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## **Digital Sensory Marketing:**

### **Integrating New Technologies into Multisensory Online Experience**

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**Abstract**

People are increasingly purchasing (e.g., food, clothes) and consuming (e.g., movies, courses) online where, traditionally, the sensory interaction has mostly been limited to visual, and to a lesser extent auditory, inputs. However, other sensory interfaces (e.g., including touch screens, together with a range of virtual, and augmented solutions) are increasingly being made available to people to interact online. Moreover, recent progress in the field of human-computer interaction means that online environments will likely engage more of the senses and become more connected with offline environments in the coming years. This expansion will likely coincide with an increasing engagement with the consumer's more emotional senses, namely touch/haptics, and possibly even olfaction. Forward-thinking marketers and researchers will therefore need to appropriate the latest tools/technologies in order to deliver richer online experiences for tomorrow's consumers. This review is designed to help the interested reader better understand what sensory marketing in a digital context can offer, thus hopefully opening the way for further research and development in the area.

*Keywords:* consumer behaviour, digital marketing, sensory marketing, HCI, online environment.

*COLOURED, STEREOSCOPIC FEELY. WITH SYNCHRONIZED SCENTORGAN ACCOMPANIMENT. "Take hold of those metal knobs on the arms of your chair," whispered Lenina. "Otherwise you won't get any of the feely effects."* (Huxley 1932, p. 119)

## **Introduction**

Who has not wondered, when browsing the website of an online retailer, what one would look like wearing that new sweater, or what it might feel like against the skin; Or perhaps whether those new Chinese noodles really would taste as good as they look? Just imagine, for instance, how great it would be if one could actually taste the dishes that one sees on Instagram, or feel the warmth of the virtual sand under your feet, not to mention smell the coconut oil, when viewing your friends' travel photos on Facebook. And who would not you want to virtually embrace your partner before saying goodbye after a Skype call? The current lack of genuinely multisensory interaction with the online environment is undoubtedly a missed opportunity given that we are spending ever more of our time on the Internet (Statista 2016).

Digital interactive technologies (which enable the creation and/or manipulation of products on the screen), especially sensory-enabling technologies (i.e., SETs, those that can deliver sensory inputs), can be helpful when, for instance, it comes to creating a "webmosphere" (i.e., the conscious designing of web environments to create positive effects). These technologies can also help inform the consumer about those other sensory properties of a product (e.g., its texture, smell, and possibly even taste) that simply are not available currently in most (primarily-visual) online environments (Childers et al. 2001; Eroglu, Machleit, & Davis 2001; Gallace et al. 2012; Hsieh et al. 2014; Kim & Forsythe 2008a; Rose

et al. 2012; Song & Zinkhan 2008). SETs include both those devices that are already widespread (such as headphones and touch screens), as well as a whole host of other new technologies that have yet to be fully commercialized in this context such as virtual reality (VR), augmented reality (AR), and even digital taste/smell interfaces.

We believe that marketers can do a much better job when it comes to considering and integrating these various technologies and their potential evolution to make the multisensory online experience more engaging, immersive, informative, and, ultimately, enjoyable in the future. Doing so will likely help companies to differentiate themselves from the competition in the crowded online marketplace. Future research is therefore really needed in order to better understand how SETs can be used to enhance the consumer experience (e.g., how immersed they are in ‘the experience’ and how persuasive such experiences are) and nudge their behaviours (e.g., how much do they choose to spend, and on what?).

The main objective of this article is therefore to introduce a new way of thinking about (digital-) sensory marketing. This new approach focuses on the use of digital technologies in online contexts, based on theories and concepts taken directly from the growing field of sensory marketing research. We try to bridge the gap between those researchers in sensory marketing and those working in the field of human-computer interaction (HCI). It is our belief that marketers need to better familiarize themselves with the full range of SETs that are available while those working in HCI may benefit from making themselves aware of some of the potentially profitable uses that their technology might one day permit (Velasco et al. 2018). In order to achieve these goals, we return to the main sensory marketing theories that can be used to help understand consumer behaviour in the online environment. In the next sections, we explain, based on theories and practices, how sensory information can be delivered more effectively online by means of digital interfaces that have evolved the most in recent years (i.e., visual and haptic devices). We also illustrate how the latest advances in

other SETs (e.g., in auditory, olfactory, and gustatory devices) can potentially be used to reinforce this communication and even suggest new multisensory marketing strategies. We finish by providing some ideas concerning potentially fruitful directions for further research (see Table 1 for a technology summary).

Insert Table 1 about here

### **Theoretical framework: What does Sensory Marketing Mean in the Online Environment?**

According to the theory of embodied cognition, all cognitive processes are grounded in bodily states and in the brain's sensory modality-specific processing systems (Barsalou 2008; Niedenthal et al. 2005). Thus, all consumer experiences are based on the integration of sensory inputs that affect their judgment and behaviour (Krishna 2012). Therefore, by engaging the consumers' senses more effectively, sensory marketing strategies can potentially impact the decision making process in store (Krishna 2012; see Spence et al., 2014, for a review). However, one might wonder what impact sensory marketing can really have during online shopping when interactions with the environment are limited to a computer screen.

According to the theory of embodied cognition, cognition can be situated (i.e., operated directly on the real-world environment, that is, online embodiment), or decoupled from the real-world environment (offline embodiment, Wilson 2002). A priori, the options for communicating sensory information in the online environment would appear to be rather limited. After all, it has traditionally not been possible to touch, smell, or taste objects over the Internet (see Gallace & Spence 2014, for a review). Thus, the online environment might be considered as a context of offline embodiment, in which interactions with the world occur only through digital interfaces. However, this does not mean that the senses stop affecting

cognition in the online environment. In this context, cognitive activity is still supported by modality-specific sensory systems (Niedenthal et al. 2005).

When consumers experience stimuli in the real-world (e.g., eating potato chips), the brain captures perceptual, motor, and introspective states relating to the various senses and integrates them into multisensory representations that are stored in memory (e.g., texture of the chips crunching between the teeth, Barsalou 2008; Papies and Barsalou, 2015). Later, the exposure to product pictures (potato chips) in online stores can trigger spontaneous perceptual re-enactments (i.e., embodied mental simulations: think of this as a more automatic form of mental imagery) of those multisensory representations (Chen, Papies, & Barsalou 2016; Petit et al. 2016a). These perceptual re-enactments engage some of the same brain areas that were recruited during the previous experiences, which, in turn, can produce similar sensations (Simmons, Martin, & Barsalou 2005; Spence et al. 2016).

Perceptual re-enactments have been observed in different senses. Seeing the picture of a given food or reading its name can activate the olfactory and the gustatory cortices (González et al. 2006; Simmons et al. 2005). Similarly, the sight of lip movements appears to stimulate the auditory cortex too (Calvert et al. 1997). A recent study also showed that watching the hand of someone else grasping food leads to activations in motor-related brain areas (Basso et al. 2018). These studies suggest that through perceptual re-enactments, the consumer's senses might be stimulated online. More specifically, the perceptual re-enactments produced by images on websites can serve to fill in the missing features of the products that are not physically present (this can be thought of as perceptual completion, Pessoa & De Weerd 2003; Spence & Deroy 2013). Thus, by viewing product-related images on websites, consumers might define sensory expectations, and even offset their need for touch. We will see in the following sessions that the new visual-enabling technologies might help reinforce perceptual reenactments, notably, by improving the feeling of immersion.

In addition to images, devices such as computers and smartphones can facilitate auditory (via loudspeakers) and haptic interactions (via touch screens and vibrations) with a positive effect on product evaluation. These sensory inputs might also elicit perceptual re-enactments in other sensory modalities. For example, Kitagawa and Igarashi (2005) used sound to induce virtual touch sensations. They gave the impression to their participants that their ears had been tickled by diffusing the sound of a brush stroking the ear of a dummy head. Several studies have also shown that hearing and touch can be used to stimulate visual imagery (de Volder et al. 2001; Lacey et al. 2010). Although product pictures are generally present on websites, by broadcasting sounds, producing vibrations, and allowing consumers to zoom/rotate the images with their fingers, marketers might give them a better visual representation. Moreover, these sensory inputs might facilitate multisensory integration, and thus have a positive effect on visual attention and search (Spence 2011).

Recent progress in HCI has also led to the suggestion that marketers might be able to benefit from new multisensory tools (including olfactory and even taste stimulation, Obrist et al. 2016; Petit et al. 2015; Spence et al. 2017). Thus, it might not be necessary to go via mental imagery in order to fill in the missing sensations in the online environment. The SETs highlight a glimpse of a new “online” embodied environment, providing multisensory experiences similar to those observed in the real world. In the following sections, we show that the visual-enabling technologies are now able to improve perceptual re-enactments in the online environment with positive effects on both consumer experience and product evaluation. Thereafter, we highlight how the other SETs (i.e., already haptic and auditory, and eventually potentially even olfactory and gustatory devices) are likely to improve the effects of visual devices, while suggesting new forms of interaction with the consumer online (see Table 2 for a summary of the research).

Insert Table 2 about here



## **Visual-Enabling Technologies: A New Form of Mental Imagery**

Icons, pictures, font, and videos all constitute visual stimuli (and are key elements associated with a brand) that marketers can adjust (in terms of the resolution, colour, depth, size, position, etc.) over the Internet in order to improve consumer experience. Moreover, it is currently possible to include 3D objects (see Figure 1a, Algharabat et al. 2017) as well as to create VR environments (see Figure 1b; Jin 2009). Visual-enabling technologies include larger views (super close-up; zoom in/out; enlargement), alternate views (e.g., views from 2-3 angles), 3D-interactive view (views from every angle as a consumer drags their mouse), and virtual try-ons (VTO). These technologies allow a consumer to zoom in on the product that they happen to be interested in, to rotate it and, by so doing, view it from a variety of different angles (Kim & Forsythe 2008a). These technologies can undoubtedly change the way in which the consumer interacts with content online. They might be used to facilitate consumers' perceptual re-enactments, and help them to fill in the missing sensory inputs (Spence & Deroy 2013). In the next subsections, we discuss how these new forms of interaction through visual-enabling are likely (or not) to improve the experience and product evaluation.

### ***Embodied Online Experience***

Much of the research has demonstrated that carefully considered visual features can make the online experience more immersive, aesthetically pleasing, and enjoyable (Bölte et al. 2017; Childers et al. 2001; Eroglu et al. 2001; Rose et al. 2012; Varadarajan et al. 2010). Li, Daugherty, and Biocca (2001, p. 14) developed the concept of virtual experience to represent “*psychological and emotional states that consumers undergo while interacting with products in a 3-D environment*”. According to a recent review by Javornik (2016a), visual-enabling technologies have been used to improve web atmospheres. They may create a

sensation of immersion (or telepresence), detaching people from the physical reality, thus absorbing them in their virtual experience (Animesh et al. 2011; Klein 2003; Li, Daugherty, & Biocca 2002; Nah, Eschenbrenner, & DeWester 2011; Yim, Chu, & Sauer 2017). It has been argued that 3D environments might deliver higher levels of enjoyment than 2D or physical environments (Kim & Forsythe 2008b; Lee & Chung 2008; Nah et al. 2011). Crucially, this seemingly more enjoyable experience provided by virtual and augmented reality was found to have a positive impact on both purchase intentions and on the consumers' willingness to pay (Animesh et al. 2011; Beck & Crié 2018; Gabisch 2011; Jin 2009; Poushneh & Vasquez-Parraga 2017). Thus, the virtual environment seems to provide a fuller experience to the consumer. From the point of view of the theory of embodied cognition, this would lead to considering the online environment as a place of online embodiment, in which the perceptual, motor, and introspective states across the various senses should be considered in detail (Barsalou 2008; Niedenthal et al. 2005).

It should, however, be noted that to date the research has mainly highlighted the impact of visual-enabling technologies on the affective reactions to the online experience (see Javornik 2016a). Their effects on *the flow*, a cognitive state experienced during online navigation, in which consumers are completely absorbed in their activity, are rather mixed (Animesh et al. 2011; Huang 2012, Huang & Lio 2017; Jiang & Benbasat 2004; Novak, Hoffmann, & Yung 2000; Van Noort, Voorveld, & Van Reijmersdal 2012). This mixed effects on the cognitive state is all the more problematic because that utilitarian value (i.e., functional benefit) is more strongly related to preference towards the Internet retailer and online buying than hedonic value (i.e., experiential benefits, Bridges & Florsheim 2008; Overby & Lee 2006). However, this does not necessarily mean that the impact of sensory marketing on consumer behaviour is limited in the online environment, but that it does not necessarily go through the same channels as those used in the physical environment. In the

next subsection, we show how visual-enabling technologies are likely to affect online behaviour by proposing new ways to interact with the product.

### ***Embodied Online Product Evaluation***

As noted earlier, seeing a picture of an object reactivates, at least in part, the same brain areas that were mobilized during the previous perceptual episodes (Barsalou 2008; Simmons et al. 2005). Thus, simply by displaying a picture of a food on the screen, the wily marketer may be able to stimulate mental images of its texture, smell, and even flavour that can facilitate the customer's evaluation of the food (Elder & Krishna 2012; Krishna, Cian, & Sokolova 2016; Petit et al. 2017; Spence & Deroy 2013; Spence et al. 2016). In order to help consumers mentally simulate interactions with products during their online experiences, marketers can change the way in which the product image is presented (Krishna & Schwarz 2014). For example, they may want to favour the use of dynamic (over static) images of the product (Cian, Krishna, & Elder 2014; Gvili et al. 2017; see Spence et al. 2016, for a review).

By using dynamic images, marketers can increase the consumer's ability to generate mental simulations of transformation, rotation, and reorganizations of the imagined product with a positive effect on its evaluation (Cian et al. 2014). At the cerebral level, Basso et al. (2018) found that watching videos featuring a hand grasping food (vs. object) leads to an increase of activity in somatosensory-motor brain areas. Neural activity in these areas is often seen when grasping objects and could potentially facilitate the simulation of food consumption (Chen et al. 2016; Vingerhoets 2014). Similar to dynamic images, mental simulations might also be stimulated simply by orienting a product on the screen in the direction of the hand that is normally used when grasping (e.g., Eelen, Dewitte, & Warlop 2013; Elder & Krishna 2012; Shen & Sengupta 2012), or by changing the perspective from which a product is viewed (Basso et al. 2018; Christian et al. 2016). Therefore, one might

expect that simply by capitalizing on such visual manipulations, the marketer could make a customer's online product evaluation more immersive, despite the separation necessarily created by viewing a product on a screen.

The new visual-enabling technologies are likely to enhance this sensation of immersion. 3D images give the user the feeling of being able to interact with the product itself, and thus stimulate mental simulations of product interaction (Li et al. 2001). Such effects of 3D images on product evaluation can be reinforced by allowing the user to spin/rotate the product, thus enabling them to examine the product from all possible angles. For instance, in one study, Park, Stoel, and Lennon (2008) displayed two pairs of khaki trousers (rotating vs. non-rotating) on a website. They found that the rotating version increased perceived information quantity among the participants with a knock-on positive effect on attitude and purchase intentions.

Jai, O'Boyle, and Fang (2014) analysed the effect of format (static, zooming and rotate views) of pictures of dresses on brain activity during the encoding (visual presentation period) and decision processes. During the decision process, women were instructed to create a mental image of the product and to indicate how much money they wanted to bid for the dress. They found that during the encoding period, image zooming (vs. static images) led to higher activations in the primary visual cortex, but did not lead to higher modulation in motor areas. As such, these results suggest that image zooming provides more detailed visual information than static images, but does not stimulate mental simulations of grasping movements. They also failed to find any difference between both images during the decision process. By contrast, during this period, rotation videos (vs. static images) led to higher activities in visual and premotor cortices, suggesting that participants had more vivid mental images of product interactions in their mind. In this condition, participants also present more activity in those areas known to code the reward value of stimuli (caudate nucleus and

putamen), and self-related mental processing (precuneus) areas (Fransson & Marrelec 2008; Knutson et al. 2007). These results suggest that rotation view might promote a better sense of self-referencing with a higher level of product preference.

Insert Figure 1 about here

Self-referencing can also be improved by providing a more personalized virtual experience. VTO allows the shopper to use an avatar, create their own virtual models based on their facial characteristics, or else even to use a “virtual mirror” (created with their own digital photo uploaded to a retailer’s Website, Pantano & Naccarato 2010; or by using augmented-reality interactive technology, see Figure 1c, Huang & Lio 2017). The research suggests that VTO can provide reliable information regarding the fit and how a product might look on the potential consumer (Cho & Schwarz 2012; Kim & Forsythe 2008b; Javornik 2016b; Merle, Senecal, & St-Onge 2012). Cho and Schwartz highlighted that VTO positively impacts people’s product evaluation, especially when the latter upload their favourite (rather than just a conveniently available) pictures of themselves. Similarly, Merle et al. (2012) reported that personalized (vs. non-personalized) VTO improves self-congruity and the confidence of consumers in their product choices. More recently, Huang and Lio (2017) also demonstrated that VTO can have a positive impact on flow experience, by affecting perceived ownership, and self-explorative engagement. Therefore, VTO might help reduce “bracketing”, a trend to buy multiple products, select the best one, and then returning the rest (Sharma 2017). However, while these new visual-enabling technologies offer a more direct interaction with the product than 2D visuals, it is not certain that this interaction is sufficient to allow consumers to evaluate all the products. Some products may have material properties difficult to evaluate without a real touch, this point is discussed in the next subsection.

### ***Need for Touch for Geometric Evaluation***

Researchers have demonstrated that some people feel a need to touch the product (or imagine touching it) in order to be confident in their choices (Peck, Barger, & Webb 2013; Peck, & Childers 2003a, b; Peck & Shu 2009; Shu & Peck 2011). However, the need for touch (NFT) varies depending on the tactile properties of the products themselves. Some products, for instance, have more salient geometric (e.g., shape, size, and structure) and other material (e.g., texture, temperature, and weight) properties than do others (see Choi & Taylor 2014; Lederman 1974; Spence & Gallace 2008). An image and/or a written description of the haptic properties might therefore be sufficient to evaluate a product with more salient geometric properties (e.g., a smartphone). However, consumers might need to touch a product with more salient material properties (e.g., a sweater) in order to evaluate it, especially those consumers with a high NFT (McCabe & Nowlis 2003; Peck & Childers 2003a, b). Thus, some haptic dimensions might be easier to simulate than others in an online environment.

Visual-enabling technologies have been shown to enhance the ability of consumers to imagine touching and trying-on products on a shopping website (Li et al. 2001 2002). Thus, these technologies appear interesting as far as addressing the NFT of consumers in virtual environments is concerned (Peck & Childers 2003a, b). For instance, Choi and Taylor (2014) demonstrated that 3D images can stimulate mental imagery with a knock-on positive impact on persuasion. In their study, websites with 2D and 3D formats were developed in order to advertise two products with different haptic properties: a watch (geometric properties) and a jacket (material properties). The results indicated that 3D advertising for the watch created more vivid mental images with a positive effect on attitude toward the brand, purchase intentions, and intention to revisit the website as compared to the 2D advertising. However, for the jacket, 3D advertising only exerted a positive effect on product evaluation for those people with a lower NFT. Thus, consumers with a high NFT might need to physically contact

material products online in order to facilitate their decision-making. This physical contact could be provided by the new haptic-enabling technologies, as discussed below.

### **Haptic-Enabling Technologies: A New Form of Physical Contact**

While consumers cannot literally touch the products that they see online, they normally do interact haptically with multiple interfaces already (e.g., mice and touch screens). These haptic interfaces might compensate for the lack of actual touch in those who feel a high NFT. Moreover, several devices have already been developed to improve haptic interactions through the Internet, such as vibrotactile interfaces (Kim et al. 2013), body-grounded tactile actuators (tapping on, squeezing, and twisting, Stanley & Kuchenbecker 2011), or even mid-air haptics (Ablart, Velasco, & Obrist 2017; Obrist, Seah, & Subramanian 2013; Vi et al. 2017; see Huisman 2017, for a recent review). These technological developments may prove useful as far as improving physical interactions with both objects and people are concerned (Bregman, Willems, & Van Kerrebroeck, in press; Van Kerrebroeck, Willems, & Bregman 2017). Below, we describe how such developments may impact product selection, the NFT, and even interpersonal interactions.

#### ***Haptic Product Evaluation***

Using a direct touch interface has consequences for how people search for a product or service and make their choices online (see Brasel & Gips 2015; Shen, Zhang, & Krishna 2016). For instance, the participants in one study by Brasel and Gips had to search for hotels on a travel review website using either a touch screen or a mouse interface. Interestingly, those who used the touch screen mentioned more tangible elements of the room (e.g., referring to its décor and furniture), and considered internal sources of information (e.g., gut feel and instinct) as being more important in their choice process. By contrast, those who used

the mouse were more affected by external objective sources (user reviews and star ratings), and mentioned more intangible attributes as instrumental in making their decision (e.g., the availability of Wi-Fi and employee demeanour). Thus, touch screen devices would appear more likely to bias the online purchase process than more traditional mouse interfaces.

Using a haptic interface can also affect the consumer's preference. Shen et al. (2016) found that using a direct touch interface compared with a non-touch interface made people more likely to choose a hedonic option over a utilitarian one. They also demonstrated that mental interaction with the products mediates this direct-touch effect. These results suggest that similar to visual design, haptic design can be manipulated to enhance mental simulations of product interaction. Based on the available evidence, marketers should, whenever possible, therefore consider whether it is possible to use different interfaces as a function of the kind of product that they wish to promote.

### ***Need For Touch for Material Evaluation***

Visual-enabling technologies have proven unsuitable for the evaluation of products with material properties by individuals with a high NFT (Choi & Taylor 2014). However, the online environment offers the consumer other ways in which to interact with the products that they may happen to be evaluating. For instance, Brasel and Gips (2014) demonstrated that touch screens elicit stronger feelings of perceived product ownership than touchpads or mice. In turn, this perceived ownership increases what people are willing to pay in order to acquire the products. They also found that the touch-ownership link is stronger for those products that have high material properties (e.g., a sweatshirt as compared to a city tour). By providing a more direct interaction with the product than visual interfaces, haptic interfaces have no doubt stimulated mental imagery and thus increased the perception of ownership for material products. However, these techniques have not been successful in compensating for the NFT of



material products, something that might potentially be addressed by certain of the new haptic interfaces (Cano et al. 2017; Jin 2011). For example, Cano et al. used a digital tool called Shoogleit which allows the user to virtually pinch and scrunch a section of the clothing fabric with their fingertips on a tablet during product evaluation (see Figure 2). This technology contributed to a higher level of user engagement, regardless of participants' NFT. Thus, further studies should be conducted in order to see whether this type of technology could be used to improve the assessment of people with high NFT for other material properties such as flexibility or elasticity of clothing.

Insert Figure 2 about here

Recent progress in HCI suggests that it will soon be possible to imitate the feel of different textures by means of tactile interfaces. For instance, Obrist et al. (2013) created different non-contact tactile sensations using ultrasound waves with modulation frequencies (16Hz, 250Hz). They found that participants associated the 16Hz stimulation frequency with physical materials, such as thin textiles, whereas the experience on being stimulated by 250Hz was related to wind/breeze, such as air-conditioning in the car instead. These haptic stimulations might one day, perhaps, help to communicate different material properties concerning the products via the Internet, and by so doing compensate for the customer's NFT. These new haptic-enabling technologies can also help the consumer to understand how the product works, by interacting physically with it at a distance. Leithinger and his colleagues (2014) developed inFORM, a shapeshifting display, with an operation that, similar to the Pinscreen, creates rough 3-D model of objects by pressing them into flattened pins. The "pins" of inFORM are connected to a laptop, and can be manipulated to make physical representations of digital contents, and also to interact with real-life objects (e.g., playing with a ball, Figure 3). The idea is that consumers would benefit from such a technology in that it would enable them to manipulate products with salient material properties before buying them

remotely (e.g., to feel the delicacy of a fabric or the robustness of a chair, say). Thus, they will not need to go through mental imagery to fill in the missing sensations in the online environment (Spence & Deroy 2013).

Insert Figure 3 about here

### ***Midas Online Touch Effect***

In the future, marketers will likely also want to promote interpersonal relationships in the online environment in order to make their website more trustworthy, or even promote word of mouth on social media. Kreijns et al. (2007) suggest that improving the perceived sociability of a website is likely to facilitate a consumer's trust, belongingness, and sense of community. Animesh et al. (2011) also highlighted that perceived sociability in the virtual environment is positively related to the experience of flow. Haptic-enabling technologies might help to improve interpersonal relationships when communication is over the Internet. Touch is very important when it comes to establishing secure attachments and interpersonal connections between people (see Gallace & Spence 2014, for a review; Guerrero & Andersen 1994). Touching someone can result in prosocial behaviour, a phenomenon known as the "Midas touch effect" (Crusco & Wetzel 1984). For instance, Crusco and Wetzel found that when a server physically touches a customer it leads to an increase in the size of the tip. Similarly, being touched by a salesperson can give rise to a feeling of social attachment, which can then enhance the evaluation of products and services (Hornik 1992). Social touch also has the power to communicate specific emotions. So, for example, Hertenstein et al. (2006) showed that hitting, squeezing, or shaking the forearm of another person can be used to communicate anger, whereas love is mostly communicated by stroking, finger interlocking, and rubbing.

Similar to real touch, haptic devices allow people to induce affective reactions over the Internet (Sumioka et al. 2013, see Gallace & Spence 2014; Huisman 2017, for reviews). For

example, by producing specific patterns of vibrotactile feedback, Rantala et al. (2013) were able to induce emotions in users. Thus, unpleasant and high-arousal emotions were found to be better transmitted by means of squeeze-like gestures, whereas the finger touch gesture was more suitable for pleasant and low aroused emotions. Other studies have also showed that digital haptic input can be used to increase feelings of telepresence (Sällnas, Rasmus-Gröhn, & Sjöström 2000; see Gallace et al. 2012, for a review). Interestingly, though, the Midas touch effect has proved difficult to reproduce using haptic-enabling technologies. For instance, Haans and IJsselsteijn (2009) failed to find a virtual “Midas touch effect” when people were touched by a haptic device. More recently, though, Haans, de Bruijn, and IJsselsteijn (2014) succeeded in demonstrating a virtual Midas touch effect, but only when the confederate (i.e., the person who initiated the virtual touch) knew in which experimental condition (virtual touch vs. no touch) was the participant who had to exhibit signs of prosocial behaviour. They may have been biased to elicit helping behaviour in the touch condition. Thus, it is possible that only specific prosocial behaviours might be affected by the virtual “Midas touch effect”. Consistent with such a view, Spapé et al. (2015) reported that vibrotactile feedback affected generosity (i.e., increasing the size of an offer) but not direct compliance (i.e., accepting an offer).

Without going as far as prosocial behaviour, these technologies can simply improve the felt closeness between people (and between people and brands). For instance, Mueller et al. (2005) developed a device that allows one person to send a hug to another by rubbing the belly of a stuffed animal. Similarly, the inFORM display allows the users to touch their hands remotely, to extend the physical embodiment in the online environment (see Figure 3, Leithinger et al. 2014). Developing this kind of interaction for use while on the Internet may be of interest to marketers, given that online consumer socialization through peer communication plays a key role in purchase decisions (Wang, Yu, & Wei 2012). However, to

facilitate haptic communication online, cheaper and more convenient interfaces, adaptable to computers and mobile phones, will likely need to be developed. For example, Park and Nam (2013) created a device to share haptic “pokes” during phone calls. Pokes are sent through an inflatable surface on the front of a mobile phone, while another person receives finger pressure inputs on the back of another phone. It is easy to imagine how such a device might one day be used on social media, to poke friends, followers, and even potential customers. However, it is worth noting that such a Poke might still be very similar to a notification signalled by vibration of the mobile phone that can be turned off.

### **Multisensory-Enabling Technologies: The future of the Internet**

The majority of life’s most enjoyable experiences are inherently multisensory (Spence 2002). In the real world, the more store atmospherics are multisensorially-congruent, the more pleasant and interesting they will likely be evaluated (Mattila & Wirtz 2001; see Spence et al. 2014, for a review). The same is likely to be true for online environments (Dinh et al. 1999; Feng, Dey, & Lindeman 2016; Liu, Hannum, & Simons 2018; Obrist et al. 2016; Spence et al. 2017). Previous research has shown that multisensory integration increases the likelihood that the brain detects a stimulus and/or initiates a response to this stimulus (see Stein & Stanford 2008 for a review). Furthermore, multisensory integration (and other forms of crossmodal interaction) might be facilitated by semantic congruency and crossmodal correspondences (Chen & Spence in press; Spence 2011).

Semantic congruency refers to those situations in which pairs of stimuli in different sensory modalities share common identity or meaning (e.g., woofing sound paired with a static picture of a dog). Crossmodal correspondences describe a more general tendency for a feature, or attribute (e.g., larger/smaller objects), in one sensory modality to be matched (or

associated) with a sensory feature, or attribute (e.g., lower/higher-pitched sounds), in another (Spence 2011). Based on crossmodal correspondences, mental imagery occurring in one sensory modality (not only visual) might result from the presentation of a physical stimulus in another. Crossmodal mental imagery has been considered as a form of perceptual completion and might thus be used to fill in the missing features through the Internet (Spence & Deroy 2013).

Crossmodal correspondences and sensory congruency have been shown to influence performance across a range of different tasks (e.g., speed of detection, perceptual discrimination) that can be relevant to make decisions in the online environment (Spence 2011). Specifically, in the following subsections, we show how visual and auditory designs can be used/combined in order to improve information search and sensory expectations, and how new multisensory-enabling technologies can lead to rethink consumer's online experience.

### ***Sensory Congruency in Product Search***

During online purchases on a retailer's websites (e.g., shoes, digital cameras, or food), it is often necessary to display a large number of images representing relatively similar products. The choice between items can be difficult to make. In this context, brands have to attract customers' attention on their product images in order to increase their chances of selection (Armel, Beaumel, & Rangel 2008; Milosavljevic et al. 2012). In order to improve product saliency, marketers might want to ensure that the visual features used to promote the products are congruent with their other sensory attributes.

Sunaga, Park, and Spence (2016) highlighted that lighter coloured objects tend to be perceived as lighter (in weight), and objects appear lighter when they are presented at the upper part of the visual field. Based on these associations, they were able to facilitate their

participants' visual search by using a display on the screen with light (dark) coloured products positioned in the upper (lower) shelf positions. Here, the crossmodal correspondences between the lightness of product colours and their location increased the speed and accuracy with which products were detected, facilitating visual search and product selection. Similar correspondences also exist between light (dark) colour and high (low) sound frequency (Mark 1987). Relevant here, Hagtvedt and Brasel (2016) recently found that low (vs. high) sound frequency leads people to fixate on dark (vs. light) objects faster and for longer.

Semantic congruency can also affect visual search. For example, Velasco et al. (2015) reported that people search for, and find, target products in online displays significantly faster when the colour of the packaging happens to be (semantically) congruent with the flavour of the product (e.g., red/tomato) than when it is less congruent (e.g., yellow/tomato). Similarly, Knoeferle et al. (2016) demonstrated that using sounds that are semantically associated with particular brands/product categories reduces the amount of time used to search on a virtual shelf, whether this sound is made by the packaging (e.g., the popping sound of the cork when a bottle of Champagne is opened), or a product-related jingle (e.g., the slogan of a laundry brand). Thus, congruent sounds may be used to help the consumer find the products that they are looking for on a cluttered website more rapidly, even if this product does not itself have any particularly salient sound associated with it. However, since crossmodal associations can be contextually and culturally determined (e.g., flavour expectations of coloured beverage, Spence 2011; Wan et al. 2014), it is important for marketers to adapt the visual and auditory features not only to the products but also to the targeted customers.

### ***Sensory Congruency in Product Evaluation***

Once the customers' attention has been captured, they will need to analyse the attributes of the product to know whether or not it meets their expectations (Dawar & Parker

1994). Similar to visual search, visual and auditory features can communicate sensory expectations by considering semantic congruency and crossmodal correspondences. For instance, round shapes (e.g., logos, labels, figures, typefaces) have been shown to be more appropriate when it comes to communicating sweetness, while bitter, salty, and sour tastes might be better promoted through the use of more angular shapes instead (see Velasco et al. 2016b, for a review). Similarly, pink, white, green, and black foreground colours should be used to enhance people's expectations that a product is going to taste sweet, salty, sour, and bitter, respectively (see Favre & November 1979; Spence et al. 2015; Woods & Spence 2016).

At this stage, auditory features can be used to convey, or accentuate, the sensory features of a product online through semantic congruency (e.g., the crack of the chocolate of an ice-cream bar, or even the sound of a vacuum cleaner or coffee machine, see Minsky & Fahey 2017). For example, Zampini and Spence (2004) demonstrated that simply by manipulating the sounds made while biting into crisps (potato chips), the perceived crispness and freshness of crisps can be enhanced. Similarly, Spence and Zampini (2007) found that the level and frequency of sounds can also affect a consumer's perception of the forcefulness (and hence efficacy) of aerosol sprays. Meanwhile, Ho et al. (2013) were able to improve the virtual experience associated with trying on new clothing (product with more salient material properties) based on semantic congruency, by adding synchronized naturalistic auditory feedback. Immersed in the virtual clothing environment, participants imagined that they were out shopping for a winter jacket and had to try on two options in two conditions (with the sound made by the clothes when the wearer moves were synchronized vs. silence). The authors found that in the presence of sound during the virtual trial, the users were willing to pay more for the jacket than when they tried it on in silence. Thus, by playing on the semantic congruency between sounds and material properties in virtual environments, marketers might help those consumers with a high NFT to be more confident in their choices.

Care should, however, be taken not to bore the customer or to assault their ears with too much auditory stimulation (what is often referred to as ‘noise’; see Malhotra 1984; Spence 2014). Consumers may prefer to shop on the Internet for the peace of mind it provides, and the possibility of turning-off the sound (interestingly, some bricks-and-mortar stores have now started offering silent chill-out spaces: e.g., Selfridges, the London department store offered this back in 2013; see Mardin 2013). Nevertheless, while consumers may sometimes find background sound to be distracting, it is important to remember that product sounds can provide an essential source of information in terms of product evaluation (see Spence & Zampini 2006, for a review). Moreover, marketers should be able to benefit from new multisensory-enabling technologies to stimulate several senses at once, which should further facilitate sensory integration (Spence 2011; Stein & Stanford 2008). Some of these technologies are presented in the following section.

### ***Multisensory Online Experience***

New multisensory devices are emerging, offering the opportunity to stimulate more of the customer’s senses over the Internet. While these technologies are not yet fully commercialized, they let us dream of an online environment more connected to the senses. For example, Ranasinghe et al. (2018) recently developed “Season Traveller”, a customized wearable Head Mounted Display (HMD) system that features smells, thermal, and wind stimuli to simulate real-world environmental conditions when users explore (virtually) different landscapes. Similarly, an AR device called MetaCookie+ allow the user to change the perceived flavour of food (e.g., a plain cookie) by virtually manipulating its appearance and diffusing additional smell (e.g., chocolate, strawberry; see Figure 4, Narumi et al. 2011; see also Okajima & Spence 2011).

Insert Figure 4 about here



New adaptations of sensory marketing strategies in online environments may be possible based on these multisensory interfaces. One day odours might be diffused while people are online in order to stimulate perceptual re-enactment and facilitate memorization and recall of information in the online environment (Braun et al. 2016; Krishna, Lwin, & Morrin 2010; Morrin & Ratneshwar 2003). For instance, one could imagine the Doubletree chain of hotels diffusing the same scent of the cookies offered to customers at the reception desk, via smell devices, during online booking, say, to set up an anticipation of what's to come (though see Spence 2015). However, this requires that the devices have enough odours in stock to be able to diffuse the one corresponding to the brand, and that consumers also think of reloading the odour diffusers (and that they are available for refill), which seems unrealistic at this stage.

One can also dream that it would be possible to share the taste of products on the Internet (see Velasco et al. 2018, for a review on multisensory technologies for online and mixed reality food experiences). However, only a few SETs have succeeded in simulating the sense of taste (and mostly only within the confines of the technology labs; Straw-like User Interface, Hashimoto, Inami, & Kajimoto 2008; food simulator, Iwata et al. 2004; Spence et al. 2017; Velasco et al. 2016a). Recently, Ranasinghe et al. (2017) presented a new method by which to potentially share drinking experiences digitally over the Internet. First, they presented a device that is able to capture the colour and pH value of a lemonade (among other liquids) and explained that this data might be digitally transmitted to a special tumbler filled with plain water in another location. On receiving the information from the device, the tumbler changed the colour of the liquid in the glass using LEDs and produced electrical stimulations on the user's tongue (note that the user has to stick their tongue out and touch it on the glass) with the hope of manipulating the experienced sourness of the ensuing taste sensation (see Figure 5).

On reading about the aforementioned techniques, marketers might imagine a future in which people could upload the flavour (including taste and smell) before making their product choice in a supermarket or pizza home-delivery website. However, before jumping straight into such futuristic scenarios, it is worth noting that there are many biological (e.g., individual differences in gustatory perception on the basis of thermal stimulation of the tongue) and technical challenges (e.g., sweet taste sensations are more difficult to elicit than sour or salty sensations) that need to be addressed before such systems become viable (see Spence et al. 2017). Such technologies are, then, not necessarily all that interesting to marketers in their current form. That said, they do perhaps suggest new ways of interacting with consumers online in the (near) future. Next, we discuss opportunities for research.

Insert Figure 5 about here

### **Need for Research**

There have been many efforts in HCI directed at integrating different sensory modalities online. However, further research is still needed in order to create more enjoyable and informative multisensory experiences for the consumer by means of SETs. Marketing and HCI researchers should therefore think about what kind of experiences they wish to offer to consumers and both capitalize on those new tools and develop others that facilitate the delivery of multisensory experiences. We try to provide some answers to a series of outstanding relevant questions, by suggesting some lines of research.

*How do offline and online environments differ in terms of multisensory information processing?*

Although the new SETs bring online and in-store environments closer together, the consumer's experiences are still not comparable. For instance, when consumers browse a retailer's website, the interaction is mainly through the screen of the computer or the mobile phone, while in-store the consumer is completely immersed. Even if VR makes the online experience more immersive (Animesh et al. 2011; Li et al. 2002), people are not totally separated from their offline environment (at home, at the office, at a terrace of a cafe). Additionally, although these technologies provide sensory interactions with products (Cano et al. 2017; Jin 2011), their effects on the online experience might not necessarily be identical to those in-store. Therefore, comparative studies between the online and offline environments are still needed (see Javornik 2016a, for a review). Further research might also investigate the effects in terms of information processing (visual attention, visual search, memorization, preferences, e.g., Knoeferle et al. 2016; Shen et al. 2016; Sunaga et al. 2016; Velasco et al. 2015), aspects of communication (e.g., connectivity, Calder, Malthouse, & Schaedel 2009; hyper-textuality, Su 2008; interactivity, Song & Zinkhan 2008; and mobility, Sultan, Rohm, & Gao 2009), and also informativeness and entertainment (Childers et al. 2001; Eroglu et al. 2001; Hsieh et al. 2014; Kim & Forsythe 2008a, b; Novak et al. 2000; Rose et al. 2012).

It might also be interesting to evaluate the extent to which SETs stimulate mental imagery by facilitating the perceptual re-enactments of previous experiences, or otherwise reduce their relevance for consumers in the online purchase process. If consumers can (virtually) touch, feel, or taste the products by means of SETs, mental imagery might not be necessary anymore. Moreover, it would be (virtually) possible to taste a product before (or without) smelling or touching it, which could potentially change the psychological distance (i.e., make the subjective experience that it is close regardless of the actual physical distance), with products on the Internet (Elder et al. 2017).

***How to decide whether information should be communicated through visual, haptic, auditory, or multisensory-enabling technologies?***

Depending on their objectives, marketers might should consider what kind of experience they wish to provide to consumers and make a choice between different SETs. For instance, we highlighted that visual-enabling technologies might serve to make the online experience more immersive and enjoyable (Animesh et al. 2011; Li et al. 2002), and that haptic interfaces are useful when it comes to affecting the generosity of individuals (Spapé et al. 2015). Both technologies also appear helpful in terms of facilitating product evaluation and purchase behaviour, and might potentially one day be combined (Cano et al. 2017; Choi & Taylor 2014; Jin 2011). Other applications may undoubtedly be developed in order to improve the interaction between online retailers and their customers (e.g., transaction uncertainty, Pavlou, Liang, & Xue 2007; engagement with the retailer, Shah & Murtaza 2005), or other interlocutors (e.g., trust, satisfaction, and commitment between buyer and seller, Comer, Mehta, & Holmes 1998; see Varadarajan et al. 2010).

Marketers should think carefully about their online sensory needs and work jointly with HCI researchers on new interfaces that are more suited to consumers. For instance, Obrist et al. (2013) used ultrasound (mid-air haptics) in order to create non-contact tactile sensations (associated by users with wind/breeze, textiles). At this stage, the interface has not been integrated into consumer experiences. Who knows, future versions might be developed in order to provide different textile qualities (e.g., roughness, softness, elasticity), and might thus help consumers to evaluate the clothes during online shopping.

***How can one assess the optimal personalized multisensory balance?***

Further research is needed in order to determine the right balance in terms of the involvement of each sense in consumers' experiences. Too much sensory stimulation, and one

is in danger of creating ‘sensory overload’ (Malhotra 1984; Raju 1980; Richard & Chebat 2016). It is not necessarily desirable to always engage each and every one of the user’s sense in order to make an effective multisensory virtual display (Gallace et al. 2012). Ultimately, the level of stimulation of each sense should perhaps be adapted to the ‘sensotype’ of the individual (e.g., liking Lush/A&F-like olfactory rich environments vs. feeling sensory overload) and determined by the context, which could encourage consumer acceptance of SETs (Dunn 2007; Wober 1991). For example, vision might dominate when the geometric aspects (size, orientation) of the products are relevant for its evaluation, and haptic/smell/taste might be considered when it comes to a product’s material properties (Gallace et al. 2012).

Personalizing online information can be expensive for brands. Therefore, the latter should question what individual differences in multisensory perception might be interesting to consider, and when and how multisensory experiences should be personalized in online environments. For example, it may not be necessary to customize the interaction of consumers with a watch (i.e., a product with salient geometric properties) based on their NFT. It should also be noted that consumers are currently not used to manipulate the new SETs on the Internet. Therefore, further studies should also be conducted to understand any novelty effects, as well as how to facilitate the acceptance these new technologies.

### ***How to better connect the online and the offline environments?***

In a traditional retail context, the atmospherics created notably by sensory environmental cues (e.g., colour, lighting, music, scent) have been shown to influence the behaviour of customers through their emotional reactions (Baker, Levy, & Grewald, 1992; Kotler, 1973; Turley & Milliman, 2000). Diffusing a pleasant odour, colour, or music can contribute to the positive evaluation of the store and influences the time and the money that consumers spend there (Chebat & Michon, 2003; Sherman, Mathur, & Smith, 1997;

Spangenberg, Crowley, & Henderson, 1996). In addition, the more store atmospherics are multisensory and congruent through the senses, the more pleasant and interesting for consumers they are evaluated (see Spence et al. 2014, for a review).

Several interactive technologies, such as shopping assistant systems and smart mirrors, are already modifying the traditional store experience (Brasel & Gips 2014; Cano et al. 2017; see Pantano & Naccarato 2010, for a review). For instance, touch screens can facilitate the interaction with the product and create stronger perceived ownership, enabling extended use both in-store and out to the store (Brasel & Gips, 2014; Cano et al., 2017). Technologies are becoming an increasingly important part of store atmosphere and an effective means of luring consumers in to the store. In this way, Poncin and Mimoun (2014) highlighted that using magic mirrors with augmented reality and interactive game terminals in a physical store has a positive effect on the perception of store atmospherics.

The SETs offer the customer the opportunity to browse online from the store, getting more information about products, in addition to having a positive effect on the perception of a store's atmosphere (Kent et al. 2015). However, SETs should not simply be seen as tools with which to connect the online environment with the physical store, but also as a means to create new environments in which physical and virtual objects/products coexist and potentially interact (Milgram & Kishino 1994). For instance, Pokemon Go revealed a bright new future in which the borders between the real and imaginary world are no longer so clearly delineated (Milgram & Kishino 1994). In a mixed reality environment, people might be more easily detached from reality than from a simple in-store experience (Javornik 2016a).

Marketers should think about building new spaces for interaction with consumers through mixed reality and proposing new modes of experiential consumption (see Petit, Velasco, & Spence in press, for a review on digital multisensory packaging). The virtual grocery store opened by Tesco in a South Korean subway station provides a good example of

mixed reality. The glass walls of certain subway stations were covered with images of supermarket shelves (including products, prices, and bare codes), and commuters were able to shop using their smartphones (see Figure 6a). Another example comes from Keiichi Matsuda, who proposes a glimpse of a world in which all the elements of everyday life are enhanced through the eyes of a woman (e.g., a supermarket, in which an avatar pet on a shopping trolley offers discounts, see Figure 6b, Fisher 2016). Through mixed reality, people might share the same physical space and have different AR contents. They might also view the same AR layer while dispersed across different locations (Scholz & Smith 2016). Therefore, it is important to understand whether these situations are similar in terms of embodiment (Wilson 2002).

To finish, it remains to be determined what level of hyper-connectivity and realism would be acceptable and beneficial to consumers. According to Belk (1988), persons, places, and things to which one feels attached are part of the extended self. If the SETs offer new opportunities for people to extend their self through the possession of digital objects, above all, they highlight a disappearance of the boundaries between consumers, products, and brands (Belk 2013). The objects of the mixed reality will become more embodied, invisible, to constitute a natural part of the self (Belk 2014). Therefore, further studies should explore how digital products can match consumers' expectations of themselves (Scholz & Duffy 2018).

Insert Figure 6 about here

## **Conclusions**

In this review, we have highlighted the key role that multisensory information has in mediating consumer experience not only in “the real world”, but also in a range of online environments. Including sensory information via websites is all the more important given that it results in consumers being more confident in their choices and increases the likelihood that

a liked product will be purchased. However, consumers do not necessarily need to touch or smell the products in order to get the relevant sensory information. They can also imagine the expected sensory properties of the products based on their previous product experiences, with the support of basic digital interfaces (e.g., screen, mouse, and headphones). Moreover, recent progress in HCI suggests that at least new visual- and haptic-enabling technologies should be available on the Internet soon. Hopefully, these technologies will go beyond simply reinforcing the effects of sensory marketing strategies on consumer's online behaviour, but also create new forms of interaction taking place not only in virtual or in the real places but in mixed reality environments too.

We have presented a selective list of potential sensory technological developments for digital environments, sometimes raising their limits (distractive, untrustworthy, and sensory overload). We have highlighted some of the ways in which marketers can use these innovations to better transfer sensory information to consumers in the online environment. Here it is worth remembering that many SETs currently only exist as prototypes (and hence people are not necessarily accustomed to them), while others are still to be invented! For this reason, the objective was not to describe and delimited what is exactly digital sensory marketing, but rather to provide a greater understanding of its interests for the future of marketing research. Many challenges and questions await marketers and researchers in the integration of sensory marketing in the digital world. For us, these challenges mainly revolve around finding the right balance between the different sensory inputs that might be stimulated online and/or offline in mixed reality, and potentially adapted to an individual's preferences, and location (e.g., at home, at the office, in a physical store). We believe that it is important that marketers become aware of this new evolution to anticipate and analyse how new technologies will impact market attitudes and behaviours through the "sensorialization" of digital environments.



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**Table 1 Summary of common and new sensory-enabling technologies**

Common interfaces			New sensory-enabling technologies	
Sense	Means/cues	Concepts	Means/Cues	Concepts
<b>Sight</b>	Screen: Font, icon, picture, videos (colour depth, size, position, dynamic).	Mental imagery (Cian et al. 2014; Eelen et al. 2013; Elder & Krishna 2014 ; Petit et al. 2016a) sensory congruency (Sunaga et al. 2016 ; Velasco et al. 2015; Velasco et al. 2016b; Woods & Spence 2016), interactivity (Song & Zinkhan 2008; van Noort et al. 2012).	3D-interactive view, virtual try-ons, augmented reality.	Mental imagery (Choi & Taylor 2014; Huang & Lio 2017), telepresence/ immersion (Animesh et al. 2011; Klein 2003; Li et al. 2002; Nah et al. 2011; Yim et al. 2017), enjoyment (Kim & Forsythe 2008a, b; Lee & Chung 2008; Nah et al. 2011; Yim et al. 2017), flow (Animesh et al. 2011; Huang 2012; Huang & Lio 2017; Jiang & Benbasat 2004; Nah et al. 2011; Novak, et al. 2000; Van Noort, Voorveld, & Van Reijmersdal 2012), interactivity (Huang 2012; Yim et al. 2017); self-congruity (Merle et al. 2012), ownership (Bregman et al. in press; Huang & Lio 2017), need for touch (Bregman et al. in press; Choi & Taylor 2014), curiosity (Beck & Crié 2018).
<b>Hearing</b>	Headphones, loud-speaker (music, sound, jingle).	Sensory congruency (Hagtvedt & Brasel 2016; Knoefler et al. 2016).	Multisensory experience with auditory inputs (Food simulator, Straw-like User Interface).	Sensory congruency (Hashimoto et al. 2008; Ho et al. 2013; Liu et al. 2018)
<b>Touch</b>	Mouse, touchscreen.	Mental imagery (Shen et al. 2016), ownership (Brasel & Gips 2014), affect (Brasel & Gips 2015; Shen et al. 2016)/	Vibrotactile interfaces, body-grounded tactile actuators, mid-air haptics.	Need for touch (Brasel & Gips 2014; Cano et al. 2017; Jin 2011), telepresence (Leithinger et al. 2014; Sällnas 2000), emotion (Rantala et al. 2013), Midas touch effect (Haans & IJsselsteijn 2009; Haans et al. 2014; Spapé et al. 2015).
<b>Smell</b>	X	X	Multisensory experience with smell inputs (Season Traveller, MetaCookie+).	Sensory congruency (Koh & Ranasinghe 2018; Liu et al. 2018).

**Table 2 Research summary on digital sensory marketing concepts and interfaces**

	Sensory Design	Relevant literature examples	Key findings
Virtual experience	3D virtual environment	Animesh et al. (2011)	Interactivity which the environment has a positive impact on telepresence and flow. Self-image congruence and perceived diagnosticity moderate the effects of virtual world on purchase intent. Affective involvement has a more positive effect than flow on purchase intention in virtual world. Modality richness and prior involvement positively impact shopping behavior in 3D virtual stores. Virtual shopping mall creates stronger quality assurance and enjoyment than ordinary mall. Virtual world increases telepresence and enjoyment with a positive effect on brand equity.
		Gabisch (2011)	
		Huang (2012)	
		Jin (2009)	
		Lee & Chung (2008)	
Nah et al. (2011)			
	AR environment	Beck & Crié (2018)	Using a Virtual Fitting Room on a website increases curiosity about the product, intention to patronize (online and offline) and intention to purchase (online and offline). AR has a positive effect on user experience that subsequently influences satisfaction and willingness to buy.  AR has a positive influence on novelty, immersion, enjoyment, and usefulness, resulting in positive attitudes and purchase intentions. AR shopping app used at homes creates a close and intimate (rather than transactional) relationship with the brand Users experience food textures by using a device generating a force on their teeth. Users virtually experience the sensations of drinking with straw through pressure change in the mouth, vibrations on the lips, and sound. The sensor produces electrical stimulations on the user's tongue with the hope of manipulating the sourness.
		Poushneh & Vasquez-Parraga (2017)	
		Yim et al. (2017)	
		Scholz & Duffy (2018)	
		Iwata et al. (2004)	
Force feedback Audio-tactile interface	Hashimoto et al. (2008)		
	Digital taste interface	Ranasinghe et al. (2017)	
Product evaluation	Visual features	Christian et al. (2016)	3 <sup>rd</sup> (vs. 1 <sup>st</sup> ) person perspective decreased the mental representation, actual consumption, and willingness to pay for unhealthy food. Perceived movement evoked by pictures stimulate dynamic imagery that positively affects consumer engagement. Monitoring orientation cues affects product evaluation and choice Product orientation (handle leftwards vs. rightwards) affect purchase intent. Evoked motion in food pictures enhance projected taste and freshness Occupying the dominant (vs. non-dominant) hand impairs the ease of simulation which leads to lower evaluations of the product. Virtual product control has a positive impact on perceived diagnosticity and flow. Virtual product experience increases telepresence with a positive impact on purchase intent.
		Cian et al. (2014)	
		Eelen et al. (2013)	
		Elder & Krishna (2012)	
		Gvili et al. (2017)	
	3D product visualization	Jiang & Benbasat (2004)	
		Li et al. (2002)	

		Park et al. (2008)	Rotation in online product presentation impacts perceived information quantity and mood with a positive effect on attitude, and purchase intent.
	Virtual try-on	Cho & Schwarz (2012) Huang & Lio (2017) Kim & Forsythe (2008a, b) Merle et al. (2012)	The quality of image used to construct a virtual mirror play an important role in product evaluation. Haptic imagery and sense of self-location during virtual try-on positively impact flow experience. Virtual try-on reduces product risk and increases the entertainment value of the online shopping process. Personalized (vs. non-personalized) virtual try-on leads to higher utilitarian value and purchase intent.
	Touch screen	Brasel & Gips (2015)	Touch screen (vs. mouse interface) increases the number of alternatives searched, and leads to consider more tangible attributes and internal sources of information in the choice process.
	Auditory features	Shen et al. (2016)	Touch screen (vs. mouse interface) enhances the choice of a hedonic option over a utilitarian one.
	Mid-air haptic	Ho et al. (2013)	Sound feedback (vs. no sound) from material products during virtual trial increase the willingness to pay.
	Shapeshifting display	Obrist et al. (2013) Leithinger et al. (2014)	Ultrasound waves with modulation frequencies (16Hz, 250Hz) create textiles and wind/breeze sensations. Haptic interface allowing the user to manipulate objects remotely.
Need for touch	3D product visualization	Choi & Taylor (2014)	For geometric products: 3D product image have higher persuasive effects than 2D product image for both high- and low-NFT consumers. For material products, 3D visualization only have a positive effect for low-NFT consumers. Mental imagery mediates the persuasive effects of the 3D versus 2D format.
	Touch screen	Brasel & Gips (2014)	Touch screen (vs. mouse interface) elicit stronger feelings of perceived product ownership, with stronger effects for material products.
	Augmented reality	Brengman et al. (in press)	AR product manipulation AR result in higher levels of perceived ownership, with stronger effect for material products.
	Force feedback	Jin (2011)	Force feedback (vs. no force feedback) leads to more positive product evaluation, test-driving experience, and brand-self connection for consumers high in instrumental NFT.
	Tactile features	Cano et al. (2017)	Product rotation and scrunch increase use engagement for material products, regardless their NFT.
Midas touch effect	Force feedback	Sällnas (2000)	Haptic force feedback increases perceived social presence.
	Vibrotactile feedback	Haans & IJsselsteijn (2009) Haans et al. (2014)	Vibrotactile touch (vs. no touch) does not lead to more helping behaviour. Helping behaviour was higher in the vibrotactile (vs. no) touch condition when participants who initiated the virtual touch knew the purpose of the study in advance.
		Rantala et al. (2013)	Squeeze is better to communicate unpleasant and aroused emotion, while finger touch is better for pleasant and relaxed emotion.
		Spapé et al. (2015)	Vibrotactile feedback affects generosity (increasing an offer) but not direct compliance (accepting an offer).
	Human-shaped cushion	Sumioka et al. (2013)	Conversations with a remote partner using huggable human-shaped device (vs. mobile phone) reduces the cortisol levels (stress hormone).
Sensory congruency	Visual features	Sunaga et al. (2016) Velasco et al. (2015) Velasco et al. (2016b.) Woods & Spence (2016)	Visual search is facilitated when light (dark) coloured products are positioned in the upper (lower) shelf positions. Semantic congruence between colour (e.g., red) and flavour (e.g., tomato) facilitates visual search. Rounder designs are evaluated more often as sweeter than angular designs.



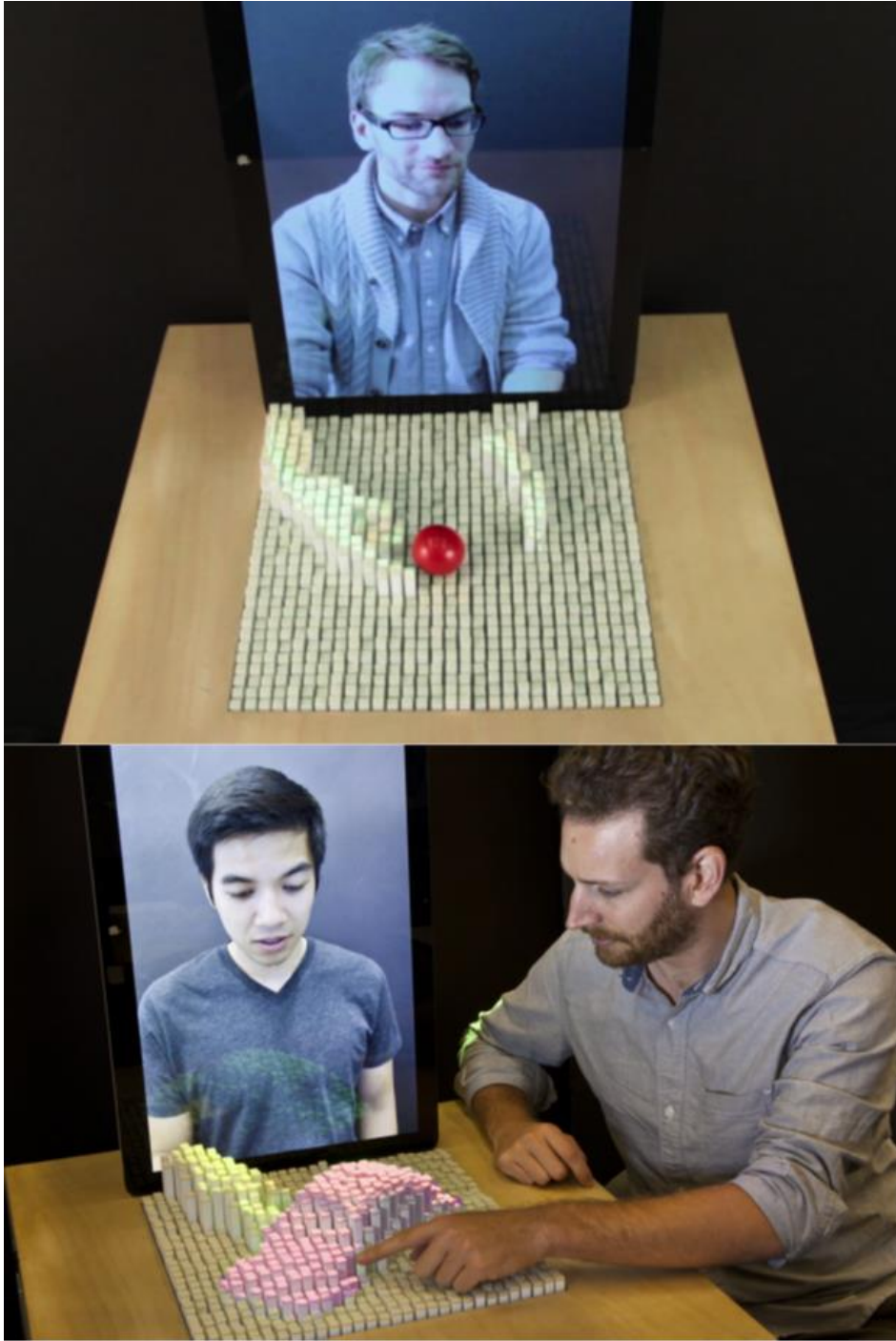
Auditory features	Hagtvedt & Brasel (2016)	Specific colours (e.g., red, green, black, and white) can help to communicate basic tastes (e.g., sweet, sour, bitter, and salty).
	Knoeferle et al. (2016)	Low (vs. high) sound frequency leads people to fixate on dark (vs. light) objects faster and longer and increase purchase intent.
	Spence & Zampini (2007)	Semantic congruence between sound (e.g., popping sound) and product (e.g., bottle of Champaign) facilitates visual search
	Zampini & Spence (2004)	Aerosol sprays are perceived as being more pleasant (but significantly less forceful) when the high-frequency sounds is attenuated.
Multisensory features	Liu et al. (2018)	Potato chips are perceived as being both crisper and fresher when the high frequency sounds are amplified. Sight, sound and smell congruencies in virtual environment do not impact liking, but significantly affect the time spent evaluating product.



**Fig. 1.** a. 3D product presentation, *Algharabat et al. (2017)*; b. Spokes-avatars in a virtual retail store, *Jin (2009)*; c. Personalized virtual try-on: Augmented-reality interactive technology, *Huang and Lio (2017)*



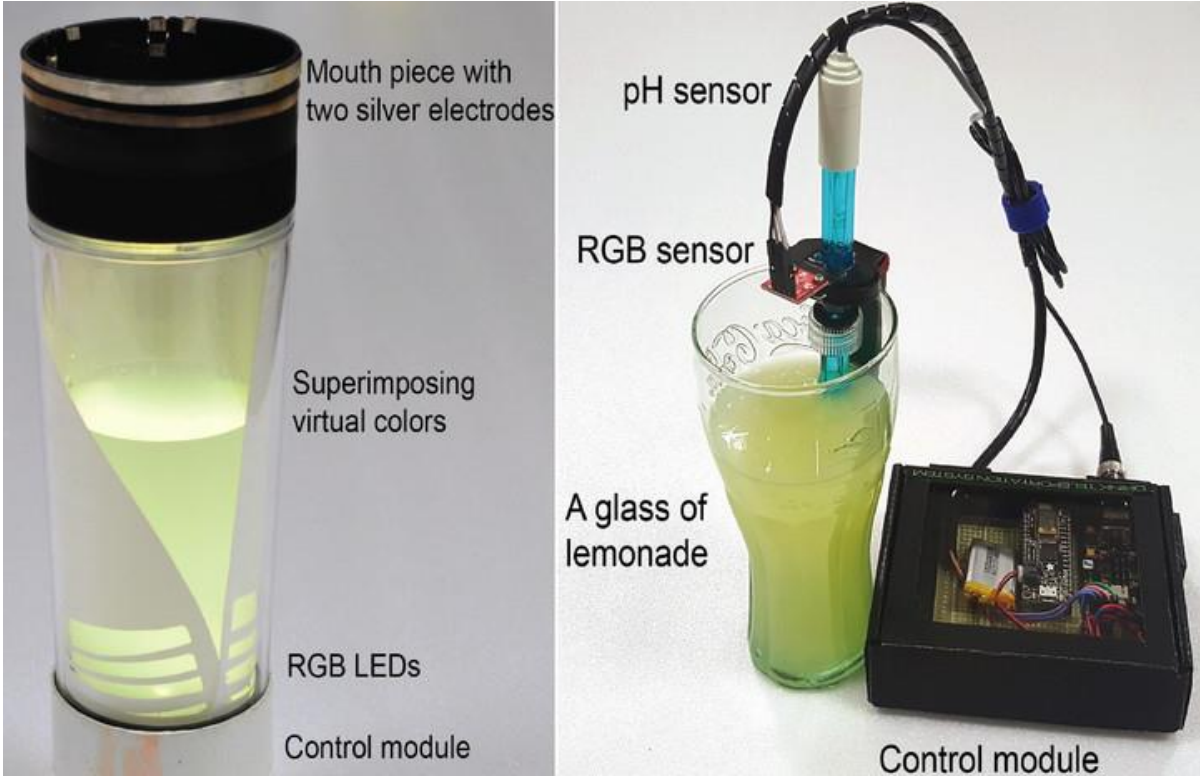
**Fig. 2.** Shoogleit multi-gesture interface on touch screen, *Cano et al. (2017)*



**Fig. 3.** InFORM shapeshifting display, *Leithinger et al. (2014)*.



**Fig. 4.** MetaCookie+, *Narumi et al. (2011)*



**Fig. 5.** Virtual Lemonade, *Ranasinghe et al. (2017).*

a



b



**Fig. 6. a.** Tesco virtual supermarket in a subway station

[www.designboom.com/technology/tesco-virtual-supermarket-in-a-subway-station/](http://www.designboom.com/technology/tesco-virtual-supermarket-in-a-subway-station/) **b.** Factual augmented supermarket [www.bbc.com/future/story/20160519-this-augmented-reality-film-is-incredible-and-terrifying](http://www.bbc.com/future/story/20160519-this-augmented-reality-film-is-incredible-and-terrifying).