Multisensory Technology in the Wine Industry: Where the Senses Meet Technology

Yuanyuan (Gina) Cui (yuanyuan.cui@aut.ac.nz)
Clemson University, USA

Patrick van Esch (pvanesch@kennesaw.edu)
Kennesaw State University, USA

Charles Spence (charles.spence@psy.ox.ac.uk)
University of Oxford, UK

Abstract

Advances in technology have brought about transformative changes in the wine industry, leading to a convergence of multisensory perception and technological innovation. This special issue explores the intersection of multisensory experiences and technology within the context of the wine industry, examining the impact that various digital technologies have had on sensory engagement, consumer behavior, and the vinicultural landscape. From augmented reality (AR) wine label experiences to smart decanters and aroma simulators, technology is reshaping the way in which consumers perceive, interact with, and appreciate wine. The research curated in this special issue investigates how multisensory technologies influence consumers' wine consumption experiences by enhancing their visual, olfactory, gustatory, tactile, and auditory sensations. Additionally, it explores some of the implications of multisensory digital technology on wine production, marketing strategies, and brand storytelling. By examining the dynamic interplay between sensory perception and technological innovation, this special issue offers insights into the evolving nature of the wine industry and the potential for multisensory digital technologies to redefine the future of wine consumption.

Keywords: *Multisensory; Technology; Wine; Experience.*

Introduction

Advances in digital technology have led to rapid evolution in the wine industry, influencing not only the composition of wine but also the way in which it is consumed (Humphreys & Carpenter, 2018). From QR code-based wine tracking to smart decanters, technology has significantly impacted the sensory experiences associated with wine consumption (Wen & Leung, 2021). The environment in which wine is consumed, along with various sensory components such as visual, auditory, haptic, tactile, gustatory, and olfactory stimuli, play a crucial role in shaping the consumers' perception of wine. Wine growers, marketers, and retailers have introduced various digital technologies in order to enhance the multisensory experience of consuming wine, recognizing that wine is rarely enjoyed in isolation from its sensory context (Spence, Wang, Reinoso-Carvalho, & Keller, 2021; Van Esch et al., 2016). However, as the wine marketplace undergoes dynamic changes, a number of intriguing questions arise. Can these technologies effectively curate consumers' multi-sensory experiences when selecting wines? Which sensory elements in consumers' wine consumption can be influenced by multi-sensory technologies, and which remain unaffected? Will the integration of multisensory technologies reshape the future trajectory of the wine industry? These questions underscore the complexity of the evolving relationship between technology, sensory perception, and consumer behavior within the wine industry.

In this special issue we showcase cutting-edge, thought-provoking research that challenges/informs our understanding of how multisensory technologies affect how consumers experience wine consumption, whether it be consumers' own multisensory experiences in technology-oriented wine consumption, or their receptiveness towards multisensory experiences created by wine manufacturers and/or retailers.

Exploring Multisensory Experiences and Technology in Wine Consumption

Wine consumption has long been associated with multisensory experiences, encompassing the interplay of sight, smell, taste, touch, and even sound (Spence, 2019a; Spence, Velasco, & Knoeferle, 2014). In recent years, advancements in digital technology have facilitated innovative approaches to enhancing these sensory encounters within the context of wine appreciation (Brochado, Stoleriu, & Lupu, 2021). This section delves into the convergence of multisensory experiences and technology, examining the implications for wine consumption and sensory perception. The enjoyment of wine involves a complex interplay of sensory stimuli, with each modality contributing to the overall perception and evaluation of the beverage (Northey, Chylinski, Ngo, & Van Esch, 2018). Visual cues such as color and clarity (Van Esch, Heller, & Northey, 2019), set initial expectations, while olfactory and gustatory sensations provide crucial information about aroma, flavor, and mouthfeel (cf. Barnett, Juravle, & Spence, 2017). Furthermore, tactile feedback and auditory cues, such as the sound of a cork popping or the texture of glassware, further enrich the sensory experience, influencing perceptions of quality and enjoyment (Spence, 2020; Spence & Wang, 2017).

Various digital technological innovations have introduced new dimensions to the multisensory exploration of wine, offering tools and platforms to augment and refine multisensory perceptions. Virtual reality (VR) and augmented reality (AR) applications, for instance, enable users to immerse themselves in virtual vineyard tours, wine tastings, and educational experiences, transcending geographical limitations, and enhancing engagement (Pala, Kapitan, & Van Esch, 2022; Spielmann & Mantonakis, 2018). Additionally, sensory evaluation devices, such as electronic noses and tongues, offer quantitative assessments of aroma and taste profiles, providing valuable insights for producers and consumers alike. The integration of technology into wine experiences extends beyond sensory enhancement, encompassing diverse applications and implications (Paluch & Wittkop, 2021). Social media

platforms and digital communities provide avenues for sharing tasting notes, recommendations, and experiences, fostering a global dialogue around wine culture and appreciation. Such tasting notes can then be analysed using machine learning to uncover novel combinations of compounds that may enhance the taste (cf. Scheurer et al., 2024). Moreover, e-commerce platforms and mobile applications streamline the wine purchasing process, offering personalized recommendations based on individual preferences and sensory profiles.

In the lead paper for this special issue, Velasco, Vargas, and Petit (2024) present a brief review of how multisensory experiences in extended reality (e.g. AR, VR, IoTs, and Web 3.0) are shaping the way in which we understand, conceive, and design wine experiences (see also Petit, Velasco, & Spence, 2019). Moreover, 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, the authors argue for the need for further academic research to clarify when and how specific digital technologies might be the right experiential tools in the context of wine experience design.

Immersive Experiences with Virtual Reality

Wine consumption is inherently multisensory, involving the integration of visual, olfactory, gustatory, tactile, and auditory cues to perceive and evaluate the beverage. Virtual reality (VR) technology offers a platform to enhance these sensory experiences by immersing users in virtual environments that simulate vineyards, cellars, and tasting rooms (Spence, 2019; Wang, Escobar, Da Mota, & Velasco, 2021). VR technology enables users to immerse themselves in virtual environments that replicate real-world wine settings with a high degree of fidelity. Through VR headsets, users can explore vineyards, observe winemaking processes, and participate in virtual tastings, thereby transcending geographical limitations and accessing unique vinicultural experiences. The immersive nature of VR facilitates heightened

engagement and emotional resonance, fostering a deeper connection with wine and its cultural heritage (Maumon & Bédé, 2023).

VR technology augments sensory exploration by simulating the sights, sounds, and sensations associated with wine consumption. Users can visually inspect grapevines, interact with virtual wine bottles, and even experience the sounds of a bustling vineyard or the gentle pour of wine into a glass (Burzynska, 2012, 2018). Moreover, VR can simulate aroma diffusion and taste sensations, allowing users to experience the complex aromas and flavors of different wine varietals in a controlled and customizable manner (Bhavadharini, Monica, Anbarasan, & Mahendran, 2023). VR technology offers educational and experiential opportunities for consumers to learn about wine production, varietals, and tasting techniques in an immersive and interactive manner. Virtual wine tastings led by experts, interactive tutorials on wine appreciation, and virtual sommelier consultations provide avenues for knowledge acquisition and skill development. Furthermore, VR experiences can facilitate cultural exchange by introducing users to wines from diverse regions and traditions, enriching their understanding and appreciation of viniculture (Kirova, 2021).

The multisensory nature of VR immersive experiences enables sommeliers to engage with wine aromas and flavors in unprecedented ways. Virtual simulations can replicate the olfactory and gustatory sensations associated with different grape varietals, fermentation methods, and aging processes, allowing sommeliers to refine their aroma and flavor recognition skills in a controlled and standardized environment. Research conducted by Moonen, Heller, Hilken, Danny Han, and Mahr (2024) investigates the impact of immersive experiences on sommeliers' learning in the wine industry, specifically examining the role of immersion and social presence. Drawing upon research on immersive technologies like VR headsets and cave automatic virtual environments, the study explores creating immersive wine tasting experiences for sommelier learning in relation to the wine industry's workforce training and

customer engagement strategies. VR immersive experiences offer sommeliers opportunities for experiential learning and skill development in a dynamic and adaptive manner. Virtual wine tastings and sensory training modules can be tailored to individual needs, preferences and proficiency levels, providing sommeliers with personalized feedback and guidance to enhance their sensory acuity and analytical capabilities over time.

Unique Brand Storytelling with Augmented Reality

The wine industry has embraced augmented reality (AR) technology as a powerful tool for crafting immersive and multisensory brand storytelling experiences (Chandra Kruse & Drechsler, 2022). By overlaying digital content onto physical wine labels, bottles, and environments, AR offers wineries and wine brands the opportunity to engage consumers in captivating narratives that transcend traditional marketing approaches. AR technology enables wineries to transform static wine labels into dynamic portals that transport consumers into immersive storytelling experiences. By scanning a wine label with a mobile device, consumers can unlock virtual content, such as animated characters, vineyard tours, and winemaker interviews, that enhance their understanding and appreciation of the wine's origin, production process, and tasting notes. These immersive label experiences engage multiple senses, captivating consumers with visually stunning animations, evocative soundscapes, and informative narratives that deepen their connection to the brand (Van Esch et al., 2019).

AR technology extends beyond wine labels to create virtual vineyard tours and tastings experiences that bring the terroir and ambiance of wine regions to life. Through AR-enabled mobile applications or wearable devices, consumers can explore virtual vineyards, cellar tours, and tasting rooms, immersing themselves in the sights, sounds, and sensations of the winemaking process. These virtual experiences allow consumers to engage with the brand story in a multisensory manner, fostering a deeper appreciation for the wine and its cultural heritage

(Kastenholz et al., 2022). AR technology facilitates personalized and interactive engagement by tailoring brand storytelling experiences to individual preferences and behaviors. Wineries can create dynamic narratives that adapt based on user interactions, allowing consumers to customize their journey through the brand story. Furthermore, AR enables users to access additional layers of content and information within the narrative, such as food pairing suggestions, winemaker insights, and user-generated reviews, enriching their overall wine experience and fostering a sense of community and belonging within the brand ecosystem.

By leveraging multisensory storytelling through AR technology, wineries can evoke strong emotional responses and build lasting connections with consumers. Immersive brand narratives that appeal to multiple senses have been shown to elicit higher levels of engagement, empathy, and brand loyalty compared to traditional marketing approaches (Cowan, Ketron, Kostyk, & Kristofferson, 2023). Moreover, AR experiences create memorable moments that leave a lasting impression on consumers, driving word-of-mouth advocacy and repeat purchase behavior. Robertson, Ferreira, Kietzmann, and Botha (2024) showcase how three wine brands used AR technology as a form of disruptive rhetoric, to supplement their wine label storytelling. Their study sheds light on how multisensory technology such as AR can be used to carve out new wine target markets and proposes an AR experience model with accompanying propositions outlining how the experiential realms can be leveraged to achieve key brand objectives.

Analogue Wine Creation

The Double-Grip Analysis method involves a comprehensive evaluation of sensory attributes through the integration of two distinct sensory modalities: grip and grip release (Herdenstam, 2011). Grip represents the initial sensory perception, encompassing visual, olfactory, and gustatory sensations, while grip release denotes the subsequent sensory response,

including tactile, auditory, and emotional feedback. By examining both grips in tandem, the Double-Grip Analysis method provides a holistic understanding of the wine's sensory profile, facilitating targeted interventions to enhance its appeal and authenticity. The Double-Grip Analysis method serves as a valuable tool in the creation of analogue wines by guiding the iterative refinement of sensory attributes to align with desired flavor profiles and consumer preferences. Winemakers can leverage this approach to experiment with different grape varietals, fermentation techniques, and aging processes, tailoring sensory characteristics to evoke specific emotions and sensations in consumers. Moreover, the multisensory framework of the Double-Grip Analysis method enables winemakers to incorporate innovative elements, such as texture, sound, and storytelling, to enhance the overall wine drinking experience.

Analog wines crafted using the Double-Grip Analysis method offer consumers a multisensory journey that engages and stimulates multiple senses, fostering a deeper connection with the product and its narrative. By aligning sensory attributes with consumer expectations and cultural contexts, winemakers can create analogue wines that resonate with diverse audiences, transcending traditional notions of taste and aroma (Danner et al., 2017). However, while the Double-Grip Analysis method holds promise in analog wine creation, it also presents certain challenges and considerations. Issues such as standardization of sensory evaluation criteria, reproducibility of results, and scalability of production require careful attention to ensure consistency and reliability across batches. Moreover, ethical considerations related to consumer manipulation and sensory overload warrant ongoing scrutiny to uphold transparency and trust in the analogue wine industry (Dressler & Paunovic, 2021).

As the analogue wine industry continues to evolve, the Double-Grip Analysis method provides a valuable tool for innovation and creativity, shaping the future of sensory-driven wine production and consumption. Crichton-Fock and Spence (2024), via a pilot study, investigated the use of the Double-Grip Analysis method as a tool to create analogue wines.

The research involved four groups of sommeliers using the method to identify critical analytical and analogical attributes in four commercial wines. The results help to shed light on the effectiveness of the Double-Grip Analysis Method, while at the same time providing insights into the acceptability of analogue products amongst consumers.

The Vinicultural Potential of the Metaverse

The emergence of the metaverse has sparked discussions across various domains, including its potential for diverse applications beyond entertainment and gaming. Among these potential applications lies the concept of virtual vineyards, which present a unique opportunity to explore vinicultural practices in a digital realm (Florès & Lejealle, 2023). The metaverse, offers a novel platform for the creation and exploration of digital landscapes, including vineyards. Unlike traditional vineyards rooted in physical terrain, metaverse vineyards exist as digital representations, transcending geographical limitations. Through immersive technologies, users can navigate, interact with, and even cultivate virtual grapevines within these simulated environments (Tom Dieck & Han, 2019).

Within the metaverse vineyard, vinicultural practices mimic those found in the physical world, albeit with distinct digital nuances. Users may engage in activities such as planting, pruning, harvesting, and fermenting virtual grapes, thereby simulating the lifecycle of viticulture. Moreover, the metaverse enables experimentation with innovative techniques and varietals without real-world constraints, fostering creativity and exploration within viniculture. Beyond recreational pursuits, metaverse vineyards hold cultural and educational value, serving as platforms for knowledge dissemination and cultural exchange. Virtual wine tastings, seminars, and workshops hosted within these digital spaces facilitate global collaboration among wine enthusiasts, researchers, and industry professionals. Moreover, metaverse vineyards offer opportunities for experiential learning, allowing users to gain insights into

vinicultural processes and traditions across different regions and epochs (Monaco & Sacchi, 2023).

Despite its potential, the concept of vineyards in the metaverse presents several challenges and considerations. Issues such as digital representation fidelity, sensory immersion, and accessibility require careful attention to ensure a meaningful and inclusive user experience. Moreover, questions regarding intellectual property rights, data privacy, and virtual economy dynamics warrant further exploration within the context of metaverse viticulture. In response to the challenges and considerations highlighted above, Cui and van Esch (2023) offer a glimpse of how the Metaverse can revolutionize consumers' wine tasting experiences and provide a comprehensive definition of the Metaverse – *an interactive, immersive environment that allows users to traverse between virtual and physical worlds and enables them to interact with digital content and each other in a shared space, transcending the limitations of time, space, and physicality in a more realistic and engaging way*. Moreover, they propose a VINEYARD framework for academics and practitioners to consider in navigating through the 'metaversification' of virtual vineyard experiences. Furthermore, the authors showcase key benefits and potential challenges as well as several new metrics to assess the sustainable development of virtual vineyard experiences when incorporating the Metaverse into vineyard management and marketing.

The Future of Multisensory Technology in the Wine Industry

The scope of multisensory technology in the wine industry that warrants future investigation certainly exceeds what could be captured in this special issue. Nonetheless, the collective curiosity of the contributing authors, informed by their recent research on multisensory technology in the wine industry, has led us to offer a list of topics for future

research, summarized below. To us, there is a slew of interesting research areas that remain unexplored within the important domain of multisensory technology in the wine industry.

Research Themes on Multisensory Technology in the Wine Industry

Consumption questions

- What are the foundations (affective vs. cognitive) for multisensory technologies to affect consumers' wine consumption experiences?
- Are there systematic differences in the effect of multisensory digital technologies on different senses (e.g., sight, touch, smell, taste, and hearing)?
- Are multisensory technologies universally effective (i.e., do they work for all consumers)? If not, what are the indicators, both situational and chronic, that predict their effectiveness?
- Do individual difference factors play a role in the way consumers respond to multisensory digital technologies in the wine industry? Some examples include: The Big Five personality traits (extraversion, agreeableness, openness, conscientiousness, and neuroticism), sensory processing sensitivity, political partisanship and orientation, culture, age, education, and gender (see Spence, 2019b, 2022).
- What do multisensory technologies impact the way consumers respond to non-alcoholic wine?
- How can multisensory technologies curb maladaptive alcohol consumption?

Consumer socialization questions

- How do multi-sensory technologies influence consumers' social drinking?
- Is it possible to use multisensory technologies in group/social settings?
- What are the implications of technology-oriented wine consumption on consumers' social status?

Multisensory marketing questions

- How do different senses (e.g., visual, auditory, haptic, tactile, gustatory, and/or olfactory) in both, online and offline settings affect consumers' wine consumption?
- Specifically, how can audition be taken more seriously in online settings – to not limit research to stimuli that relate only to vision but, instead, to explore the full capacity of using stimuli that relate to all senses?
- Specifically, how can we help to further develop the effective use of sound stimuli in new forms of sensory marketing, such as virtual reality and other digital experiences in the marketing and sales context?
- Can auditory stimuli in general, but more specifically music, be used to influence consumer wine consumption behavior in online marketing (Spence et al., 2021)?

The future of multisensory technology in the wine industry questions

- To what extent can a metaverse vineyard evoke multisensory experiences?
- Does virtual tasting affect consumers' wine enjoyment and satisfaction?
- How do AI wine critics affect consumers' perception and enjoyment of wine?

Thank You to Our Reviewers

Clearly, there are many areas worthy of investigation under the general dome of multisensory technology in the wine industry. We believe this special issue provides an important push toward answering some of these open questions. However, this issue would not have been possible without the generous contributions of time and thought by the reviewers. To them, we extend our thanks for their vital contributions to the publication of this issue of the *Journal of Wine Research*.

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