1. Introduction

The last few years have seen a phenomenal growth in the field of sensory marketing (e.g., see 'Does it make sense?', 2007; Hultén, Broweus, & van Dijk, 2009; Krishna, 2010; Spence, 2002; Springer, 2008). While there has never been any doubt about the importance of the visual aspects of design, what we are now seeing is an increased emphasis by marketers on the impact of the other senses: Sound, touch, smell, and, on occasion, taste (Lindstrom, 2005). Many companies and brand managers are increasingly being told that they should engage as many of a consumer's senses as possible in order to increase brand engagement/loyalty (e.g., Neff, 2000; Lindstrom, 2005). But beyond the mantra of "the more senses your brand stimulates, the better" what guidelines/rules are there to help the brand manager or product developer improve the sound of their products? And what consequences might changing a product's sound have for the customers' overall multisensory product experience? (see Schifferstein & Spence, 2008).

What sensory marketers typically fail to mention to brand managers and product designers is that they should not consider each of the sensory attributes of their products in isolation. Why not? Well, because the
Brain Science and Multisensory Product & Brand Development

brain is a fundamentally multisensory organ, and, consequently, changing any one sensory attribute of a product (be it the sound, feel, or colour) is likely to impact on the customer’s overall product experience (or Gestalt). Let me repeat: Consumer perception is inherently multisensory! What this means is that each of our senses are intimately connected to all of the other senses (see Figure 1). As a consequence, you cannot expect to change the sound of a product, say, without also likely impacting on the product’s feel. In short, the traditional approach to studying and modifying the sensory attributes of a product individually doesn’t work, at least not always.

Figure 1. The latest cognitive neuroscience research demonstrates that the senses talk to one another in the customer’s brain. Consequently, their perception of a product is inherently multisensory.

2. Multisensory Integration and Product Perception

Recent cognitive neuroscience research has provided a number of key insights into how the senses interact in the human brain. Importantly, these insights are now starting to provide actionable guidelines for product designers. For example, we now know why it is that changing
the sound of a product can change its feel (e.g., Spence, 2008b; Spence & Zampini, 2006), why it is that changing a product’s colour often changes its taste (or flavour; see Spence, Levitan, Shankar, & Zampini, 2010, for a review), and why it is that changing a product’s scent can change everything from its apparent colour to its perceived softness (e.g., Demattè, Sanabria, Sugarman, & Spence, 2006; Spence, 2008b).

Figure 2. Our brains combine individually weakly-effective signals in non-linear ways. One such non-linear multisensory interaction is known as superadditivity. The idea is that one can use superadditivity to deliver more stimulating products and consumer experiences, by making sure that the senses work together to deliver as congruent a message (or experience) as possible to the consumer.

The three key rules of multisensory integration that every designer and brand manager needs to know about are superadditivity, subadditivity, and sensory dominance. Superadditivity refers to the fact that our brains integrate sensory cues in a non-linear manner. Hence, you simply cannot predict the consequences of combining two or more sensory inputs by looking at the impact of each sense in isolation. If you get the combination of sensory cues right, then individually weakly-effective cues can integrate superadditively, giving rise to a percept that is far richer than would have been anticipated by studying the senses individually (see
Figure 2). However, get the combination of sensory cues wrong, and what you get is subadditivity instead. Subadditivity normally occurs when the senses are combined in an incongruent manner, think here of an aggressive and harsh sounding aerosol sound for a soft and gentle personal care spray (e.g., for a brand such as Dove).

Subadditivity means that the effective brand communication achieved by one sense, can be rendered ineffective by the input provided to another sense which just so happens to be incongruent with it. Think, Clear Tab. Both the cola taste and the clear colour were individually appropriate for a fizzy soft drink; it’s just that their combination was incongruent. We expect clear drinks to taste, if anything, of lemonade, while cola drinks should be dark brown. The product was withdrawn from the shelves within a year of its launch, despite having undergone extensive consumer testing. The promise is that by understanding the science behind sensory interaction, many such product failures can be avoided.

Sensory dominance refers to the fact that our brain often uses the most informative (least variable) sensory estimate in order to infer what is out there (Ernst & Bülthoff, 2004). Hence, simply by changing the lip movements that you see, it is possible to change which speech sound you think you are hearing someone speak – this is known as the McGurk effect (McGurk & McDonald, 1976). The taste, flavour, and aroma of food and drink items can also be changed simply by changing the colour of the food or drink item (see Spence et al., 2010). Having highlighted the three key rules governing multisensory perception, I now want to demonstrate how such cognitive neuroscience insights can, and already are, being used by innovative companies in a range of sectors in order to modify the sound of their customers’ product experiences, all the time highlighting the multisensory impact that such changes can have.

Below, I will illustrate how the neuroscience-inspired approach to sound design is already being applied to the design of products, their packaging, the environments in which those products are purchased / used, not to mention in marketing communications, and finally to the area of product naming.
3. Multisensory Product and Packaging Design

Here at the Crossmodal Research Laboratory in Oxford, we have conducted numerous studies on behalf of industry demonstrating that by understanding the principle of sensory dominance, one can enhance the multisensory attributes of a product simply by changing its sound. So, for example, we have shown that a person's perception of the pleasantness of an electric toothbrush can be altered by modifying the sound that it makes while in use (see Figure 3). In another commercially-funded project, we demonstrated that people's perception of the forcefulness and powerfulness of a deodorant spray could also be enhanced by changing the sound that the aerosol makes when sprayed (Spence & Zampini, 2007). In fact, as a consequence of research conducted at the Crossmodal Research Laboratory, the product development scientists at Unilever Research were able to develop and protect new nozzle technology for the Lynx (Axe in Europe) range of deodorant cans, products that you can now find on pretty much every supermarket shelf. It is though important to note that the cognitive neuroscience insights that have gone into the sound design of many commercial products may not always be noticed by the average customer. This isn’t always a bad thing, given many people’s concerns about too much scientific meddling (e.g., in their foods). More often than not, the cognitive neuroscience approach is used to keep the consumers’ perception more-or-less constant while at the same time reducing the proportion of expensive and/or unhealthy ingredients in a product. Our perception of the crispness of dry food products such as potato chips and breakfast cereals can also be modified by changing the sound that they make when we bite into them (Zampini & Spence, 2004). Similarly, the perception of carbonation in a fizzy beverage can be enhanced simply by modifying the sound given off by the beverage when held in a cup in a consumer’s hand (Zampini & Spence, 2005). In fact, our perception of potato chips can even be modified by changing how much noise the packet in which the crisps happen to be presented makes (Spence, Shankar, & Blumenthal, 2010).
Figure 3. Graph highlighting the results of Zampini, Guest, and Spence’s (2003; adapted pictures, copyright International Association for Dental Research) research demonstrating the significant effect that changing the sound can have on people’s perception of the pleasantness of an electric toothbrush while in use. Mean responses for the unpleasant-pleasant response scales are plotted for three overall sound attenuation levels (0, -20, or -40 dB) against the three frequency manipulations (high frequencies attenuated, veridical auditory feedback, or high frequencies amplified). Each data point reflects the average of 100 trials (5 trials for each of 20 participants). Error bars represent the between-participants standard errors of the mean. The results show the negative impact of high-frequency sounds on people’s perception of electric toothbrushes.

It should, though, be noted that the modification of product-intrinsic sounds tends to have a larger effect on product perception than the modification of packaging sounds. In the example just given, the perceived crispness of potato chips was enhanced 15% by changing the sound made by the product when the consumer bit into it, as compared to around a 5% modification of crispness perception when consumers simply heard different packaging sounds instead while evaluating the crisps.
In all of the examples just mentioned, we used a paradigm adapted from the psychologist’s laboratory in order to investigate the consequences of changing the sound of a range of products (not to mention their packaging) on the consumer’s overall multisensory product experience. Importantly, we were able to do this without having to create a whole range of new products that actually made the novel product sounds that we were interested in. That is, we were able to explore the consequences of modifying various product and packaging sounds using a computer-controlled procedure instead (based solely on manipulating the original product/packaging sounds in unusual ways). Given that no new prototypes need to be made in order to explore the product sound space in this way, this psychologically-inspired approach to product sound innovation is consequently much cheaper and quicker to implement than many traditional approaches, approaches that typically rely on iterative product design (see Spence & Zampini, 2006, for a review).

It is presumably for this very reason that companies such as Unilever, Proctor & Gamble, and Nestlé have, over the last few years, all been using the sound design procedure, developed here in Oxford, in-house in order to improve the sensory attributes of their food and drink products. While, thus far, we have restricted our research on product sound design at the Crossmodal Research Laboratory to the area of food and drink and fast-moving consumer goods (FMCG) there is no reason why the same approach could not be extended to the area of car sound design in the future. Indeed, the cognitive neuroscience approach has already proved its worth in terms of providing guidelines for the design of more effective warning signals for car drivers (see Ho & Spence, 2009).

4. Multisensory Atmospherics

There is a growing awareness that the ‘atmospherics’ (Kotler, 1974) of the environments in which we purchase and/or use products can have a profound effect on our multisensory product experiences. Indeed, there is a long line of research that has investigated the consequences of changing the loudness, tempo, and style, of music on the behaviour of
people in a wide range of different consumer contexts, from supermar-
kets to restaurants, and from wine shops to bars (see Spence & Shankar,
2010, for a recent review).

On the back of such research, a number of companies have sprung-up
in recent years promising to help improve the acoustic environment of
retail spaces (e.g., see Treasure, 2007). They do this both by helping to
reduce extraneous background sound (e.g., from fridges in supermar-
kets, say), and/or by introducing more appropriate music or naturalistic
soundscales. My favourite example of this being the artificial birdsound
that was played over the Tannoy at Glasgow airport a couple of years ago
(though sadly no more). Note also that there has been much interest in
the possibilities associated with enhancing the multisensory appeal at
the point of purchase too (Middleton, 2002; Spence, 2002).

I have been collaborating with Heston Blumenthal, currently rated
the world’s second best chef over the last decade or so, in order to en-
hance the auditory impact of the dining experience at his flagship resta-
urnant, The Fat Duck, in Bray, near London (see http://www.thefat
duck.co.uk). One area of mutual interest has involved the two of us con-
ducting research to investigate the impact that environmental sounds
have on people’s perception of the flavour and hedonic qualities of food
and drink items (see Spence, 2010; Spence et al., 2010).

So, for example, in one study, we demonstrated that people rate ba-
con-and-egg ice cream as tasting significantly more bacon when listen-
ing to the sound of sizzling bacon than to a farmyard full of clucking
chickens. In another study, people rated oysters eaten while listening to
the ‘sound of the sea’ (a soundtrack incorporating the sound of seagulls
squawking and waves rhythmically crashing on the beach) as tasting
significantly more pleasant than oysters eaten while listening to farm-
yard noises instead. Taken together, these results highlight just how
dramatically environmental sounds can influence people’s perception of
food. They also emphasize the need to make sure that the ambient sound
is not just pleasant on the ear, but also that it is congruent with the
product/experience that the consumer is hopefully enjoying.
These findings led to the introduction of the ‘Sound of the Sea’ dish on the tasting menu at The Fat Duck restaurant. With this dish, diners are presented with a plate of food that is reminiscent of a beach (with what looks like foam, seaweed, and sand all visible on the plate). The dish comes with a mini iPod hidden inside a sea-shell, with the earphones sticking out. Diners at the restaurant are encouraged to insert the headphones (whereupon they hear the ‘sounds of the sea’ soundtrack) before starting to eat. People really appear to enjoy the dish (e.g., see Blumenthal, 2008, pp. 206-213). So much so that the dish is currently the signature dish on the menu at the restaurant. Of course, wearing the headphones also has the advantage that it tends to focus the diner’s attention on the food itself, and this too helps to enhance the flavour of the food. Note here that the recent development of hyperdirectional loudspeakers means that each diner can potentially now have the soundtrack tailored to the dishes that they happen to choose without the need to wear headphones.

Sound design in the world of fine dining has now come so far that it is not unheard of to find musical composers working alongside chefs in some of the world’s top restaurants (see, for example, Restaurant Denise Martin; www.denismartin.ch). The composers are charged with trying to create the music and soundscapes that will optimally complement the various courses in the meal. That said, until recently, intuition was all that they had to go on when thinking about which particular sounds / instruments to best complement a given dish.

The key question is whether cognitive neuroscience can provide any insights here? I would argue that the answer is yes. In fact, I have recently worked on a project with Starbucks to design a piece of music to complement the coffee-drinking experience. This project was based on the latest research from Anne-Sylvie Crisinel in my laboratory showing that people consistently match certain instruments and musical notes to specific tastes and flavours in food (see Crisinel & Spence, 2010). So, for example, Anne-Sylvie has demonstrated that people consistently match sweet tastes with high pitched notes on the piano, whereas bitter-tasting foods (such as coffee and dark chocolate) and more commonly matched
with lower pitched notes played on brass and woodwind instruments instead. Starbucks were recently able to use these insights in order to compose a new musical score to match the taste of their coffee (listen to it at http://www.starbuckscoffee.co.uk/starbucks-via/). In the coming years, there will be many more such opportunities to enhance the customer’s multisensory product experience by enhancing the auditory and other sensory aspects of the environments in which they select and use/consume those products (Spence et al., 2010; Spence & Shankar, 2010).

5. Advertising/Marketing Communications

Nowadays, sound design is coming to play an increasingly important role in marketing communications. Everything from using the sound of the edge of a credit card being dragged across a person’s cheek to highlight the smoothness of the shave in television ads through to the boosting of the sound of the crack of the chocolate coating when the actress seductively bites into a Magnum chocolate-coated ice cream on the screen at your local cinema. Spence and Zampini (2006) discuss these, and a number of other, examples of the effective use of sound in advertising, both to communicate the sonic attributes of a product, but also through multisensory integration, to highlight many of the product’s other non-visual (especially tactile) features.

Indeed, although the marketer typically only has direct access to a consumer’s eyes and/or ears in the majority of their communications, it is interesting to see the recent growth in genuinely multisensory marketing shots (see ‘Does it make sense?’, 2007; Spence & Gallace, 2011). There is also a currently-underutilized opportunity to use synaesthetic metaphor in one’s copy in order to elicit sensations that cannot necessarily be stimulated directly (e.g., see Meehan, Samuel, & Abrahamson, 1998; Nelson & Hitchin, 1995, 1999; Solomon, 2009). As an example, take the following evocative (and synaesthetic) phrase used to describe a perfume called, appropriately enough, ‘Listen’: “Once in a while there comes a fragrance that hits the perfect note.”
Finally, I would like to argue that sound design does not stop with the product, its packaging, with marketing, or even with the atmospherics of the retail space. The cognitive neuroscience-inspired approach to sound design can, and now is, being used to help constrain the development of new brand names for products (see Belli, 2001; Klink, 2000, 2001). To give but one example of the potential of this approach, people’s impressions about a new product can be shaped by the vowel sounds that happened to be contained within its name. So, for example, people are more likely to think that an ice cream is going to taste creamy if it happens to be called ‘Frosch’ than if it is called ‘Frisch’ instead (Yorkston & Menon, 2004).

Figure 4. An example of the labelled analog scales used to assess which shapes and speech sounds are better associated with particular tastes/flavours (see Gallace, Boschin, & Spence, 2011; Spence & Gallace, 2011). The participants in our research are given various food and drink items to taste and then have to mark the line where they think appropriate. The shape and nonsense words on the left are rounded/softer while the shape and nonsense words on the right are sharper.

7. Sound Design: Conclusions

From the literature and case studies described above, I hope that it is now clear just how important it is to focus on the multisensory (rather than just the auditory) product/brand experience. While changing the auditory attributes of a product or its packaging can certainly influence
the consumer’s auditory experience, it is crucial to realize that more often than not it will change the whole multisensory product experience. Changing the sound may, for example, significantly alter the feel, the roughness, the forcefulness, even the perceived powerfulness of a product while in use. I would argue that it is only by understanding the brain of the consumer that product designers and brand managers can hope to design multisensory products and experiences that more effectively stimulate the senses of the consumer, be that through the better design of multisensory products (Schifferstein & Spence, 2008), their multisensory packaging (Raine, 2007), and/or the multisensory Point of Purchase experience (Middleton, 2002).

I hope that it is also clear from this necessarily brief review that the latest insights from cognitive neuroscience are now starting to provide crucial insights to help many companies in a variety of sectors understand how it is that changing one attribute of a product (e.g., its sound) may impact on many other sensory attributes as well. I would argue that we are now on the cusp of a revolution in sonic design/branding whereby innovation based on the intuitions and whims of the marketing manager are steadily being supplemented, and who knows one day soon even replaced, by the cognitive neuroscience-inspired principles of design. Over the next few years, I predict that we will increasingly come to see product design/innovation that will really live up to the sensory marketers aspirations of stimulating all of the consumer’s senses more effectively. Who knows, it may even help companies to reduce the percentage of new products that fail in the marketplace (see Zaltman, 2003).
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Brain Science and Multisensory Product & Brand Development


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