SensoryX '22 Workshop on Multisensory Experiences at ACM IMX '22

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Our interactions with the world are multisensory in nature - the senses move us through spaces, mix with our memories and are constantly connected by our brains. Focused only on vision for a long time, the field of human computer interaction (HCI) started to meaningfully bring together all our senses in designing interactions for a variety of media. With this workshop, we look at different aspects of multisensory design - from authoring tools to the evaluation of multisensory experiences with the aim of identifying the current challenges and opportunities of mulsemedia.

CCS Concepts: • **Human-centered computing → Virtual reality**.

Additional Key Words and Phrases: Multisensory experiences, Mulsemedia, Sensory effects, Immersive media

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1 BACKGROUND, SCOPE, AND AIM

Multisensory applications seem to be riding an upward trend nowadays [12, 17–19, 19, 20, 20, 33, 39, 53, 56]. Novel use cases such as tourism [21, 23, 30], education [4, 5], health [48, 51, 52, 55], security [3], digital twins [26] are consistently- and with increasing intensity - being brought to the attention of the interactive media community. The potential of multisensory interaction in a digital space, enabled by increasingly affordable technologies has, unsurprisingly, enabled new possibilities in the fields of VR/AR/XR [40, 41, 43–46]. An enhanced Quality of Experience [11, 35, 37–40, 57, 59], sense of presence [9], and information recall [1, 8, 54, 60] are often touted as end user benefits, and justifiably so; however, adopting a cross-layer perspective also brings to the fore new possibilities, such as that of green computing and building sustainable digital ecosystems [6, 26].

Nonetheless, it remains that our understanding of multimodal and multisensory interaction in physical spaces [13, 15, 16, 22, 25, 27, 28, 47, 49, 50, 58] dwarfs that of corresponding interactions in the digital realm [2, 10, 31, 32]. Naïve mappings and translations between the two have been shown to be just that – naïve. Moreover, in a world in which Artificial Intelligence and Machine Learning algorithms are grabbing headlines, the lack of digital multisensory datasets [34], modelling initiatives [7, 36, 42], as well as programming environments [14, 24, 29] represent but three

challenges. Indeed, considerable more research needs to take place to explore in order to deepen our comprehension of digital multisensory interaction. SensoryX 2022 taps into this need.

This is the second edition of SensoryX, building on last year's successful workshop. This one-day workshop will offer an interdisciplinary forum of discussion interested in research on designing experiences that align rich data from multiple human senses.

1.1 Context and Topics

The workshop focuses on putting the following multisensory media topics in an actualised context:

- An understanding of how digital content can be enriched with multisensory features in different phases of the production-distribution-rendering workflow
- The exploration of various opportunities that provide designers and developers with the means for creating meaningful multisensory experiences by making use of a wide spectrum of sensory experiences
- An overview of different application areas and interaction scenarios that can benefit from multisensory stimulation

Topics of interest include, but are not limited to, the following:

- Multisensory Experiences QoE evaluation (subjective, objective, online vs offline)
- Human Factors (including user modelling) in Multisensory Experiences
- Application areas for Multisensory Experiences (Health, Education, Arts, Tourism, e-Commerce, etc.)
- Multisensory Experiences Standardization
- Multisensory Experiences in Augmented and Virtual Reality
- Cross-layer Mulsemedia design for Multisensory Experiences
- Multisensory Experiences datasets/databases

2 ORGANISERS

2.1 Workshop Chairs

- **Alexandra Covaci** is a researcher in the field of virtual reality, currently Lecturer in Digital Arts and Technology at the University of Kent, UK. Her main research area is on the interface between computer science and neuroscience, where she design and develops environments focused on skills training. She has an interest in the design of meaningful multisensory experiences by exploiting different combinations of sensory modalities and she is working towards creating a systematic understanding of multisensory experiences for interactive technologies.
- **Estêvão Bissoli Saleme** obtained his PhD degree in Computer Science from UFES, Brazil, in 2019. During his PhD, he was an Academic Visitor at Brunel University London, UK, supported by CAPES, had his thesis nominated among the top six 2019 PhD theses in Computer Science by the Brazilian Computing Society, and received an honourable mention at the Brazilian Symposium on Multimedia and Web. His research interests include multimedia and human-computer interaction with a focus on digital multisensory systems, quality of experience of users, immersive technologies (VR/AR/XR), signal processing, middleware, and frameworks.
- **Celine Jost** is an Associate Professor in Computer Science at Paris 8 University in France, working in the CHArt laboratory for her research, since 2015. She obtained her Ph.D. in Computer Science from South Brittany University (France) in 2013. She mostly conducts multidisciplinary research with different disciplines, for which she received the "RJS/KROS Distinguished Interdisciplinary Research Award" in RO-MAN 2014. She participated in several national projects (EmotiRob, Robadom, MoCa, and INGREDIBLE) and she created and led

four projects (EMSHRI, StimSense, MemoRob, and PRIM). Her research interests include Human-Machine Interaction, multisensory interaction, evaluation methods, user experience, connected objects, social robots, natural interaction, individualized interaction, interaction paradigm, cognitive ergonomics, serious game, artificial companion, disabilities, education, and cognitive stimulation.

- **Joel dos Santos** is a professor in the Computer Science Department at CEFET/RJ, Brasil. He obtained his Telecommunication Engineering (2009), Masters in Computer Science (2012), and Doctorate in Computer Science (2016) degrees from UFF, Brazil. He was an academic visitor during his undergraduate studies at Universität Ulm (2007-2008) and during his doctorate studies at Inria-Grenoble (2014-2015). He acts since 2006 in multimedia-related projects in the areas of Digital TV, Multimedia Authoring, Application Validation, Multisensory Applications, and Virtual Reality. He currently coordinates the Special Committee on Multimedia Systems and the Web from the Brazilian Computer Society.
- **Gheorghita Ghinea** is a Professor of Mulsemedia Computing in the Computer Science Department at Brunel University London, UK. His research activities lie at the confluence of Computer Science, Media and Psychology. In particular, his work focuses on the area of perceptual multimedia quality and how one builds end-to-end communication systems incorporating user perceptual requirements. Currently, his research pursuits are centred on extending the notion of multimedia with that of mulsemedia a term which he has put forward to denote multiple sensorial media, ie. media applications that go beyond engaging the by now traditional auditory and visual senses, engaging three of our other human in a realistic manner akin to our experiences of everyday life.

3 PROGRAMME

SensoryX 2022 will take place in Aveiro, Portugal, on June 22nd, 2022, in conjunction with the the ACM International Conference on Interactive Media Experiences (ACM IMX 2022). The workshop will feature a world-class keynote by Dr. Carlos Velasco, from the BI Norwegian Business School, Oslo, Norway, on "*Multisensory experiences: Where the senses meet technology*." The accepted papers encompass discussions about multisensory wearables, multisensory healthcare therapies, mulsemedia editing paradigms and authoring, and mulsemedia QoE challenges. The full programme is detailed in Table 1.

SensoryX '22 will focus on enhancing the multisensory scope of both designers and developers of multimedia and Mixed Reality experiences who could thus harness the whole spectrum of sensory experiences. For this, the workshop will foster and challenge current practices in designing experiences, and will explore and identify future research directions for creating experiences at the intersection of various sensory dimensions.

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REFERENCES

[1] O. Ademoye and G. Ghinea. 2013. Information recall task impact in olfaction-enhanced multimedia. *ACM Transactions on Multimedia Computing, Communications, and Applications (TOMM)* 9, 3 (2013), 17.

[2] O. A. Ademoye, N. Murray, G-M. Muntean, and G. Ghinea. 2016. Audio masking effect on inter-component skews in olfaction-enhanced multimedia presentations. *ACM Transactions on Multimedia Computing, Communications, and Applications (TOMM)* 12, 4 (2016), 51.

[3] Anas Ali Alkasasbeh and Gheorghita Ghinea. 2020. Using olfactory media cues in e-learning–perspectives from an empirical investigation. *Multimedia Tools and Applications* (2020), 1–23.

Table 1. Detailed programme for the workshop. The schedule is set in Western European Summer Time, Portugal, UTC +1.

Hour	Activity
14:00 – 14:15	Welcome to the workshop and participants' introductions
14:15 – 15:15	Keynote speech. Dr. Carlos Velasco
15:15 – 15:20	Short break
15:20 – 16:00	Papers session I: – *Quantifying Multisensory Immersive Experiences using Wearables: Is (Stimulating) More (Senses) Always Merrier?* Belmir Jose De Jesus Jr (INRS-EMT, Canada), Marilia K. S. Lopes (INRS-EMT, Canada), Marc-Antoine Moinnereau (INRS-EMT, Canada), Reza A. Gougeh (INRS-EMT, Canada), Olivier M. Rosanne (INRS-EMT, Canada), Alcyr A. Oliveira (Universidade Federal de Ciências da Saúde de Porto Alegre, Brazil), Walter Schubert (INRS-EMT, Canada), and Tiago H. Falk (INRS-EMT, Canada) – *An Open-Source Socially Assistive Robot for Multisensory Healthcare Therapies* Marcelo Marques da Rocha (Fluminense Federal University, Brazil), Dagoberto Cruz-Sandoval (University of California, USA), Jesus Favela (Centro de Investigación Científica y de Educación Superior de Ensenada, Mexico), and Débora Christina Muchaluat-Saade (Fluminense Federal University, Brazil)
16:00 – 16:15	Lunch break
16:15 – 17:15	Papers session II: – *Interactions in Multisensory Experiences: Toward a New Timeline Metaphor* Céline Jost (Université Paris 8, France), Brigitte Le Pévédic (Université Bretagne Sud, France), Justin Debloos (Université Paris 8, France), and Gérard Uzan (Université Paris 8, France) – *How to integrate interactions into video editing software?* Céline Jost (Université Paris 8, France), and Brigitte Le Pévédic (Université Bretagne Sud, France) – *Ongoing Challenges of Evaluating Mulsemedia QoE* Aleph Campos da Silveira (Federal University of Espirito Santo, Brazil), and Celso Alberto Saibel Santos (Federal University of Espirito Santo, Brazil)
17:15 – 17:30	Final discussion and Concluding remarks

[4] J. H. Chu, D. Harley, J. Kwan, M. McBride, and A. Mazalek. 2016. Sensing History: Contextualizing Artifacts with Sensory Interactions and Narrative Design. In *Proceedings of the 2016 ACM Conference on Designing Interactive Systems* (Brisbane, QLD, Australia) *(DIS '16)*. ACM, New York, NY, USA, 1294–1302. https://doi.org/10.1145/2901790.2901829

[5] C. Claisse, D. Petrelli, N. Dulake, M. Marshall, and L. Ciolfi. 2018. Multisensory interactive storytelling to augment the visit of a historical house museum. In *Proceedings of the 2018 Digital Heritage International Congress*. IEEE. http://shura.shu.ac.uk/22646/

[6] I-S Comsa, E. B. Saleme, A. Covaci, G. Mesfin, R. Trestian, C. A. S. Santos, and G. Ghinea. 2019. Do I Smell Coffee? The Tale of a 360° Mulsemedia Experience. *IEEE MultiMedia* (2019), 10 pages.

[7] Ioan-Sorin Comsa, Ramona Trestian, and Gheorghita Ghinea. 2018. 360 mulsemedia experience over next generation wireless networks-a reinforcement learning approach. In *2018 Tenth International Conference on Quality of Multimedia Experience (QoMEX)*. IEEE, 1–6.

[8] A. Covaci, G. Ghinea, C-H. Lin, S-H. Huang, and J-L. Shih. 2018. Multisensory games-based learning-lessons learnt from olfactory enhancement of a digital board game. *Multimedia Tools and Applications* (2018), 1–19.

[9] Alexandra Covaci, Estevao Bissoli Saleme, Gebremariam Assres, Ioan-Sorin Comsa, Ramona Trestian, Celso Alberto Saibel Santos, and Gheorghita Ghinea. 2022. Multisensory 360 videos under varying resolution levels enhance presence. *IEEE Transactions on Visualization and Computer Graphics* (2022).

[10] Alexandra Covaci, Estevao Bissoli Saleme, Gebremariam Mesfin, Nadia Hussain, Elahe Kani-Zabihi, and Gheorghita Ghinea. 2019. How do we experience crossmodal correspondent mulsemedia content? *IEEE Transactions on Multimedia* 22, 5 (2019), 1249–1258.

[11] A. Covaci, R. Trestian, E. B. Saleme, I-S Comsa, G. Mesfin, C. A. S. Santos, and G. Ghinea. 2019. 360° Mulsemedia: A Way to Improve Subjective QoE in 360° Videos. In *Proceedings of the 27th ACM International Conference on Multimedia* (Nice, France) *(MM '19)*. ACM, New York, NY, USA, 2378–2386. https://doi.org/10.1145/3343031.3350954

[12] A. Covaci, L. Zou, I. Tal, G-M. Muntean, and G. Ghinea. 2018. Is Multimedia Multisensorial? - A Review of Mulsemedia Systems. *Comput. Surveys* 51, 5, Article 91 (Sept. 2018), 35 pages. https://doi.org/10.1145/3233774

[13] Anne-Sylvie Crisinel and Charles Spence. 2009. Implicit association between basic tastes and pitch. *Neuroscience letters* 464, 1 (2009), 39–42.

[14] Raphael Silva de Abreu, Douglas Mattos, Joel dos Santos, Gheorghita Ghinea, and Débora Christina Muchaluat-Saade. 2020. Toward content-driven intelligent authoring of mulsemedia applications. *IEEE MultiMedia* 28, 1 (2020), 7–16.

[15] Sophie Forster and Charles Spence. 2018. "What smell?" Temporarily loading visual attention induces a prolonged loss of olfactory awareness. *Psychological Science* 29, 10 (2018), 1642–1652.

[16] David Gal, S Christian Wheeler, and Baba Shiv. 2007. Cross-modal influences on gustatory perception. (2007).

[17] G. Ghinea and O. Ademoye. 2012. The sweet smell of success: Enhancing multimedia applications with olfaction. *ACM Transactions on Multimedia Computing, Communications, and Applications (TOMM)* 8, 1 (2012), 2.

[18] G. Ghinea and O. Ademoye. 2012. User perception of media content association in olfaction-enhanced multimedia. *ACM Trans. on Multimedia Computing, Communications, and Applications (TOMM)* 8, 4 (2012), 52.

[19] G. Ghinea, F. Andres, and S. R. Gulliver. 2011. *Multiple Sensorial Media Advances and Applications: New Developments in MulSeMedia: New Developments in MulSeMedia*. Information Science Reference.

[20] G. Ghinea, C. Timmerer, W. Lin, and S. R. Gulliver. 2014. Mulsemedia: State of the Art, Perspectives, and Challenges. *ACM Trans. Multimedia Comput. Commun. Appl.* 11, 1s, Article 17 (Oct. 2014), 23 pages. https://doi.org/10.1145/2617994

[21] Kexin Guo, Alei Fan, Xinran Lehto, and Jonathon Day. 2021. Immersive digital tourism: the role of multisensory cues in digital museum experiences. *Journal of Hospitality & Tourism Research* (2021), 10963480211030319.

[22] Henrik Hagtvedt and S Adam Brasel. 2016. Cross-Modal Communication: Sound Frequency Influences Consumer Responses to Color Lightness. *Journal of Marketing Research* 53, 4 (2016), 551–562.

[23] Jasmin Hopf, Melina Scholl, Barbara Neuhofer, and Roman Egger. 2020. Exploring the impact of multisensory VR on travel recommendation: A presence perspective. In *Information and communication technologies in tourism 2020*. Springer, 169–180.

[24] Céline Jost, Brigitte Le Pévédic, and Gérard Uzan. 2021. Using Multisensory Technologies to Stimulate People: a Reflexive Paper on Scenagrams. In *Proceedings of the 1st Workshop on Multisensory Experiences-SensoryX'21*. SBC.

[25] Yamen Koubaa and Amira Eleuch. 2021. Multimodal perceptual processing of cues in food ads: Do you smell what you see?: Visual-induced olfactory imagery and its effects on taste perception and food consumption. *Journal of Advertising Research* 61, 1 (2021), 78–94.

[26] Weisi Lin and Gheorghita Ghinea. 2021. Progress and Opportunities in Modelling Just-Noticeable Difference (JND) for Multimedia. *IEEE Transactions on Multimedia* (2021).

[27] Lawrence E Marks. 1974. On associations of light and sound: The mediation of brightness, pitch, and loudness. *The American journal of psychology* (1974), 173–188.

[28] Lawrence E Marks. 1987. On cross-modal similarity: Auditory–visual interactions in speeded discrimination. *Journal of Experimental Psychology: Human Perception and Performance* 13, 3 (1987), 384.

[29] Douglas Paulo De Mattos, Débora C Muchaluat-Saade, and Gheorghita Ghinea. 2021. Beyond multimedia authoring: On the need for mulsemedia authoring tools. *ACM Computing Surveys (CSUR)* 54, 7 (2021), 1–31.

[30] Miguel Melo, Hugo Coelho, Guilherme Gonçalves, Nieves Losada, Filipa Jorge, Mário Sérgio Teixeira, and Maximino Bessa. 2022. Immersive multisensory virtual reality technologies for virtual tourism. *Multimedia Systems* 28, 3 (2022), 1027–1037.

[31] Gebremariam Mesfin, Nadia Hussain, Alexandra Covaci, and Gheorghita Ghinea. 2019. Using eye tracking and heart-rate activity to examine crossmodal correspondences QoE in mulsemedia. *ACM Transactions on Multimedia Computing, Communications, and Applications (TOMM)* 15, 2 (2019), 1–22.

[32] G. A. Mesfin, N. Hussain, E. Kani-Zabihi, A. Covaci, E. B. Saleme, and G. Ghinea. 2019. QoE of Cross-modally Mapped Mulsemedia: an Assessment Using Eye Gaze and Heart Rate. *Multimedia Tools and Applications* (2019), 21 pages.

[33] N. Murray, O. A. Ademoye, G. Ghinea, and G-M. Muntean. 2017. A Tutorial for Olfaction-Based Multisensorial Media Application Design and Evaluation. *ACM Comp. Surveys* 50, 5, Article 67 (2017), 30 pages. https://doi.org/10.1145/3108243

[34] Niall Murray, Oluwakemi A Ademoye, George Ghinea, Yuansong Qiao, Gabriel-Miro Muntean, and Brian Lee. 2017. Olfactory-enhanced multimedia video clips datasets. In *2017 Ninth International Conference on Quality of Multimedia Experience (QoMEX)*. IEEE, 1–5.

[35] Niall Murray, Brian Lee, Yuansong Qiao, and Gabriel Miro-Muntean. 2016. The impact of scent type on olfaction-enhanced multimedia quality of experience. *IEEE Transactions on Systems, Man, and Cybernetics: Systems* 47, 9 (2016), 2503–2515.

[36] Niall Murray, Gabriel-Miro Muntean, Yuansong Qiao, Sean Brennan, and Brian Lee. 2018. Modeling user quality of experience of olfaction-enhanced multimedia. *IEEE Transactions on Broadcasting* 64, 2 (2018), 539–551.

[37] M. Obrist, E. Gatti, E. Maggioni, C. T. Vi, and C. Velasco. 2017. Multisensory Experiences in HCI. *IEEE MultiMedia* 24, 2 (Apr 2017), 9–13. https://doi.org/10.1109/MMUL.2017.33

[38] M. Obrist, A. N. Tuch, and K. Hornbaek. 2014. Opportunities for odor: experiences with smell and implications for technology. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, 2843–2852.

[39] M. Obrist, C. Velasco, C. Vi, N. Ranasinghe, A. Israr, A. Cheok, C. Spence, and P. Gopalakrishnakone. 2016. Sensing the future of HCI: touch, taste, and smell user interfaces. *interactions* 23, 5 (2016), 40–49.

[40] N. Ranasinghe, P. Jain, N. Thi Ngoc Tram, K. C. R. Koh, D. Tolley, S. Karwita, L. Lien-Ya, Y. Liangkun, K. Shamaiah, C. Eason Wai Tung, C. C. Yen, and E. Y-L. Do. 2018. Season Traveller: Multisensory Narration for Enhancing the Virtual Reality Experience. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems* (Montreal QC, Canada) *(CHI '18)*. ACM, New York, NY, USA, Article 577, 13 pages. https://doi.org/10.1145/3173574.3174151

[41] N. Ranasinghe, T. N. T. Nguyen, Y. Liangkun, L-Y. Lin, D. Tolley, and E. Y-L. Do. 2017. Vocktail: A Virtual Cocktail for Pairing Digital Taste, Smell, and Color Sensations. In *Proceedings of the 2017 ACM on Multimedia Conference* (Mountain View, California, USA) *(MM '17)*. ACM, New York, NY, USA, 1139–1147. https://doi.org/10.1145/3123266.3123440

[42] Estêvão B Saleme, Alexandra Covaci, Gebremariam Assres, Ioan-Sorin Comsa, Ramona Trestian, Celso AS Santos, and Gheorghita Ghinea. 2021. The influence of human factors on 360 mulsemedia QoE. *International Journal of Human-Computer Studies* 146 (2021), 102550.

[43] E. B. Saleme, A. Covaci, G. Mesfin, C. A. S. Santos, and G. Ghinea. 2019. Mulsemedia DIY: A Survey of Devices and a Tutorial for Building Your Own Mulsemedia Environment. *Comput. Surveys* 52, 3, Article 58 (June 2019), 29 pages.

[44] E. B. Saleme, C. A. S. Santos, R. A. Falbo, G. Ghinea, and F. Andres. 2019. MulseOnto: a Reference Ontology to Support the Design of Mulsemedia Systems. *Journal of Universal Computer Science* (2019), 26 pages.

[45] E. B. Saleme, C. A. S. Santos, and G. Ghinea. 2019. Coping With the Challenges of Delivering Multiple Sensorial Media. *IEEE MultiMedia* 26, 2 (April 2019), 66–75. https://doi.org/10.1109/MMUL.2018.2873565

[46] E. B. Saleme, C. A. S. Santos, and G. Ghinea. 2019. A mulsemedia framework for delivering sensory effects to heterogeneous systems. *Multimedia Systems* 25, 4 (01 Aug 2019), 421–447. https://doi.org/10.1007/s00530-019-00618-8

[47] H-S. Seo, A. Arshamian, K. Schemmer, I. Scheer, T. Sander, G. Ritter, and T. Hummel. 2010. Cross-modal integration between odors and abstract symbols. *Neuroscience letters* 478, 3 (2010), 175–178.

[48] B. Serrano, R. M. Baños, and C. Botella. 2016. Virtual reality and stimulation of touch and smell for inducing relaxation: A randomized controlled trial. *Computers in Human Behavior* 55 (2016), 1–8.

[49] Charles Spence. 2010. The color of wine–Part 1. *The World of Fine Wine* 28 (2010), 122–129.

[50] Charles Spence. 2011. Crossmodal correspondences: A tutorial review. *Attention, Perception, & Psychophysics* 73, 4 (2011), 971–995.

[51] B. S. Spencer. 2006. Incorporating the sense of smell into patient and haptic surgical simulators. *IEEE Transactions on Information Technology in Biomedicine* 10, 1 (Jan 2006), 168–173. https://doi.org/10.1109/TITB.2005.856851

[52] R. J. Stone, R. Guest, P. Mahoney, D. Lamb, and C. Gibson. 2017. A 'mixed reality' simulator concept for future Medical Emergency Response Team training. *Journal of the Royal Army Medical Corps* 163, 4 (2017), 280–287. https://doi.org/10.1136/jramc-2016-000726

[53] Y. Sulema. 2016. Mulsemedia vs. Multimedia: State of the art and future trends. In *2016 International Conference on Systems, Signals and Image Processing (IWSSIP)*. 1–5. https://doi.org/10.1109/IWSSIP.2016.7502696

[54] Irina Tal, Longhao Zou, Alexandra Covaci, Eva Ibarrola, Marilena Bratu, Gheorghita Ghinea, and Gabriel-Miro Muntean. 2019. Mulsemedia in Telecommunication and Networking Education: A Novel Teaching Approach that Improves the Learning Process. *IEEE Communications Magazine* 57, 11 (2019), 60–66.

[55] Erik van der Meulen, Marina A Cidota, Stephan G Lukosch, Paulina JM Bank, Aadjan JC van der Helm, and Valentijn T Visch. 2016. A haptic serious augmented reality game for motor assessment of parkinson's disease patients. In *2016 IEEE International Symposium on Mixed and Augmented Reality (ISMAR-Adjunct)*. IEEE, 102–104.

[56] C. Velasco and M. Obrist. 2021. Multisensory Experiences: A Primer. *Frontiers in Computer Science* 3 (2021), 12. https://doi.org/10.3389/fcomp.2021.614524

[57] C. T. Vi, D. Arthur, and M. Obrist. 2018. TasteBud: Bring Taste Back into the Game. In *Proceedings of the 3rd International Workshop on Multisensory Approaches to Human-Food Interaction* (Boulder, CO, USA) *(MHFI'18)*. ACM, New York, NY, USA, Article 1, 5 pages. https://doi.org/10.1145/3279954.3279955

[58] Ryan J Ward, Sophie M Wuerger, and Alan Marshall. 2021. Smelling sensations: olfactory crossmodal correspondences. *Journal of Perceptual Imaging* (2021).

[59] B. Yecies. 2016. Transnational collaboration of the multisensory kind: exploiting Korean 4D cinema in China. *Media International Australia* 159, 1 (2016), 22–31.

[60] L. Zou, I. Tal, A. Covaci, E. Ibarrola, G. Ghinea, and G-M. Muntean. 2017. Can Multisensorial Media Improve Learner Experience?. In *Proceedings of the 8th ACM on Multimedia Systems Conference*. ACM, 315–320.