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Reflection on the design of food systems and experiences for sustainable transformations

ABSTRACT

The importance of food and technology in modern society is undeniable. Technological advances have revolutionized how we produce, distribute and prepare food beyond local boundaries, and even how we eat. Eating is one of the most multisensory experiences in everyday life. All of our five senses (i.e. taste, smell, vision, hearing and touch) are involved. We first eat with our eyes, we can smell the food before we taste it, and then experience its textures and flavours in our mouth. However, the experience does not stop there. The sounds that come both from the environment in which we are immersed in while eating and our interactions with the food (e.g. chewing) and utensils we use to eat further influence our eating experiences. In all that, digital technology plays an increasingly important role, especially using emerging immersive technologies such as virtual and augmented reality (VR/AR). Designing at the intersection between technology and food requires multi-stakeholder commitments and a human experience-centred approach. Furthermore, it is essential to look beyond disciplinary boundaries and account for insights on various levels including the perceptual effects, experiential layers and technological advancements.

KEYWORDS

multisensory experiences
human-food interaction
multisensory technologies
technology-enabled transformations
gustatory interfaces
olfactory interfaces
immersive technology
extended reality

For example, Wang et al. (2020) explored how food colour perception can benefit from virtual reality (VR) technology, by allowing for the easy alteration of the visual appearance of stimuli. Their results revealed that beverage colour as viewed in VR significantly influenced perceived creaminess, with the light brown coffee rated to be creamier than dark brown coffee. However, beverage colour did not influence perceived sweetness or liking. In another study, Stäger et al. (2021) further demonstrated that the visual appearance of a beverage cannot only influence flavour perception, but that flavour might also influence colour perception. Technology has even the potential to influence the users purchasing intentions (Suzuki et al. 2021). The authors demonstrate that boiling motion texture, projected directly onto food itself, influences users' expectations for saltiness, spiciness, temperature, deliciousness, price and appetite before eating the meal and perceived saltiness, spiciness and appetite when eating.

More recently, Cornelio et al. (2022) used advances in VR technology to manipulate multisensory features and investigate the effects of coloured (red, blue, neutral) virtual environments on the taste (sweet, neutral) perception of differently shaped taste samples (rounded/spiky shapes according to the Kiki-Bouba paradigm). The results showed increased ratings of sweetness when participants tasted Bouba-shaped samples (rounded) relative to Kiki-shaped samples (spiky) suggesting that tactile attributes perceived inside the mouth can influence sweetness perception. Furthermore, they concluded that lighting colour in a virtual setting might dampen experiences of sweetness. However, this effect may only be present when there is a cross-modal correspondence with taste.

Research on cross-model effects and the digitalization of the chemical senses (Spence et al. 2017; Velasco et al. 2018a) has enabled a range of investigations into the design of multisensory human–food experiences (Obrist et al. 2018b; Velasco et al. 2018a; Velasco et al. 2018b). We are at the dawn of a new era of innovation, where technology meets the senses (multisensory technologies) enabling the creation of previously unthinkable experiences (Cornelio et al. 2021; Velasco and Obrist n.d.). While we can see various advances with regards to VR/AR and projection mapping, there are demonstrations of novel gustatory interfaces that allow us to create even more experimental and novel experiences, such as eating food that is magically levitated (Vi et al. 2017, 2020).

For example, TastyFloats (Vi et al. 2017) is using two phased arrays of low-cost ultrasonic transducers opposite each other to form a standing wave of ultrasound between them that enables the levitation of small amounts of liquids and solids in the nodes of the wave. Changing the phase can move these nodes in three dimensions, pulling the contents along with it and allowing the materials to be transported in 3D space as long as they stay between the arrays. While this food levitation system is still mainly used inside laboratory environments, it offers the opportunity to expand into real-world environments (e.g. as showcased in a London-based restaurant in collaboration with the Multi-Sensory Devices group at University College London [Wonderland Restaurants 2022]). In the future, more complex food experiences can be created through combining technological advances with insights into human sensory experiences. Indeed, initial perceptual findings studying TastyFloats have shown that a sweet taste is perceived sweeter when levitated and a bitter taste is perceived less aversive (Vi et al. 2017). While more empirical work is needed, those results create excitement for future experimentations, possibly into healthier eating. Moreover, we can further integrate

taste/food stimuli with other sensory effects that we know affect our eating experience (e.g. light, sound, scents) as demonstrated with LeviSense (Vi et al. 2020), a multisensory integration platform that can inspire professionals (e.g. molecular gastronomy chefs) in their culinary experience design efforts.

As our scientific understanding of the senses grows, and our creative explorations and experimentations with novel multisensory technologies develop (Velasco and Obrist n.d.), we will be able to enhance existing experiences and create previously unimaginable ones. In other words, devices and prototypes can and will be created to enrich 'traditional' experiences. For instance, we will be able to facilitate distance dining experiences, where two people eat together while they are at a different location. In such scenarios, 5G technology is creating new opportunities for real time and realistic food interactions over distance. Next to fast and reliable networks, there will also be a need for a reliable ecosystem of sensory devices, interfaces and design libraries, so that we can move beyond one-off applications and singular experiences.

However, in all those exciting developments, we also need to reflect upon the implications of such developments and their long-term impact and sustainability. Taste and food perception is influenced by cues from other sensory modalities, the context and transformed through technology. Having this power to transform eating experiences, requires us to carefully understand who is behind designing those experiences and their motives. Moreover, it is important to keep in mind that today, we (aka humans) design multisensory experiences, but in the future, designers may be machines, enabled through advances in artificial intelligence (AI) doing it. Perhaps, they may even do it better than humans through better sensing and processing of data about the context and user/s. Maybe technology will not only enable the design of new food and eating experiences in the future, but also become an integral part in the production, distribution and consumption of food, through making decisions about who receives what food to eat. After all, many people still die from hunger and much food is wasted in certain countries. Technology could help balance that inequality and guarantee that the production and distribution of food is optimized. But just how much control do we really want to outsource to technology? And, maybe even more importantly, who controls and deploys this technology? The answers to these questions are not black or white but depend on many factors and multiple stakeholders. There are multiple thought guidelines that we may follow when considering designing food and eating experiences and technologies. Transparency and fairness should be at the heart of our considerations.

We need to reflect, anticipate, engage and act in ways that promote responsible living and eating (Obrist et al. 2018a). Food is fundamental to everyday life, but also has a key function in human societies, including the need for inter-personal and inter-cultural understanding through food.

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Marianna Obrist is professor of multisensory interfaces at University College London (UCL), Department of Computer Science and deputy director (digital health) for the UCL Institute of Healthcare Engineering. Her research ambition is to establish touch, taste and smell as interaction modalities in human–computer interaction (HCI), spanning a range of application scenarios, from immersive virtual reality (VR) experiences to automotive and health/well-being uses. Before joining UCL, Marianna was professor of multisensory experiences at the School of Engineering and Informatics at the University of Sussex and Marie Curie Fellow at Newcastle University. She is also a visiting professor at the Material Science Research Centre at the Royal College of Art (RCA) in London. Her ongoing research projects include an ERC PoC on digital smell training, EU FET on touchless interfaces for social interaction and a UKRI centre on textiles circularity. She has published over one hundred articles, including high-impact journals like *Nature Scientific Report* and leading HCI journals like *ACM Transactions on Computer-Human Interaction* (*TOCHI*), *International Journal of Human-Computer Studies* (*IJHCS*) and the premier HCI conferences *ACM Conference on Human Factors in Computing Systems* (*CHI*), *ACM Symposium on User Interface Software and Technology* (*UIST*). An overview of her work was recently published in the popular science book *Multisensory Experiences: Where the Senses Meet Technology* (2020) by Oxford University Press. Marianna has also co-founded OWidgets LTD (smell made digital), a University spin-out that is developing novel digital smell technology.

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