certainly does. For example, it turns out that the wavelength tuning of the cones in the retina is optimal for detecting the blood-oxygenation level in bare skin (regardless of skin colour), which provides a barometer of emotional arousal.[36] But important as it may be as a social signal, pink, and specifically Baker-Miller pink, is probably not the colour for your kitchen – so relax. Researchers have struggled to

demonstrate any influence of this colour on people's behaviour in settings such as prison detention cells, and what is more, the effects that have been reported were only short-lasting anyway.[37]

Have you come across those colour-changing LED light bulbs? Twenty-four different colours or more in a single unit, but what to do with them all? Well, for those of you struggling in this regard, let me give you a little inspiration. According to my colleague Han-Seok Seo and others, coloured light *can* actually be used to help suppress our appetite. These researchers found that bathing men in blue light led to their eating significantly fewer omelettes and mini-pancakes for breakfast than those eating under regular white or yellow lighting. What is more, those who ate less under the blue lighting did not report being any less full after their diminished breakfast. One possible explanation for this intriguing result is that the blue lighting may have made the food look unappealing. This is the same claim that lies behind the blue-tinted dieting glasses sold by the Japanese company Yumetai.[38] For whatever reason, the appetite-suppressing effect of blue light was seen only in men. The women who took part in the study were not so easily swayed by such a cheap psychologist's 'trick of the light', perhaps because they tend to be rather more knowledgeable about what is in their food in the first place. However, before rushing out to buy a colour-changing light bulb for your own breakfast table, or perhaps sending off for a pair of those azure specs, it would, I think, be wise to wait for more robust studies to be published confirming just how long any appetite-suppressing effects of blue light last.

Can a nicely decorated table really make the food taste better?

On one of my Colombian father-in-law Ricardo's final visits to England, my wife and I decided to take him out for a fancy molecular gastronomy meal in a very trendy, not to mention rather expensive, London restaurant. Unfortunately, what was meant to be a special occasion was ruined for my *suegro* (as they say in Spanish) by the paper napkins, not to mention the absence of a starched white linen tablecloth. As soon as Ricardo, a renowned architect back home, laid his eyes, and worse still his hands, on the rough feel of the napkin, it was all over; he simply could not enjoy the meal. The problem was that he just could not see past the table settings. And while this was frustrating at the time, given how much effort we had gone to in order to secure the table etc., the latest research has proved him right. A well-appointed table really can make the food taste better.

Coloured napkins, tablecloths and place settings can all exert a modest influence over a diner's emotional state in much the same way as changing the colour of the room.[39] Even the mere presence of a tablecloth can make a world of difference.[fn9] According to the results of a study published in 2020, diners rated a bowl of tomato soup as tasting significantly better when there was a tablecloth as compared to when it had been removed. The enhancement in this case amounted to a not inconsiderable 10 per cent, and went together with a 50 per cent increase in how much was eaten – all this assessed in a reasonably naturalistic social dining situation where several people were eating together. The study also compared the influence of setting a nice table with that of varying the lighting intensity.[40] Traditionally, it was suggested that a darker, more intimate environment was better for dining, perhaps because it reminded us of that time long, long ago when, after a long day hunting bison or some such, the prehistoric family of the day could finally sit and relax in their cave in front of the fire and feel, for a few moments at least, safe. (Trust me, I am not making this stuff up.)[41] Interestingly in this regard, the nicely appointed table setting actually exerted a more

pronounced effect on food ratings than did the lighting, which varied between romantic dark and bright light. Who says that table decorations do not matter?

So what, then, are some of my top tips for sensehacking the dining table to make that special meal really special? Classical music would seem like a good idea, given that it primes notions of quality and class. Soft lighting can't do any harm. My all-time favourite, though, has to be to make sure you get out the heaviest cutlery that you can find, as that will definitely help to ensure that your guests are impressed with whatever it is you have prepared, as I have described in my last book – *Gastrophysics: The new science of eating*. If you must have the TV on, try to watch something like *Downton Abbey* or perhaps an episode of *The Crown*. According to research commissioned by Aldi and conducted by Mindlab in 2013, watching *Downton* (and so also, presumably, anything in the same genre) results in people rating drinks such as wine, beer and brandy as tasting more elegant and refined. At least it did when compared with watching an episode of *Only Fools and Horses*, a sitcom set on a south London council estate. Once again, this is likely to be an example of sensation transference, much like the effects of pleasant music on fabric softness we encountered earlier.

Do you really want a silent kitchen?

'The kitchen that sounds like a library' – this was the promise made in one print advertisement for AEG kitchens at the turn of the twenty-first century. Drawing our attention specifically to the quietness of the kitchen is unusual, and just like the silent car that features in the Commuting chapter, I am not so sure that it is something that any of us really want, at least not once we think about it. You would, I suspect, be taken aback if you knew just how much sensehacking goes into the design of our seemingly mundane white goods. Everything from the sound made by your fridge door when it closes through to the grinding, gurgling and steaming of your coffee machine has in all likelihood been engineered to sound 'just so'. Of course, when you realize that some kettles make more than 85dB of noise when boiling water (equivalent to heavy traffic, and the point at which long-term exposure starts to become damaging), it is no surprise that many of us complain that our electronic appliances make far too much noise and we would prefer them to be quieter.

Whether we realize it or not, sound often plays a functional role in our product experience. When engineers or designers do sometimes manage to remove it, thus making the washing machine, blender or vacuum cleaner silent, trouble often ensues. The problem is that it often feels like it is no longer doing a good job; for example, researchers have found that it is very difficult to convince people that a silent vacuum cleaner is picking up anything like as much dirt as a noisier model.[42] My team and I have been working for a number of years on modifying the sound of kitchen devices such as coffee machines. And surprising though it might sound, it turns out that it is possible to change people's perception of the harshness, or bitterness, of the coffee simply by changing the sharpness (i.e. the loudness and frequency profile) of the noise made by the machine. Getting the sound of the fridge door right when it closes is equally important at the high end of the kitchen appliance market. In fact, the design of fridge doors actually has more in common with the design of car doors than you might think. In both cases, having the right secure sound and feel is key. Perhaps this should not come as a surprise when one realizes that, at the upper end, your most desirable new designer kitchen can easily set you back more than even a fancy new car (as my wife will be pleased to confirm).[43]

3. Garden

I have a confession to make. I used to be a very naughty boy. From my earliest school days, I was shoplifting, letting off stink bombs and blowing things up in the chemistry lab, and receiving the appropriately named Mr Payne's plimsoll on the rear for my efforts when caught. I can still vividly remember the day I brought my own size 6 trainers to the headmaster's office, only for Mr Payne to bellow that those weren't shoes before bringing out his enormous size 13 footwear to gently caress my behind! Things went from bad to worse as the years went by until on one fateful day, aged thirteen or so, I was given a public flogging in front of all the teachers and prefects in school for 'throwing' concentrated nitric acid in another boy's face. In my defence, I only meant to brandish the bottle and give my nemesis (let's refer to him as A. S.) a scare while the chemistry teacher was out of the room. Unfortunately, however, I was holding the bottle by its glass stopper and it slipped from my grasp at the critical moment, along with its most corrosive contents, smashing onto the table and splashing my classmate in the process. I will never know whether it was this public humiliation, the last flogging in my school before the practice was outlawed in the UK, that changed my behaviour for the better. But whatever it was, my performance soon started to improve. Within a year or so I was starting to come top of the class rather than bottom and, well, the rest, as they say, is history.

In hindsight, there was another significant change that occurred at around this time: I joined the school's orienteering club. I was soon hooked. Before long I was spending most weekends and many an evening running through the woods, moors and forests of the North of England, map and compass in hand, searching out the red-and-white flags to stamp my card.[fn1] Suddenly I was being exposed to nature in all its richness on a near daily basis. Could it have been *this* change to my diet of multisensory stimulation that was responsible for the positive change in my behaviour and, ultimately, my school performance? It would never have crossed my mind to think so at the time, but a growing body of research now shows just how profoundly beneficial exposure to nature is for all of us, no matter who we are.

Even small doses of nature have been shown to improve our mood, our performance and our well-being.[1] Increase the amount of time spent in nature and the benefits rise in a seemingly dose-dependent manner. Perhaps, then, what really changed my behaviour, and I suppose my life, for the better all those years ago was not so much the pain and humiliation associated with a good hiding as all that exposure to nature.[fn2] As we saw in the opening chapter, the fundamental problem in the modern era is that we seem to have lost touch with our more sensual side. The increasing amounts of time that those living an urban existence, which is the majority of people these days, spend indoors mean that we are all in danger of losing touch with nature, and the multisensory benefits that it provides. As Marc Treib once wrote in an essay entitled