

Towards Multisensory Storytelling with Taste and Flavor

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ABSTRACT

Film makers, producers, and theaters have continuously looked at ways to embody and/or integrate multiple sensory cues in the experiences they deliver. Here, we present a reflection on past attempts, lessons learnt, and future directions for the community around multisensory TV, film, and multimedia as a historical, though renewed, space of content creation. In particular, we present an overview of what we call “tasty film”, that is, film involving taste, flavor, and more broadly food and drink inputs, to influence the audience experience. We suggest that such elements should be considered beyond “add-ons” in film experiences. We advocate for experimentation with new kinds of storytelling taking inspiration from multisensory design research and work on sensory substitution. We position this article as a starting point for anyone interested in multisensory film involving taste, flavor, and foods.

Author Keywords

Multisensory film; cinema; edible; food; taste; flavor; storytelling; narrative; multisensory design.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

“*Sensations of smell, equilibrium, or touch are, of course, never conveyed in a film through direct stimuli, but are suggested indirectly through sight [...] [The filmmaker] eliminates entire areas of sensory perception, and thereby brings others into higher relief, ingeniously making them take the place of those that are missing*” [2, pp. 3].

The quote above by [2] suggests that sensory inputs beyond those related to our senses of vision and audition have traditionally not been directly integrated in films. Now, though, there is a current advent of novel multisensory systems that allow the stimulation of the senses of touch, smell, and taste, in a way that has not been imagined before

[41]. What is more, novel forms of film formats have been developed (e.g., home theater, online video, virtual reality, etc., [56]) and have opened up new spaces for design.

Whilst audio-visual contents have largely dominated media experiences such as TV and film over the last century, there have been several attempts to integrate touch, taste, and smell as sensory interaction/content modalities contributing to these experiences ([32, 41], see also Huxley’s *Feelies* as a literary example of the cinema of sensation, which involves multiple senses [29]). However, many of these initiatives have failed to capture the public’s imagination (see [21], for examples on smell and film). Whilst the reasons for these failures have not been systematically studied, it is reasonable to suggest that, historically, elements such as the absence of required technology associated with, and knowledge about, the specific senses, might have played a role.

Potentially though, considering more than two senses in media experiences that follow the format of a film (e.g., which is constrained in time and space) may not be the way to think about multisensory storytelling. Just think of the art gallery or the restaurant. Here, stories are also told, capitalizing on multiple senses, though the format is significantly different from that of a film, where the viewer sits in a relatively constrained space and is presented with a series of audiovisual events in a relatively standard timeframe (see Figure 1B).

At present, and perhaps given the continuous advances on multisensory technologies, there seems to be a resurgence of interest in concepts such as Smell-O-Vision (which integrates smell into film, e.g., [11]), as well as renewed interest in the incorporation of foods and drinks in film experiences (e.g., *Edible Cinema*, <http://ediblecinema.co.uk/>, e.g., [14, 30]). The incorporation of these elements, as well as haptic and other olfactory cues (e.g. VR, 4DX Cinema [56]; see also [1, 6, 7, 9]) into media experiences aim, among others, to enhance the immersiveness, emotional engagement, and the overall narrative of visual and audio-visual contents [e.g., 51]. Overall, there seems to be a growing interest in multisensory media that moves from classic TV and film (based on what we see and hear), to incorporating other senses into existing or entirely new experiences [20, 37, 39, 57]. Perhaps a couple of key questions here are: 1) whether one should consider the traditional media format and add new elements to it or rather develop novel media formats that integrate the aforesaid technologies, and 2) who may actually want such new formats?

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MHFI’18, October 16, 2018, Boulder, CO, USA
© 2018 Association for Computing Machinery.
ACM ISBN 978-1-4503-6074-6/18/10...\$15.00
<https://doi.org/10.1145/3279954.3279956>

Here, we take on the challenge of reflecting upon the role that taste, flavor, and more generally foods and drinks may play in novel film narratives. We will argue that further multisensory inputs should not just be considered as ‘add-ons’ to audio-visual stories but should instead be integrated into the narrative design to add novel value to the audience’s experience. With this consideration in mind, we present the first (to the best of our knowledge) critical overview of concepts associated with, and the few prior initiatives that have been developed around taste, flavor and foods in the context of film. We reflect on the natural marriage that has developed between certain foods and film experiences. Based on this reflection, we take inspiration from existing research on topics such as, sensory substitution (‘seeing through sound’, e.g., [24]), to suggest a new approach to multisensory film. We aim to position this manuscript as a first point of contact for those interested in multisensory film experiences, in particular, those involving taste, flavor, and food.

RELATED WORK

Multisensory Film: The film of sensation

Given the multisensory nature of our everyday life experiences, it is not a surprise that, historically, film creations have aimed to embody, and in some cases integrate, multiple sensory cues into the experiences they offer [13, 32]. Importantly, whilst the incorporation of visual and auditory inputs for media such as film, TV, and online video channels has consolidated and made a major impact in our lives, the incorporation of touch, taste, and smell for such media content has not necessarily been smooth.

There have been multiple attempts, since the times of silent films to, for example, integrate smell into existing or novel media experiences (e.g., early 1900s with smell by Samuel Rothafel, e.g., [21]). Classic examples include Smell-O-Vision’s “Scent of mystery” film, apparently advertised with the following progression: “*First they moved (1895)! Then they talked (1927)! Now they smell (1960)!*” [8], and AromaRama’s “Behind the great wall” (see also Sensorama [27]). More recently, devices such as “Smelling screen” have been introduced as means to integrate smell with audio-visual TV experiences [18, 34-36]. Nevertheless, most cases have failed to capture the public’s interest relative to the way that audio-visual film has (see also [15, 45]). Multiple explanations may be considered as to why this has been the case: a different temporal scale compared to vision and audition, habituation effects, technological limitations in scent-delivery and lingering, and absence of clarity as to how to integrate olfactory cues meaningfully, both from a technological but also a design point of view (see [45], for a discussion on the digitization of the chemical senses).

Recently, the incorporation of senses such as thermoception (temperature), the vestibular sense (balance), and nociception (pain), with film has been explored beyond a mere representation via audio-visual contents [3]. Technological advances have also allowed the further

development of 4DX cinema, which integrates some of these senses and is now available in many theaters [55]. Productions and research on 4DX has been welcomed by the public, however, it seems that it is not always convincing beyond a one-off experience (at least that is what certain film critics and the public seem to suggest when referring to the experience as distracting, perhaps boring at times, and also tiring, see [15, 16, 22, 28]). One possibility is that the viewers are used to a given film format and therefore might find it hard to embrace the new experience. It is also possible that 4DX is used as an addition to films that have been initially only thought of, and produced from, an audio-visual perspective, and therefore do not embody the full potential of a multisensory narrative.

It is worth highlighting at this point that the classic idea of a film experience that is more multisensory in nature is becoming more plausible. Indeed, researchers have gone further and designed systems that allow the incorporation of visual, auditory, olfactory, and haptic/tactile attributes in film experiences. For example, [10] presented a 3D-movie theater device that allows the delivery of a multimodal experiences. These initiatives, among others, seem to reflect an ongoing interest in experimental cinema, that is, cinema that goes beyond the classic audio-visual film presentation in a theater [4]. One frontier that has not found much attention yet relates to the chemical senses (taste and smell) as they are involved in eating and drinking. Attempts like Edible Cinema in the UK encourage us, however, to take on this final challenge around taste, flavor, and more generally foods and drinks incorporation in film narratives. Perhaps the relevant question here is, should non-traditional sensory inputs be integrated into existing film formats or instead experimentation should be directed toward novel media formats that are more suitable for full blown multisensory storytelling.

Taste, Flavor, and Foods and Drinks

Here, it becomes crucial to ask what can be integrated into film experiences or used as material for media experiences in terms of foods and drinks? Everything from basic tastes to actual foods. The perception of taste is thought to involve only those sensations that arise from the stimulation of the tongue, which comprise at least sweet, sour, salty, bitter, and umami – referred to as the five basic tastes, scientists agree on to date (e.g., [12], but perhaps also other sensations such as calcium or fat [32, 48]). Flavor (e.g., the sensation derived from tasting a given food), on the other hand, arises primarily from the integration of at least taste and olfaction, in particular retronasal olfaction (i.e., smell through the mouth), though perhaps also some elements of touch [43]. Finally, food and drink experiences generally involve multiple additional sensory inputs, which are not necessarily directly related to what happens with the flavor system (intrinsic) but also elements such as the appearance of the food (how it looks like, its color), the sound it makes, the environment where we eat (more extrinsic, e.g., [44]). These distinctions are important in that we rarely experience tastes in isolation,

though they are emotional drivers [40, 46], and also because flavor and food experiences are multisensory in nature [43]. Notably, depending on whether one chooses to integrate taste, flavor, or foods/drinks, with audio-visual film experiences, different technical and experiential consequences follow and need to be considered.

Incorporating Taste/Flavor into Film, and more General, Media Experiences

But why those gustatory inputs should be integrated into film experiences or considered for more multisensory media experiences? The most straightforward answer to this question is that, given the multisensoriality of our everyday lives, the most impactful experiences one can have (i.e., on an emotional, narrative, immersive, memorable level) are multisensory. Moreover, foods and beverages are powerful hedonic drivers, closely linked to social and cultural factors, capable of conveying meaning [13, 33]. As such, one might not conceptualize them as add-ons for film experiences only, but as means for multisensory storytelling and experience design.

For the aforesaid reasons, film makers, producers, and theaters have appealed to the chemical senses and food/drink experiences through audio-visual contents (see the quote of [2]) and to a lesser extent have also tried to integrate such senses into the experience [19, 33]. In terms of the latter, for example, several theaters have recognized that combining audio-visual media with food might create a different experience for the audience (not to mention the fact that all theaters offer easy/mobile foods and drinks, e.g., pop-corn and sodas, see [19], and that foods and beverages are a general part of users' audio-visual media consumption, e.g., [17]). [33], for instance, described how some theaters in North America have presented famous food movies (e.g., *Like Water for Chocolate* or *Babette's Feast*) and combined them with actual foods that embody the film storytelling. Notably, whilst adding the actual foods to those films might enhance the overall experience of that specific media format, they are not essential to it [33].

The different roles that food can have in a film are reminiscent of the literature of food as data, where food is conceptualized as a means to convey specific information [53]. Think, for example, about using food to communicate culture-related information (e.g., foods from different human groups) or perhaps as a metaphor for specific emotions (e.g., "bittersweet") and/or specific meanings (e.g., "interesting", "complex", "difficult to swallow"). Indeed, food cues have been used to convey information about "character's status, race, culture, and class; or even as a central thematic device within the narrative, making food an important, though frequently discounted, cinematic communication tool" ([23, p. 126]; food might also convey a range of affective meanings [42]).

In certain contexts, food seems to be smoothly integrated with film experiences, but not necessarily thought of as a means to complement, or be part of the narrative. For

example, since the introduction of sound to film (about 100 years ago), it is common for people to eat pop-corn, or perhaps eat a hot dog with a soft drink, whilst watching a film in the theater or at home [19]. Beyond this, whilst the concept of "tasty film", that is, using food/drinks as means of film experience design is not widespread, examples such as 'Edible Cinema' in the UK demonstrate that food/drinks can be used to enrich the film experience in a more narrative way. In Edible Cinema, people are given a tray with numbered boxes that contain specific food bites or beverages that have been selected for specific moments/scenes in a film. This is perhaps one of the most interesting approaches at recent times, however, it is not widespread nor supported by technology. In other words, it relies on the manual delivery and signaling of when is the right time to open a box in the tray (number next to the screen) and eat or drink the items.

INSIGHTS FROM EDIBLE CINEMA

Based on the aforementioned food/film relationships, it is reasonable to argue that there are already two kinds of film experiences involving foods available to consumers. First, one of them is almost inseparable from watching films in theaters or at home, that is film food (e.g., pop-corn, hot dogs, or lunch at home, etc.). Even if unrelated, foods/drinks here seem to be a long-standing companion to the experience of watching a film with positive (e.g., entertainment), but also negative implications (e.g., unhealthy eating behavior [25]). A second experience is embodied by Edible Cinema and sees foods as an interesting means to target specific film moments with tailored foods in order to enhance the audience experience. In these two functions, food is an add-on and not strictly needed to enjoy the film itself.

We contacted the creative team behind "Edible Cinema" to hear about their experience and conducted an unstructured interview. As one member recalls that all started in the house of one of the team's members, where they used to create experiences for members. They then decided to expand towards cinemas, and other events. Currently, they have 4-5 people in a creative team, a chef who works on the food menu, a team who supports the logistics, and also food/drink sponsors. Their creative process is relatively decentralized. They usually watch different movies independently and typically pick old movies as they are already familiar to the viewers. Here, they argue, foods add a new layer of depth to the experience through elements such as tastes, aromas, mouthfeel, temperature. Their advice is that, ideally, people should not see a movie the first time in Edible Cinema. Based on the movie selected, they brainstorm ideas and suggest a script to the Chef who then goes on and makes a menu based on the script. According to Edible Cinema, the brainstorming process focuses on augmenting the narrative by making it more interesting and fun, that is, not just copying what is happening on the screen, but also trying to capture the spirit of the directors' intention. After the Chef's creation, the creative team meets up for a tasting session and they either accept the menu or provide feedback based on whether the

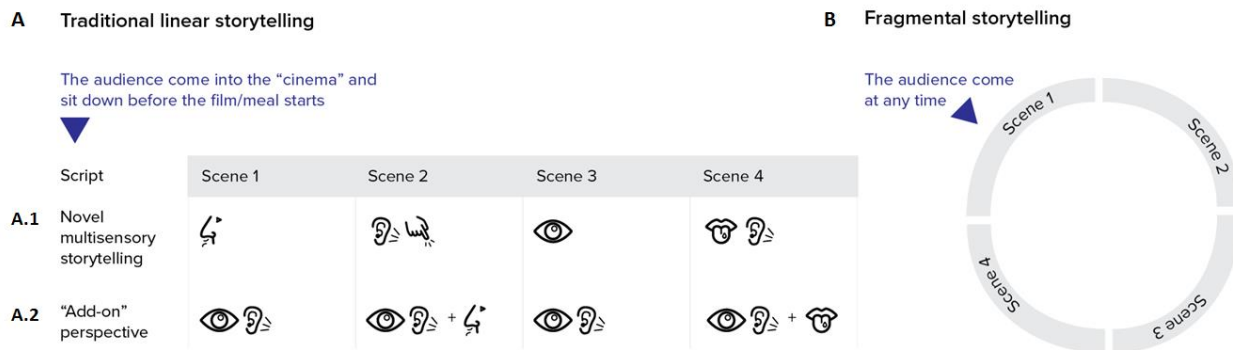


Figure 1. Perspectives on multisensory film: In the “add-on” view (1A.2), an (audiovisual) film is enhanced through taste, flavor or food (e.g., one may introduce space food, when watching specific scenes of a space film). In the multisensory storytelling view (1A.1), different combinations of sensory inputs might be used throughout the storytelling (e.g., the first scene may be a smellscape, followed by haptic and auditory feedback about the sort of environment where the smells take place, and so on). Note that in the latter, space and time are not necessarily limited to the prototypical film format. Figure 1B represents what we called “fragmental storytelling, where each scene is stand-alone and contributes to one part of the storytelling.

match feels right. From the selection of the film to the implementation of the edible version of the film, the team takes usually 4-6 weeks. According to one member of the creative team, “it is not always about making people happy, but make it [the experience] interesting”. Occasionally the teams’ aim is to replicate what is on screen, but at other times it is more about the emotional state of the viewer, giving sense of context, emphasizing funny lines/jokes, and surprising (e.g., perhaps by using the smell of something that is not chocolate in Charlie and the Chocolate Factory). Edible Cinema also describes a number of challenges associated with their practice, which involves: space, time, resources, need to be efficient, time-space efficiency is key when working with cinemas, food preparation, transportation, conservation, safety, and delivery.

The concept and practice behind Edible Cinema is intriguing and changes the way we think about films. However, is there scope for an even more radical approach to use food as a film/media input? Could a multisensory media experiences involve film materials and food that does not rely on the film format? We are convinced that there is a third way to the multisensory film, or more general media experience, one which involves taste, flavor, and foods from the production and creation process itself. As the art of film evolved from silent to sonic film, and is now evolving from static to dynamic (e.g., involving touch/haptic and olfactory elements) in some contexts (4DX), a novel form of experience design arises. All sensory cues (not only audio-visual), can be thought of as storytelling means since the conception of the narrative of a film, rather than being added or considered after the production is completed. In this sense, it may be even relatively misleading to call this multisensory film or cinema. According to the Oxford Dictionaries, a “film” is “A story or event recorded by a camera as a set of

moving images and shown in a cinema or on television”. By definition, this format involves visual and auditory inputs.

Moving from this format to a more multisensory media format for storytelling requires rethinking both the recording means, the way sensory information is delivered, as well as the spatiotemporal characteristics of the media format.

TOWARD MULTISENSORY FILM: FROM ADD-ONS TO KEY INGREDIENTS

Based on the different experiences mentioned above, there are, at least, two main directions for creating a new future for film production and consumption through taste, flavor, and food incorporation (see an overview on Figure 1A).

First, fostering the “add-on” perspective to enhance existing audio-visual contents through a meaningful incorporation of taste, flavor, and food inputs across the narrative of a film (as in the case Edible Cinema). *Second*, creating a new form of storytelling, one which takes into account all multisensory inputs (e.g., taste, vision, hearing) from the beginning of the creative design process. Exploring such a new direction of storytelling can open up the opportunity for novel experience design frontiers.

Independently of the approach one pursues, the incorporation of multisensory inputs in new media experiences should be based on the principles that govern the systematic connections that exist between the senses [26, 50]. Designing new experiences is not an easy task, in particular given the challenges associated with synchronizing and meaningfully mapping audio-visual with chemosensory (e.g., taste and smell) or multisensory (e.g., food) contents. Whilst visual and auditory inputs might be based on digitally-controlled systems, without the need of refilling (just charging), taste/smell-based interfaces are still limited and those who can deliver a meaningful experience require refills [45].

Here, the creation of novel experiences in the context of restaurants can act as inspiration for how eating is not only about the food, but the narrative around it. For example, *Le Petit Chef* is a concept that combines visual mapping and sound with the restaurant table [49]. Most notably, an animated Chef (downsized to the size of the plateware) is cooking the dishes in front of the diner in real time. This brings the dishes and their stories to life. Similar concepts, though perhaps more abstract, have been developed by a collaboration between TeamLab (an art collective) and Sagaya Restaurant in Tokyo [47] and also at Ultraviolet restaurant in Shanghai [54]. These examples suggest that a form of audio-visual media content can be meaningfully integrated with food/drinks to deliver a novel dining experience, where the storytelling is guided by multiple sensory cues (e.g., scents, light movement, colors). Such creative approaches in the world of gastronomy can extend to cinematography and inspire a new generation of film-making techniques and tools. Note here, that with this we do not suggest that the derived new media formats will be accepted by everyone and as such, designers should also consider suitable audiences for the productions, thought market segmentation.

CONCLUSIONS AND FUTURE WORK

Current developments around multisensory interfaces and experience design pave the way for novel tasty film experiences. In this paper, we have provided an overview on past efforts, lessons learnt, and most recent resurrection of the vision of a multisensory film future. Our hope is that this overview serves as a starting point to anyone interested in the development of multisensory film experiences, in particular those involving taste, flavor, and/or foods.

The idea of putting the underexploited senses in the film production, may not only benefit the entertainment industry, but may also bring with it benefits for educational contexts (e.g., integrated storytelling between food sources in documentaries, linking tastes/flavors to geography), medical (e.g., to make eating more entertaining and enjoyable in hospital contexts), and social contexts (e.g., sharing and creating meaning through taste that perhaps overcomes language barriers, increasing the engagement in the public space).

For example, one might take inspiration from modernist restaurants and build on the idea of a multi-course dinner alongside a movie experience [cf. 49]. Here, the storytelling may be based on the incorporation of multiple courses and audio-visual scenes, based on semantic congruency (e.g., food and scene representing similar identities or meanings, e.g., [31, 50], that convey a specific short story. Similarly, though perhaps somewhat more difficult to scale up, MetaCookie, a system that integrates vision, olfaction, and food might provide further inspiration [38]. This system was designed to customize the look (through augmented reality) and flavor (through smell) of a cookie. That said, it also

provides a starting point to the dynamic incorporation of multiple sensory cues into a given narrative.

One might also imagine concepts such as “silent flavor”. In particular, in this concept sound is removed from and both tastes and scents are used to replace the missing sound experience. This idea builds on the research on sensory substitution devices (SSDs), which are assistive technologies that translate rich and complex information from one sense (e.g. vision) into another sense (e.g. hearing or touch, see [5, 24]). They are typically developed for blind or deaf people, but what if we take the concept of sensory substitution further to introduce a new way to emotionally engage with content, instead of seeing you taste a scene with sound, and flavors that become part of the narrative and unfold over time. Such an experience could be delivered directly into the users’ mouth using emerging technologies such as acoustic levitation, that can track the user’s tongue and drop a liquid or solid food morsels directly on the tongue [52]. Thus, one could make a film that is more accessible to people that have no or limited visual capabilities and at the same time give the user the control over the ingestion or rejection of a tasty bit (i.e., open or close your mouth). Such a new form of sensory storyline could also introduce a new type of experience for the sighted audience engaging much more the potential of their other senses that are still underexploited in film production. Moreover, it allows to advance the delivery mechanism, often achieved manually (e.g., as in Edible Cinema), through the creation of automated delivery systems that present the tasty bit in the right moment of a scene.

Ideally, research should first establish the opportunities for designing spaces of cross-sensory narratives in the context of film making. Once such design space is further developed, more multisensory narratives and film experiences will derive naturally. Importantly though, depending on the producers and designer’s intentions it might be worth considering and assessing the level of immersion and engagement of the productions in order to understand what formats result in the desired experiences.

ACKNOWLEDGMENTS

This work is supported by funding from the European Research Council (ERC) under the European Union’s Horizon 2020 research and innovation programme under grant agreement No. 638605. Special thanks go to the Edible Cinema team, especially Polly Betton, for sharing insights on their creative process.

REFERENCES

1. Damien Ablart, Carlos Velasco, and Marianna Obrist. 2017. Integrating mid-air haptics into movie experiences. In *Proceedings of the 2017 ACM International Conference on Interactive Experiences for TV and Online Video (TVX '17)*. ACM, New York, NY, USA, 77-84. DOI: <https://doi.org/10.1145/3077548.3077551>
2. Rudolf Arnheim. 1957. *Film as art*. University of California Press.
3. Luis R. Antunes. 2016. *The multisensory film experience: A cognitive model of experiential film aesthetics*. Intellect.
4. Sarah Atkinson and Helen W. Kennedy. 2016. Inside-the-scenes: The rise of experiential cinema. *Participations* 13,1: 139-151.
5. Paul Bach-y-Rita and Stephen W. Kercel. 2003. Sensory substitution and the human-machine interface. *Trends Cogn Sci* 7, 12: 541-546.

6. Adam Baran. 2016. A movie theater that pelts you with fake rain and added smells? Bring it on. Retrieved January 20, 2018 from <https://www.theguardian.com/film/2016/mar/10/4dx-cinema-new-york-batman-v-superman-fake-rain-smells>
7. Brooks Barnes. 2014. To lure young, movie theaters shake, smell and spritz. Retrieved 20 January 2018 from <https://www.nytimes.com/2014/11/30/business/media/to-lure-young-movie-theaters-shake-smell-and-spritz.html>
8. John Brownlee. 2006. A brief history of Smell-O-Vision. Retrieved January 20, 2018 from <https://www.wired.com/2006/12/a-brief-history-2-2/>
9. Sam Byford. 2013. The sights, smells, and sprays of 'Iron Man 3' in 4DX. Retrieved 20 January, 2018 from <https://www.theverge.com/2013/5/2/4293178/the-sights-smells-and-sprays-of-iron-man-3-in-4dx>
10. Sergio Casas, Cristina Portalés, María Vidal-González, Inma García-Pereira, and Marcos Fernández. 2016. Romot: A robotic 3D-movie theater allowing interaction and multimodal experiences. In *International Conference on Love and Sex with Robots*, Adrian D. Cheok, Kate Devlin, and David Levy (eds). Springer, Cham, 50-63.
11. Nicholas Deleon. 2016. Smell-O-Vision is finally almost here. Retrieved January 20, 2018 from https://motherboard.vice.com/en_us/article/xyggad/cyrano-digital-scent-gadget
12. Jeannine Delwiche. 1996. Are there 'basic' tastes?. *Trends Food Sci Technol* 7, 12: 411-415.
13. Thomas Elsaesser and Malte Hagener. 2015. *Film theory: An introduction through the senses* (2nd ed.). Routledge.
14. Jochan Embley. 2015. Edible cinema at the Science Museum: Eat along to Charlie and the chocolate factory. Retrieved 20 January, 2018 from <https://www.standard.co.uk/go/london/edible-cinema-at-the-science-museum-eat-along-to-charlie-and-the-chocolate-factory-a2921716.html>
15. Adam Epstein. 2016. Hollywood's fantastic, failed attempts to make audiences smell and "feel" movies, from AromaRama to 4D. Retrieved 20 January 2018 from <https://qz.com/649920/hollywoods-fantastic-failed-attempts-to-make-audiences-smell-and-feel-movies-from-aromarama-to-4d/>
16. Daniel Feit. 2013. Multisensory version of iron man 3 in japan is a gimmicky waste of \$28. Retrieved 20 January, 2018 from <https://www.wired.com/2013/04/iron-man-4dx-japan/>
17. Shira Feldman, Marla E. Eisenberg, Dianne Neumark-Sztainer, and Mary Story. 2007. Associations between watching TV during family meals and dietary intake among adolescents. *J Nutr Educ Behav* 39, 5: 257-263.
18. Damien Gayle. 2013. Real smell-o-vision TV unveiled by Japanese team (and it's NOT an April Fool). Retrieved 20 January, 2018 from <http://www.dailymail.co.uk/sciencetech/article-2302414/Real-smell-o-vision-TV-unveiled-Japanese-team-NOT-April-Fool.html>
19. Natasha Geiling, N. 2013. Why do we eat popcorn at the movies? Retrieved 20 January, 2018 from <https://www.smithsonianmag.com/arts-culture/why-do-we-eat-popcorn-at-the-movies-475063/?q=>
20. Gheorghita Ghinea, Christian Timmerer, Weisi Lin, and Stephen R. Gulliver. 2014. Mulsemedia: State of the Art, Perspectives, and Challenges. *ACM Trans. Multimedia Comput. Commun. Appl.* 11, 1s, Article 17 (October 2014), 23 pages. DOI=<http://dx.doi.org/10.1145/2617994>
21. Avery Gilbert. 2014. What the nose knows: The science of scent in everyday life. Synesthetics, Inc.
22. Tim Grierson, T. 2014. 8 things you need to know about the 4dx theater experience. Retrieved 20 January, 2018 from <https://www.rollingstone.com/movies/news/8-things-you-need-to-know-about-the-4dx-theater-experience-20140519>
23. Dotty Hamilton. 2014. Appetite and aroma: Visual imagery and the perception of taste and smell in contemporary Korean film. In *Food on film: Bringing something new to the table*, Tom Hertweck (Ed.). Lanham: Rowman, 125-127.
24. Giles Hamilton-Fletcher, Marianna Obrist, Phil Watten, Michele Mengucci, and Jamie Ward. 2016. "I always wanted to see the night sky": Blind user preferences for sensory substitution devices. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (CHI '16). ACM, New York, NY, USA, 2162-2174. DOI: <https://doi.org/10.1145/2858036.2858241>
25. Jennifer L. Harris and John A. Bargh. 2009. The relationship between television viewing and unhealthy eating: Implications for children and media interventions. *Health Commun* 24, 7: 660-673.
26. Michael Haverkamp. 2014. *Synesthetic design*. Birkhäuser Verlag.
27. Morton L. Heilig. (1962). U.S. Patent No. 3,050,870. Washington, DC: U.S. Patent and Trademark Office.
28. Jeremy Hsu. 2015. Why most 4d movies fail at immersion. Retrieved 20 January, 2018 from blogs.discovermagazine.com/lovesick-cyborg/2015/06/19/why-most-4d-movies-fail-at-immersion/#.Wmb9Ozdry71
29. Aldous Huxley. 2007. A brave new world. Penguin Random House UK.
30. Ruth Jamieson, R. Is edible cinema a tasty new way to enjoy films?. Retrieved 20 January, 2018 from <https://www.theguardian.com/film/filmblog/2012/may/17/edible-cinema-taste-film>
31. Paul J. Laurienti, Robert A. Kraft, Joseph A. Maldjian, Jonathan H. Burdette, and Mark T. Wallace. 2004. Semantic congruence is a critical factor in multisensory behavioral performance. *Exp Brain Res* 158, 4: 405-414.
32. Youngseok Lee, Seeta Poudel, Yunjung Kim, Dhananjay Thakur, and Craig Montell. 2018. Calcium taste avoidance in drosophila. *Neuron* 97, 1: 67-74.
33. Laura U. Marks. 2000. *The skin of the film: Intercultural cinema, embodiment, and the senses*. Duke University Press.
34. Haruka Matsukura, Tatsuhiro Yoneda, and Hiroshi Ishida. 2012. "Smelling screen: Technique to present a virtual odor source at an arbitrary position on a screen," *2012 IEEE Virtual Reality Workshops (VRW)*, Costa Mesa, CA, pp. 127-128. doi: 10.1109/VR.2012.6180915
35. Haruka Matsukura, Tatsuhiro Yoneda, and Hiroshi Ishida. 2013. "Smelling screen: Presenting a virtual odor source on a LCD screen," *2013 IEEE Virtual Reality (VR)*, Lake Buena Vista, FL, pp. 167-168. doi: 10.1109/VR.2013.6549415
36. Haruka Matsukura, Tatsuhiro Yoneda, and Hiroshi Ishida. 2013. "Smelling screen: development and evaluation of an olfactory display system for presenting a virtual odor source". *IEEE Trans. Vis. Comput. Graphics* 19, 4: 606-615.
37. Niall Murray, Brian Lee, Yuansong Qiao, and Gabriel-Miro Muntean. 2016. Olfaction-enhanced multimedia: A survey of application domains, displays, and research challenges. *ACM Comput Surv* 48, 4, Article 56 (May 2016), 34 pages. DOI: <http://dx.doi.org/10.1145/2816454>
38. Takuji Narumi, Takashi Kajinami, Tomohiro Tanikawa, and Michitaka Hirose. 2010. Meta cookie. In *ACM SIGGRAPH 2010 Emerging Technologies* (SIGGRAPH '10). ACM, New York, NY, USA, Article 18, 1 pages. DOI=<http://dx.doi.org/10.1145/1836821.1836839>
39. Marianna Obrist. 2016. Here's how the future of tv could involve all your senses. Retrieved 20 January, 2018 from www.sciencealert.com/the-future-of-tv-how-feely-vision-could-tickle-all-our-senses
40. Marianna Obrist, Rob Comber, Sriram Subramanian, Betina Piqueras-Fiszman, Carlos Velasco, and Charles Spence. 2014. Temporal, affective, and embodied characteristics of taste experiences: A framework for design. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '14). ACM, New York, NY, USA, 2853-2862. DOI: <https://doi.org/10.1145/2556288.2557007>
41. Marianna Obrist, Elia Gatti, Emanuela Maggioni, Chi Thanh Vi, and Carlos Velasco. 2017. Multisensory experiences in HCI. *IEEE MultiMedia* 24, 2: 9-13.
42. Lorna Piatti-Farnell. 2017. Approaching food and horror. In *Consuming Gothic*, Lorna Piatti-Farnell (Ed.). Palgrave Macmillan, London, UK, 1-38.
43. John Prescott. 2015. Multisensory processes in flavour perception and their influence on food choice. *Curr Opin Food Sci* 3: 47-52.
44. Charles Spence. 2015. Multisensory flavor perception. *Cell* 161, 1: 24-35.
45. Charles Spence, Marianna Obrist, Carlos Velasco, and Nimesha Ranasinghe. 2017. Digitizing the chemical senses: Possibilities & pitfalls. *Int J Hum Comput St* 107: 62-74.
46. Jacob E. Steiner, Dieter Glaser, Maria E. Hawilo, and Kent C. Berridge. 2001. Comparative expression of hedonic impact: affective reactions to taste by human infants and other primates. *Neurosci Biobehav Rev* 25, 1: 53-74.
47. Jessica Stewart. 2017. Digital installation transforms restaurant into immersive dining experience. Retrieved January 20, 2018 from <http://mymodemmet.com/teamlab-sagaya-interactive-restaurants/>
48. Bijal P. Trivedi. 2012. Neuroscience: Hardwired for taste. *Nature* 486, 7403: S7-S9.
49. Victoria Turk. 2017. This London restaurant is using 3D projection to bring food to life. Retrieved 20 January, 2018 from www.wired.co.uk/article/le-petit-chef-dinner-theatre-projection-london-restaurant
50. Carlos Velasco, Charles Michel, Jozef Youssef, Xavier Gamez, X., Adrian D. Cheok, and Charles Spence. 2016. Colour-taste correspondences: Design food experiences to meet expectations or surprise. *International Journal of Food Design* 1, 2: 83-102.
51. Chi Thanh Vi, Damien Ablart, Elia Gatti, Carlos Velasco, and Marianna Obrist. 2017. Not just seeing, but also feeling art: Mid-air haptic experiences integrated in a multisensory art exhibition. *Int J Hum Comput St* 108, 1-14.
52. Chi Thanh Vi, Asier Marzo, Damien Ablart, Gianluca Memoli, Sriram Subramanian, Bruce Drinkwater, and Marianna Obrist. 2017. TastyFloats: A Contactless Food Delivery System. In *Proceedings of the 2017 ACM International Conference on Interactive Surfaces and Spaces* (ISS '17). ACM, New York, NY, USA, 161-170.
53. Yun Wang, Xiaojuan Ma, Qiong Luo, and Huamin Qu. 2016. Data Edibilization: Representing Data with Food. In *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems* (CHI EA '16). ACM, New York, NY, USA, 409-422. DOI: <https://doi.org/10.1145/2851581.2892570>
54. Sara Yap, S. 2016. Rise of the machines: How technology is shaking up the dining world. Retrieved January 20, 2018 from www.lifestyleasia.com/481919/rise-machines-technology-shaking-dining-world/

55. Brian Yecies. 2016. Transnational collaboration of the multisensory kind: exploiting Korean 4D cinema in China. *Media Int Aust* 159, 1: 22-31.
56. Emiko Yozuka. 2015. Multisensory cinema adds smell and touch to VR worlds. Retrieved 20 January, 2018 from https://motherboard.vice.com/en_us/article/qkv7pp/multisensory-cinema-adds-smell-and-touch-to-vr-worlds
57. Yuan, Z., Ghinea, G., & Muntean, G. M. (2015). Beyond multimedia adaptation: Quality of experience-aware multi-sensorial media delivery. *IEEE Trans. on Multimedia* 17: 104-117.