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Published online: 27 Feb 2024.

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Multisensory experiences and technology in the context of wine experiences

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ABSTRACT

In the context of the experience economy, multisensory experiences have certainly received growing attention and interest from both researchers and practitioners to guide the design and management of experiences. Importantly, multisensory experiences are increasingly influenced and transformed by a number of technologies such as those in extended reality (e.g. AR, VR), IoTs, Web 3.0, and multisensory technologies. Here, we present a brief review of how multisensory experiences and these new technologies are shaping the way in which we understand, conceive, and design wine experiences. Whilst many examples of multisensory experiences and wine can be found in research, most of the technology-related examples are observed in industry initiatives. As such, more academic research will be needed to clarify when and how specific technologies might be the right experiential tools in the context of wine experience design. Our article ends with some ethical reflections about the implications of both multisensory experiences and technology.

1. Introduction

In 1998, Pine and Gilmore presented the concept of the experience economy, which argued that as products and services become more standardized and common, the value of experiences as a distinguishing factor and competitive advantage in the market would increase. Following that, there has been a rise in both academic research and real-world initiatives centred around designing and managing customer experiences (e.g. Becker & Jaakkola, 2020; Pine & Gilmore, 2013).

One area that has received a fair amount of attention in terms of experiences is what has been referred to as multisensory experiences (Velasco & Obrist, 2020). Multisensory experiences, broadly speaking, have been defined as impressions formed by specific events, whose sensory elements have been designed by someone, following certain principles of how our brains integrate information from different senses (see also Velasco &

Obrist, 2021). As such, researchers can study, and practitioners may capitalize on, the best configuration of manipulable sensory information throughout an interactive journey in order to deliver a given impression. In the context of wine, as we will see, researchers have also capitalized on the senses to create specific experiences (see Campo et al., 2021, for a review).

The experience economy, as well as multisensory experiences, have been influenced by the swift digitization of numerous facets of our everyday lives (Petit et al., 2019). Within the marketing domain, specifically in relation to consumer behaviour, this digitization goes beyond conventional digital marketing strategies and includes ongoing changes facilitated by technologies such as extended reality (XR, which encompasses augmented and virtual reality or AR and VR, respectively), the Internet of Things (IoTs), AI-powered systems, and Web 3.0. As a result, the continual developments in these technologies introduce new ways in which to control the delivering touchpoints while enhancing realism, as well as collecting and segmenting data, ultimately leading to innovative human-computer interactions and experiences (Hoyer et al., 2020).

In this brief review, we will present some of the ways in which both multisensory experiences and new technologies are, and will potentially, transform our wine experiences. For that purpose, we begin by explaining what multisensory experiences are and how we can look at them throughout the wine experience journey. Next, we present how the landscape of the touchpoints that are part of said journey is changing through novel digital technologies. Here, we will also present some more experimental technologies developed in the context of human–computer interaction (HCI). Last but not least, we will present some ethical reflections associated with the potentially increasing precision of experience design and some general future directions of research.

2. Multisensory experiences and wine

The concept of multisensory experiences, developed in Velasco and Obrist (2020), refers to the impressions that arise from specific events, wherein the sensory components are deliberately crafted based on principles governing how our brains process information from various senses. For instance, let us consider the creation of an impression of drinking a glass of wine by the beach. In a carefully curated event (e.g. dining in a restaurant or at home), elements such as the sound of gentle waves, the feel of warm sand beneath your feet, and the scent of salty ocean air may be used. Our senses play a central role in shaping the impression of the beach scene, even when the physical beach itself is absent.

Investigating the customer experience from a customer journey perspective allows for the analysis and management of experiences (Becker et al., 2020). The customer journey (which may as well be an example of a broader experience interaction journey) consists of the pre-purchase stage, involving interactions before the purchase transaction; the purchase stage, encompassing interactions during the purchase event; and the post-purchase stage, involving interactions following the actual purchase (Lemon & Verhoef, 2016). The stimuli that contribute to the customer experience can originate from both controlled touchpoints, such as a firm's website, as well as external touchpoints, like news coverage, that are beyond the firm's direct control and dynamically manage various touchpoints that influence the experience (Stephen & Galak, 2012).

The suggestion here is that each touchpoint is a multisensory device, involving multiple sensory elements, capable of contributing to shape experiences (Velasco & Spence, 2019). The ultimate aim, from an experience designer viewpoint, is to develop a multisensory touchpoint ecosystem, throughout the customer journey, that increases the likelihood of an experience taking place.

Just think of the packaging of wine, as an example touchpoint. It has characteristics such as colour, shapes, images, sound, texture, and weight. Indeed, research suggests that these types of characteristics can influence people's impressions of wine (see Spence, 2020, for a review). For example, Piqueras-Fiszman and Spence (2012) conducted a study designed to assess whether bottle weight was a possible extrinsic cue with which to estimate quality and price. Their study revealed a strong positive correlation between the weight of the wine bottles and the prices of the wines. The same year, North (2012) conducted a study in which it was shown that task-irrelevant background music can influence the taste of wine by the emotional associations created by the background music (see also Spence & Wang, 2015). Similarly, the use of a red label on a bottle of wine has been shown to create more fruity and floral flavour expectations than labels of other colours (Lick et al., 2017).

When aiming to create an impression using different sensory elements, practitioners or researchers may rely on established research and concepts from the field of multisensory perception. This involves considering various factors. First, there is spatiotemporal congruence, which refers to aligning the timing and location of sensory stimuli (Chen & Vroomen, 2013). Semantic congruence is also important, ensuring that the sensory elements align with the intended meaning or concept (Doehrmann & Naumer, 2008). For example, in 1997, North, Hargreaves, and McKendrick showed that in-store music influences wine choice, revealing that what they called musical 'fit' (the congruence between the music's origin and the wine's origin) influences product choice (see also Hauck & Hecht, 2019, for another example).

Crossmodal correspondences, which are associations between features across the senses, need to be taken into account as well (Parise, 2016; Spence, 2011, 2022). One example of this relates to the work of Spence et al. (2014), who capitalizing on the crossmodal correspondence between taste and colour and taste and sound, evaluated the impact of task-irrelevant lighting and soundscapes on people's perception of a red wine (Campo Viejo Reserva 2008, Rioja). Their results revealed that the wine's perception of freshness (more) and intensity (less) differed significantly when presented to green lighting and sour music compared to the other environments. On average, participants expressed a preference for the wine when exposed to red lighting and sweet music (see Oberfeld et al., 2009, for another example, using light). Research on crossmodal correspondences and semantic congruence has been extended to the context of wine as well as other foods and drinks (Spence et al., 2019).

Sensory dominance is another factor considered in multisensory experiences, which describes how certain senses might be more dominant than others, at specific stages of the customer journey, in shaping our experience (Fenko et al., 2010). For example, in the expectation stage of the wine experience journey, it is fair to say that vision and olfaction play particularly critical roles in guiding our expectations (Spence, 2020). Finally, the concept of sensory overload is also important, highlighting the potential impact of excessive sensory stimulation on perception (Malhotra, 1984; concepts are also discussed in

Velasco & Spence, 2019). Perhaps, having a wine tasting experience on a noisy and busy street might not necessarily be the best way to experience its components (given, say, the way in which noise can affect the tasting experience, see Yan & Dando, 2015).

3. The changing landscape of (digital) touchpoints in our wine experiences

Multisensory experiences are being increasingly transformed and enhanced through technology, leading to increasing independent and collaborative research in the fields of human–computer interaction (HCI), psychology, and marketing (Petit et al., 2019). These experiences can incorporate physical, digital, or a combination of both elements, spanning across the reality-virtuality continuum (Flavián et al., 2019). Technology can either influence an event or become the means to create the event itself. For instance, technology can augment the experience of walking through a wine shop using AR (and thus annotate or enhance the storytelling of the shop or its products) or create a completely virtual wine shop experience through VR, with elements that go beyond the real (cf. Velasco et al., 2021). It is important to clarify here that, although the technologies themselves might bring about new elements to our experiences, in principle, both the technologies and their contents are seen here through the same lenses presented in the previous section, that namely, they are multisensory devices capable of transforming our experiences.

Several technologies have been suggested as means to transform the customer experience, such as AR and VR, the Internet of Things (IoT), AI-powered technologies (Hoyer et al., 2020), and Web 3.0 (Yilmaz et al., 2023). What is more, researchers have worked on developing multisensory technologies that enable new sensory interactions digitally and facilitate the creation of novel experiences (Cornelio et al., 2021). Below, we briefly describe each of these, together with examples in the context of wine experiences. It is important to mention, however, that several of the examples available come from industry innovations rather than academic research. As such, we also present some criticism and future directions of research with the examples.

3.1. Technologies throughout the reality-virtuality continuum and wine experiences

Multisensory experiences can range across the reality-virtuality continuum, which involves different levels of digital components through immersive technologies (Flavián et al., 2019; Milgram et al., 1995). This continuum allows us to differentiate our experiences by the level of virtuality they involve: They can be real, in mixed reality (involving both real and virtual elements), or in full VR. Mixed reality involves not only AR, whereby virtual elements are augmented onto the physical space, but also augmented virtuality (AV), where physical objects are augmented into the virtual world. VR, on the contrary, is fully virtual (see also Wang et al., 2021, for a review).

The fully virtual environment provided by VR technologies has proven to be particularly relevant for immersing the user in different realistic contexts and analysing their impact on the drinking experience (Barbosa Escobar et al., 2021). It has thus been shown, for instance, that willingness to pay for, and overall enjoyment of sparkling

wine increased when placed in a winery context, compared to a bar context (Picket & Dando, 2019).

AR has been explored in the context of wine experiences, in particular in relation to packaging (Campo et al., 2021). For example, Cawley (2017) reported on an example of how AR technology can be used to enhance the information of wine as well as to enrich the label experience. In the 19 Crimes app, consumers point their smartphones at a bottle of 19 Crimes wine and witness the animated portrayal of convicts depicted on the actual wine labels, thereby bringing the labels to life. Another similar example is Chronic Cellars' AR Wine Packaging, which brings, through AR, the brand's characters to life (McQuarrie, 2022). A study conducted on the 19 Crimes app revealed that the wine and the AR label are considered by the consumer as two distinct sub-products, whose combination creates an 'augmented product' (Faddoul & Jin, 2020). According to the authors, the pleasure created by the interaction with the augmented product as well as the desire to share the experience, creates a social motivation to re-buy the wine bottle.

ARwinelabels' SnapPress app provides a virtual tasting AR experience by providing additional information on the wine and suggesting food and wine pairings and recipe tips (AR in the Wine Industry, 2020). Some brands, such as Rabble AR, take a more educational and storytelling approach, educating consumers by delivering engaging AR videos about each wine bottle's origin and vineyard information in an interactive experience (How to Use Rabble Augmented Reality App to Bring Wine Labels to Life, 2023). Winerytale is another app in which wineries set up an AR storytelling behind their bottles of wine, featuring the stories of the people who made the wine, region details, and brand history (AR in the Wine Industry, 2020).

Another example comes from the Banfi Experience app, which offers a comprehensive journey from the vineyard to the cellar. Visitors on the Banfi estate vineyard tour can enhance their experience by accessing AR features and information through the app, by scanning QR codes. Even for those unable to physically visit the vineyard, the app still provides a captivating multimedia experience, ensuring accessibility to the vineyard's and their wine bottles information (Marchetto, 2021).

Broadly speaking, it appears as if AR in wine packaging, and perhaps other touchpoints, can create value by adding informative and experiential digital layers to offline objects and environments (Du et al., 2022). It must be said, however, that it appears as if many of the examples related to wine come from the industry rather than academic research and therefore the overall effects on experiences are still a matter of research. For example, it has been shown that AR is good at increasing willingness to pay for fresh foods but not packaged foods (Petit, Javornik, et al., 2022). What is more, given that the potential of AR is not only limited to packaging, research is needed to further study how AR can be used in relation to other moments of interaction with touchpoints associated with wine experiences.

3.2. IoTs and wine experiences

IoT refers to internet-connected computing devices. The IoT in general can locate, sense, and operate in real-time flows between them (Ng & Wakenshaw, 2017). The IoT's reach has extended beyond smart devices and into various industries like automotive and

medical devices, enabling valuable services like continuous monitoring and advanced analytics (Hoyer et al., 2020). Now, the wine industry can also harness these benefits, utilizing IoT technologies to enhance processes such as real-time vineyard monitoring, temperature control, and inventory management, some of which might not influence the wine-drinking experience directly but rather indirectly (Miller, 2022).

With constant monitoring and advanced analytics, wine producers can optimize their operations and ensure the production of high-quality wines while gaining valuable insights into consumer preferences and market trends. For example, IoTs can improve the multimodal experience of the consumer, as Pelet et al. (2019) did in the hotel business utilizing IoT to upgrade critical touchpoints to customize the digital customer journey, such as replacing switches with voice commands, which increased consumer satisfaction.

Whilst the direct effects of IoTs interactions on wine experiences remain relatively limited, there are indirect effects of IoTs on wine experiences. On the supply chain stage, an exemplary case is Pago Aylés, a Spanish winery at the forefront of leveraging IoT sensors, also known as smart Wine cellars, developed by the company Libelium. These sensors enable real-time prediction and monitoring of crucial factors such as soil conditions, temperature, rainfall, and grape quality (Libelium, 2018). By harnessing this data, Pago Aylés ensured the production of quality consistent wine, adapting to and optimizing various conditions. Another example is Infosys' 'Speaking Vineyard' technology, which employed IoT sensors to predict risk in the grape crop, allowing for just-in-time treatment as an alternative to pesticides (Robinson, 2019). The utilization of IoT sensors in the wine industry, such as smart wine cellars and 'Speaking Vineyard' technology, allows the users for real-time monitoring and predictive capabilities, enhancing the wine-drinking experience by ensuring consistent quality and optimizing production processes.

Some smart wine accessories have been designed to enhance the wine-drinking experience. An example of this is Sestra's connected wine touchless dispensers, which offer a range of benefits including portion control, in-line chilling, advanced analytics, and remote management. These dispensers may ensure that each customer receives the precise amount, quality, and customized pouring of wine, providing an enhanced wine-pouring experience (Nagpal, n.d.). This technology results in a customized and high-quality sensory experience for wine enthusiasts.

During the post-purchase stage, Pernod Ricard, a renowned wine and spirits house, leverages IoT technology to offer personalized recommendations tailored to individual tastes and previous purchases. This approach ensures that consumers are introduced to new products that align with their preferences. Moreover, depending on the wine type, users have the opportunity to receive personalized Spotify playlist recommendations, creating a matching musical ambiance to complement their wine experience (Joseph, 2017). Incorporating IoT technologies in the post-purchase stage, such as personalized suggestions and curated Spotify playlists, enriches the multisensory experience of wine consumption, giving a seamless synthesis of taste, preference, and atmosphere. Thus, IoT technologies are a way to optimize future drinking experiences based on what the consumer enjoyed during those previous ones. However, high similarity among subsequent recommendation could cause boredom and dissatisfaction (Hiemsch, 2023).

Finally, the incorporation of IoT technology in the wine business has created new opportunities for improving the multisensory wine-drinking experience. IoT has the ability to elevate different stages of the interaction journey, providing a layer of

customization and immersion, from real-time vineyard monitoring and production optimization to personalized environments, suggestions, and tailored playlists. However, it is crucial to note that, while IoT has the potential to improve the wine experience, its mainstream use as an experiential tool may be limited at present. More research is needed to investigate the extent to which wineries are utilizing IoT and its impact on consumer experiences. Given its potential to address environmental concerns, companies are increasingly investing in IoT technologies, making it likely that its adoption will expand in the industry (Sharma, 2020). Despite these concerns, current examples and breakthroughs in IoT applications in the wine industry demonstrate the potential for tailoring and unique experiences for wine connoisseurs, allowing them to embark on a genuinely sensory trip.

3.3. AI-powered technology and wine experiences

In today's digital age, the widespread impact of Artificial Intelligence (AI) in our everyday lives is undeniable (Puntoni et al., 2021). This influence extends to the realm of wine consumption, where AI has the potential to significantly enrich consumers' wine experiences. Even ChatGPT, powered by OpenAI, can now provide personalized wine recommendations based on factors like taste preferences, desired sweetness level, budget, location, and more. Additionally, AI has progressed to the point where it can analyse intricate flavour profiles and assist in creating new wines, while also serving as a valuable marketing tool to aptly describe flavours in promotional materials (Anson, 2023; Visitsphere, 2023).

From wine recommendation systems such as ChatGPT to specialized AI-powered platforms, there are advanced recommendation systems that utilize large datasets encompassing wine properties, consumer preferences, and expert reviews. These systems provide personalized wine recommendations by analysing various consumer and wine factors. For instance, the algorithms of the TastryAi platform can suggest wines based on specific inquiries, such as asking if the individual enjoys the scent of fresh-cut grass (Wine Industry Advisor, 2022). By understanding how a wine will taste, smell, and feel on a human palate, these systems play a crucial role in guiding customers on their wine journey.

In line with AI recommendation systems, virtual sommeliers are AI-driven assistants that capitalize on machine learning algorithms to offer customized wine suggestions and address consumer inquiries regarding wine. These virtual assistants excel in interactive conversations, resembling a bartender-like experience, with notable examples like Cecilia.AI, which is designed to emulate the functionalities of Siri and Alexa (Calandra, 2021).

Indirectly, in the realm of supply chain, akin to IoTs, AI can play a crucial role as predictive analytics for vineyards. Advanced algorithms have the capability to analyse data gathered from vineyard sensors, encompassing factors like weather conditions and soil moisture. By processing this data, AI provides valuable insights and predictions, aiding vineyard management (USA Wine Ratings, 2023). Moreover, agricultural tech company Pollen Systems utilizes AI-powered drone flyover services, employing image and video analysis to optimize tasks like fertilizer application, pesticide usage, pruning, and more. This technology can even generate comprehensive terrain maps to enhance prediction capabilities (Case, 2019).

Lastly, AI technology can also be employed to assess and predict wine quality, drawing insights from sensory data, chemical composition, and historical information. This approach, commonly referred to as the smart vineyard concept, has garnered interest from French wine producers who are either experimenting with or adopting AI technology to enhance their production processes (Krawitz, 2019). While AI offers advantages in terms of cost, production sustainability, and disease control, a study conducted by Atwal et al. in 2021 reveals that some suppliers remain sceptical about its adoption. Concerns arise from the potential compromise of craftsmanship, authenticity, and reputational impact, factors that certain consumers prioritize when selecting wine (Atwal et al., 2021).

In conclusion, the use of AI-powered technology in the wine sector has the potential for improving wine experiences and streamlining numerous processes. AI offers a variety of benefits, such as targeted suggestions, improved vineyard management, and enhanced quality control, from personalized wine recommendations to virtual sommeliers and predictive analytics in the supply chain. However, it is crucial to note here as well that the use of AI in the wine sector has not been without controversy. Some suppliers are concerned about the risk of compromising workmanship, authenticity, and reputation by relying extensively on AI technology. These considerations underline the importance of a balanced approach that recognizes both technological improvements and the distinct attributes that consumers seek when buying wines. To fully realize the benefits of AI while addressing potential limitations in the wine sector, more research and careful deployment will be required.

3.4. Web 3.0 and wine experiences

Web 3.0, the third generation of the World Wide Web, is characterized by its decentralized nature and its foundation in blockchain technologies (Ragnedda & Destefanis, 2019). The blockchain can be defined as a transparent and distributed data structure that records transactions within a network; a notable example of its is Bitcoin, which has gained popularity as a cryptocurrency (Ghiro et al., 2021). However, blockchain technologies go beyond the realm of cryptocurrencies and are now used in various industries (Hakkarainen & Colicev, 2023). In the context of the wine industry, these technologies appear to be advantageous for enhancing the customer journey. Importantly, however, it is important for researchers in academia to evaluate the potential of blockchain technology for enhancing experiential aspects. By conducting thorough research, they can explore how blockchain can actually contribute to creating enriched customer journeys and enhancing experiences in the wine industry and other domains.

Starting with indirect effects on experience, in the supply chain, Web 3.0, by leveraging blockchain, enables a better wine traceability. For instance, in the vineyard each participant receives a batch number and code which gets saved and it is added to the next block, all this data relies on a shared network, in which the end consumer by scanning a QR code can not only know all the information about the wine bottle but can trace all the journey of their specific wine bottle (Unurlu, 2021). This improves the experience by giving consumers improved traceability and access to detailed information about their wine bottles, fostering transparency and engagement across the entire supply chain.

In addition to enhancing consumer experience and knowledge about their bottle, this technology offers authentication and fraud detection, capitalizing on blockchain to make

it nearly impossible for third parties to manipulate. Consequently, it guarantees the authenticity of bottles through wine traceability (Foley, 2023). An example of this implementation is seen with Grosset Wines, who adopted Enseal software; by simply scanning the cap with a smartphone, in where consumers can instantly verify whether the bottle has been tampered with, and the software also records the date of bottle opening (Saladino, 2021). To summarize, the use of blockchain technology in the wine industry can improve the sensory experience by providing consumers with multimodal information about their bottles and ensuring authenticity and protection against fraud (Foley, 2023; Saladino, 2021).

Connected to this technology is the concept known as Non-Fungible Tokens (NFTs) or collectibles, which includes the tokenization of unique bottles or limited editions, encompassing the three stages of the customer journey. During the pre-purchase process, consumers may develop an affinity for NFTs due to the artistic or collectible value they offer, which can be monetary, functional, emotional, or social (Yilmaz et al., 2023). In the purchasing stage, the NFTs are sold through a smart marketplace, providing a unique and distinctive experience. Finally, in the post-purchase stage, NFT holders are likely to sell their assets, as monetary value becomes a primary driving factor (Yilmaz et al., 2023). Cuvée Collective, for example, developed an NFT wine club that gives members access to exclusive experiences such as winemaker dinners, private events, virtual tastings, and rare wine allocation (Wolinski, 2022). As a result, NFTs enhance the multisensory experience by providing unique collectibles throughout the customer journey, from pre-purchase to post-purchase stages, while also providing value in terms of artistry, exclusivity, and potential financial gain.

Regarding virtual environments, Web 3.0 empowers decentralized platforms that operate on blockchain technology, facilitating peer-to-peer wine transactions. These environments also support decentralized wine reviews and ratings, allowing users to contribute their genuine opinions and evaluations, all of which are stored transparently. For instance, Ebay Australia is an exemplar of this concept, where sellers are only required to possess a valid liquor license from the state, the platform verifies age requirements since wine is subject to varying age restrictions in different regions of the world (Wickman Wine Auction, n.d.). Aside from that, users are free to make purchases from any individual or company selling wine, and they can openly provide honest reviews for these sellers. Overall, these allow consumers to make more informed decisions and engage in personalized, authentic interactions throughout their wine exploration.

Through Web 3.0, wine has the potential to become an investment in the form of tokens. Wine producers can offer tokens that represent shares in rare or investment-grade wines, enabling investors to participate in the wine market with smaller amounts of capital (Morgan Stanley, 2019). The Vinovest exchange stands out as one of the pioneering trading platforms where consumers can buy and sell investment-grade wine, treating it akin to stocks. Additionally, the platform allows users to purchase wine by the bottle, creating a wine portfolio (Zhang, 2023). This can be viewed as an modifier of the customer journey, allowing individuals to invest in wine for long-term self-consumption or as a means of brand loyalty, investing in a preferred brand and relying on its value to potentially sell it for a higher price. The former technology improves the wine-drinking experience by allowing customers to invest in wine, build a portfolio, and potentially profit financially.

These examples collectively provide insight into how Web 3.0 may shape and broaden our perspective on multisensory experiences in wine. These innovations provide consumers with a more transparent and engaging experience throughout the wine supply chain, virtual environments, and investment aspects. However, it is important to recognize that some people are still skeptical about data privacy and security concerns associated with these technologies, emphasizing the importance of carefully considering and weighing potential risks and benefits (Hakkarainen & Colicev, 2023).

3.5. Multisensory technology and wine experiences

Last but not least, another realm where innovation is taking place, where it influences the wine experience industry, is through research and development of multisensory technologies. As indicated by Cornelio et al. (2021), The convergence of computer science, engineering, and human–computer interaction (HCI) has given rise to emerging multisensory technologies. These cutting-edge technologies have the potential to revolutionize how we stimulate, replicate, and manipulate sensory signals such as touch, taste, and smell.

Whilst many of these multisensory technologies have not been specifically directed at wine experiences, they have nevertheless used wine. A prominent example is LeviSense (Vi et al., 2020), a technology that provides a comprehensive platform for studying the impact of multiple senses, such as taste, smell, vision, hearing, and touch, to create immersive gustatory experiences. The system employs levitated food, in this case wine, as a means of exploration to experiment with innovative taste-delivery methods. This technology opens new possibilities for wine, or more broadly food and beverage experience design, advancing technical and creative expressions in the experience market.

Note that, Cornelio and colleagues also reported that due to their relatively recent emergence and rapid development, the full extent of their potential is yet to be fully recognized and explored. Notably, though, one area where they have been used in research is in the context of flavour augmentation (see Velasco et al., 2018, for a short review).

4. Conclusions and multisensory experiences through the lenses of ethics

Drinking wine has been considered as one of the most complex multisensory experiences (Shepherd, 2011). In order to analyse and manage the way consumer experiences wine, it is important to consider the customer journey (Lemon & Verhoef, 2016), and how the senses interact not only during the drinking experience, but also during the pre-consumption and post-consumption stages (Campo et al., 2021), as a function of the variety of touchpoints available to experience designers. New technologies such as AR/VR, IoTs, AI-powered systems, and Web 3.0 are providing new touchpoints, likely to evolve further in the coming years. For these technologies to have a positive but also ethical impact on the consumer wine experience, it is essential to consider how they are likely to challenge the customer journey by taking into account their impact on the integration of consumer senses.

We have presented several uses of these technologies that can affect all wine customer journey. For example, AR wine labels' SnapPress app, by providing additional information on the wine and suggesting food and wine pairings, can both be used during the

purchase stage, to better understand the qualities of the product and potentially buy others for the meal, and during the consumption stage to better appreciate the tasting. IoTs like Sestra's can also improve the consumption phase, by making it possible to control the portion of wine served, or even be used to make personalized recommendations (Pernod Ricard), for their future consumption.

The use of these new technologies to improve the consumer wine experience is not without raising a certain number of ethical issues, relative to privacy, security, accessibility, predictability, and control that involves the proper use of these technologies in the management of customer journey (Velasco et al., 2023). Additionally, the application of these technologies in the more specific wine sector requires ensuring that their use promotes more responsible, better regulated, and more ecological wine consumption. Several AR/VR apps have been developed to lead to more responsible behaviour, more respectful of the environment. For example, the Chiquita Brands, the historically controversial firm, offered to customers, to access a video showing the sustainable product development journey (from efficient plantation to eco-friendly supply chain), by scanning a QR code on the bananas. Such applications could be used to promote more ecological wine production. Moreover, the fact that VR experiences do not require physical presence, applications allowing consumers to be immersed in vineyards in France, Italy, or even Chile, could make it possible to develop new tourist experiences, with a potentially reduced carbon footprint (i.e. through reduced travel-related pollution) (Itani & Hollebeek, 2021). Furthermore, the fact that some IoT objects make it possible to control the quantity of wine poured into the glass could be a way for consumers to better control their consumption (Petit et al., 2017; Petit, Wang, et al., 2022).

The enthusiasm surrounding multisensory experiences presents numerous opportunities but also entails responsibilities. Despite the lack of comprehensive discussions on the implications of these experiences, there are various challenges that need to be addressed, such as the potential exclusion of businesses, individuals, and communities unprepared for the ongoing digital transitions. Additionally, existing concerns related to privacy, security, accessibility, predictability, and control will become increasingly important. In response to these challenges, the three laws of multisensory experiences were proposed by Velasco and Obrist (2020), inspired by Asimov's three laws of robotics. These laws emphasize the importance of using multisensory experiences for (1) positive purposes without causing harm, (2) treating receivers fairly, and (3) ensuring transparency in terms of the designers and sensory elements involved. While not all information may be disclosed upfront, receivers should have easy access to relevant details if desired.

The increasing use of digital technologies, as well as the transformations that they involve, has great potential to deliver better and augmented experiences. However, it is also raising questions about the ethical implications associated with experience design in the context of digitization. For example, as hypothesized by Velasco et al. (2023), in this unique context, there is a closer temporal and spatial proximity between customer actions, data tracking, and touchpoint mapping, which raises profound considerations. The attention economy further complicates matters for both customers and brands, prompting reflections and dilemmas. In various ways, this may imply that our experiences have the potential to be 'programmed', with the possibility of achieving greater precision as time and technology progress.

In conclusion, the multisensory approach to wine experiences, and the incorporation of new technologies such as AR, IoT, AI, and Web 3.0, opens up exciting opportunities for improving the wine consumer journey and creating novel multisensory experiences. With them, it is possible to create new experiences, and to provide additional information, personalization, and control. These technologies have the potential to transform various stages of the customer journey, from pre-consumption, through consumption, to post-consumption. Even though their implementation raises ethical issues such as privacy, security, accessibility, predictability, and control, they can potentially be addressed by ensuring responsible design that promotes fairness, transparency, and ecological sustainability in the wine industry. We can navigate the challenges and opportunities presented by multisensory experiences by adhering to the principles of positive purpose, fairness, and transparency, ultimately enhancing the wine-drinking experience while, above all, respecting the rights and well-being of consumers.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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