Mapping FoodHCI Futures

Jialin Deng*
Exertion Games Lab, Monash University, Melbourne, Australia
jialin@exertiongameslab.org

Ferran Altarriba Bertran
ERAM - Universitat de Girona, Girona, Spain
ferranaltarriba@gmail.com

Lining Yao
Carnegie Mellon University, Pittsburgh, USA,
liningy@andrew.cmu.edu

Marianna Obrist
Department of Computer Science, University College London, London, UK
m.obrist@ucl.ac.uk

Koya Narumi
The University of Tokyo
narumi@akg.t.u-tokyo.ac.jp

Humphrey Yang
Carnegie Mellon University, Pittsburgh, USA
hanliny@andrew.cmu.edu

Mako Miyatake
The University of Tokyo
mako-miyatake@g.ecc.u-tokyo.ac.jp

Florian 'Floyd' Mueller
Exertion Games Lab, Monash University, Melbourne, Australia
floyd@exertiongameslab.org

Figure 1: Various food-related explorations in HCI.

ABSTRACT

Recognizing the significant potential impact that HCI has on food practices and experiences, researchers and practitioners are undertaking a growing number of explorations of novel computing technology and food combinations. These explorations have so far primarily emphasized technology-driven systems and taken a human-centric perspective. We propose a Special Interest Group (SIG) in "foodHCI futures" that creates a space for researchers to discuss the boundaries of food incorporating HCI, and with the simultaneous aims of reconciling food with technology and extending our visions for human-food interactions towards anthropocentrism. Specifically, the SIG will be a beginning of developing a structured conceptual map of the possibilities for future technology interventions in food systems. In developing this map, we hope to encourage democratized debate, provoke new and divergent thoughts on the opportunities for foodHCI, and ultimately gain unique insights that contribute to preferable food futures.

CCS CONCEPTS

• **Human-centered computing**; • **Interactive design**;

KEYWORDS

FoodHCI, Human-Computer Interaction, Human-Food Interaction

ACM Reference Format:
Jialin Deng*, Ferran Altarriba Bertran, Lining Yao, Marianna Obrist, Koya Narumi, Humphrey Yang, Mako Miyatake, and Florian 'Floyd' Mueller. 2022. Mapping FoodHCI Futures. In *CHI Conference on Human Factors in Computing Systems Extended Abstracts (CHI '22 Extended Abstracts), April 29–May 05, 2022, New Orleans, LA, USA.* ACM, New York, NY, USA, 5 pages. https://doi.org/10.1145/3491101.3516401

CHI '22 Extended Abstracts, April 29–May 05, 2022, New Orleans, LA, USA

ACM ISBN 978-1-4503-9156-6/22/04.
https://doi.org/10.1145/3491101.3516401

1 BACKGROUGD

What images might we evoke in examining the futures of food and HCI?

1.1 The interventions of HCI in the food realm: Digital-tech driven vs. food as material concern

Over time, human eating and dietary practices have been shaped by the introduction of new foods [45]. More recently, the emergence of digital technology has taken food innovation to extremes, including significant changes in which foods are produced and prepared, along with the novelty of foodstuffs themselves [45]. Explorations in the Human-Computer Interaction (HCI) field have led to greater convergence between food and digital technology and novel engagements with food, including personal food printing [23, 28, 33, 54], extended reality [8, 39], ingestible sensors [27], digital taste [32, 40], acoustic levitation for food transportation [48, 49],

and real-time gustatory manipulation via machine learning [38]. These developments have been supplemented by a plethora of technological innovations, such as: smart kitchens [34] and robot cooking assistants [26] that enhance food preparation. Moreover, automatic diet tracking systems [3] and personal food computers for urban agriculture [9] that support personalized nutrition and home farming practices. This "Human-Food Interaction (HFI)" work [5, 14, 17, 25, 46, 47] has become a major part of HCI research into "the interconnection between the self and food" [13, 14].

While there is clearly great potential for HCI to impact on our food practices and experiences, a technology-driven research agenda (which we find to be prevalent in the literature to date) could hinder the exploration of human-food interactions because it de-emphasizes people and the ways in which they engage with food, and favors a focus on the efficiencies and novelties that new technologies might provide [15]. This focus is evident because most existing systems typically "work" without the food, and the diner does not need to consume the food to have a digital experience. We believe that it is reasonable to argue that, while they are technically novel and well-executed, many systems fail to fully realize the potential to "celebrate the pleasurable and enjoyable experiences that people have with food" through the intervention of technology [24]. In response to these issues, and to avoid the pitfalls of "technological solutionism" [35], we aim to uncover some of the broader meanings of incorporating food and HCI. Rather than just considering the utilitarian aspects of human-food interactions, we will also follow the "material-centered" approach proposed by Wiberg [52, 53] and consider food to be a "material concern" of interaction design emphasizing its aesthetic, sensory and sociocultural qualities and the interplay with people and the ways in which they engage with food.

1.2 FoodHCI for "more than human worlds": Human-centric vs. post-humanistic design

Human food production, consumption, and related practices are deeply entangled with, and dependent upon, the existence of a thriving biosphere and other non-human species [29]. In recent years, in response to the call of de-centering humans in sustainable design, there has been a growth in non-anthropocentric HCI research that seeks to reorient our attention away from a human-centered agenda and towards a multispecies worldview [19, 21, 41]. In this respect, HCI has increasingly explored the "more than human worlds" that are a part of and connected to the food realm, including plants, living cells, microbes, bacteria, and fungi [10, 29, 30], that considers the diverse impacts that food-tech innovation may have on food cultures [18]. Some recent research examples include: an ethnographic study of alternative farming practices that de-center humans in sustainable HCI by engaging symbiotic encounters with companion species [30]; the conceptualization of "collaborative survival" [29] as a way to describe an HCI design process for fungi foraging, and the exploration of how HCI can extend human capabilities of noticing living nonhuman beings; the development of "Nukabot" [11], which seeks to develop affective attachments between people and food, via living fermentative microbes; and speculative designs, such as the "Living Food" project [20], that has even proposed a series of futuristic dishes that appear to be living creatures, raising questions about the central position of the human when interacting with food.

Learning from these prior works, we attempt to extend the vision of existing HFI research paradigms beyond anthropocentrism, and to consider post-humanistic foodHCI interactions. In doing so, we hope to rethink the future of foodHCI design and expand its boundaries to reflect a world in which "humans and nonhumans [are] bound together materially, ethically, and existentially" [29].

Taken together, we propose the convening of the Special Interest Group (SIG) on "foodHCI futures". This SIG seeks to reconcile food with technology by creating a structured conceptual map of the possibilities for future technology interventions in food systems. By developing this map, we hope to encourage democratized debate, which provokes new and divergent thoughts on the opportunities for foodHCI. Consequently, we expect the SIG to create a space in which researchers and practitioners can discuss the boundaries of food incorporating HCI and gain new insights that contribute to preferable food futures.

2 GOALS OF THE SIG

This SIG provides an opportunity for researchers and practitioners interested in the intersection of food and HCI to come together to share their interests and to discuss ways to move the field forward while seeking to incorporate new theoretical contributions. We aim to:

- Facilitate discussions on a wide range of foodHCI topics (some of which are already central to the field, and others that might/should be given greater emphasis), in order to establish a common understanding between SIG attendees of food futures issues.
- Collaboratively create a map of foodHCI that demonstrates a structural understanding of the underlying relationships between these topics, that can further formulate the provocations of future HCI interventions in the realm of food.

Figure 2 shows an indicative version of the map we intend to produce through this SIG. It illustrates loosely structured emerging concepts at the intersections of food and HCI, providing an initial framework as an example for guiding SIG attendees to review and categorize past foodHCI systems, and then to discuss, envision, and collaboratively shape future possibilities and opportunities in the foodHCI futures space. This initial guiding framework runs along two dimensions: the horizontal dimension of the space conveys the original motivations for foodHCI research and design, spanning from digital-technology driven to food as material concern and comprising three categories: (i) Utility – the ability of being useful; (ii) Materiality – the sum of the system's material properties, characters, aesthetics, appearance, authenticity and meaning [53]; and (iii) Symbolism – the power of food and food practices that reinforce shared cultural, social, and religious identities and strengthen social connections [1]. The vertical dimension of the space conveys the arc of foodHCI futures, ranging from human-centric to post-humanistic considerations of material, ethical, environmental, planetary, and existential bonds between human and more than human worlds. Several open questions may arise for discussion, such as: What are the subfields across various disciplines of foodHCI? What are the approaches – across the design, implementation, evaluation, and

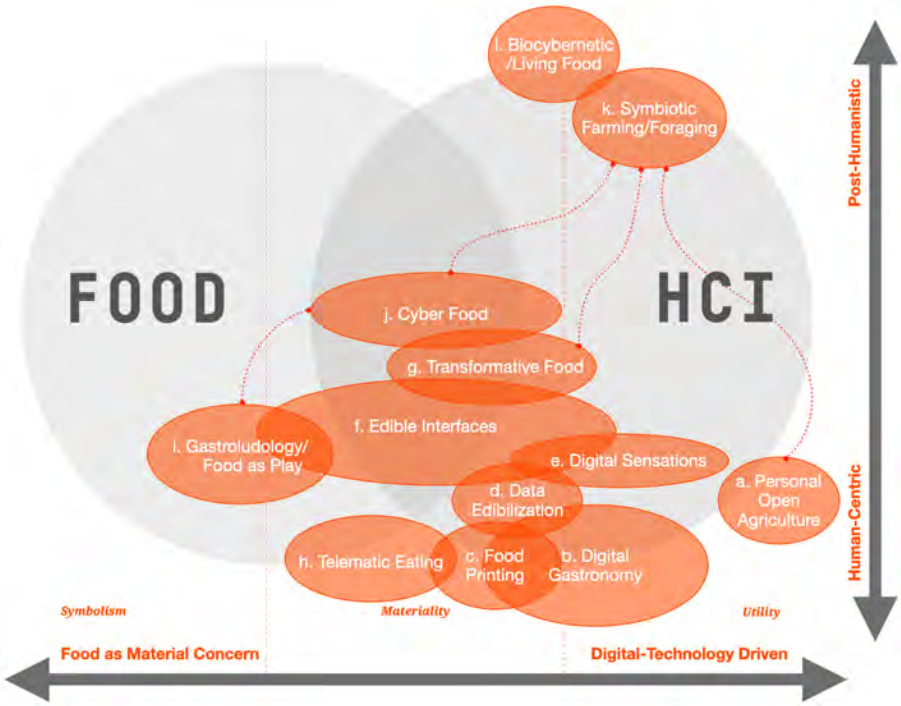

Figure 2: An example of what our map of human-computer integration might look like at the end of the SIG, with some sub-fields: a) OpenAg personal food computer [9]. b) Digital Gastronomy [7, 55]. c) Food printing [23, 28, 33, 54]. d) Data edibilization [36, 51]. e) Digital sensations [43]. f) Edible interfaces [22, 31]. g) Transformative food [44, 50]. h) Telematic eating [4, 42]. i) Gastroludology/food as play [6, 12, 37]. j) Cyber Food [16]. k) Symbiotic farming/foraging [10, 29, 30]. l) Biocybernetic/living food [2, 20].

deployment processes for incorporating food with HCI? Where do the barriers exist and what challenges might surface in attempting to do so? How can HCI interventions offer new possibilities for human-food-technology experiences?

Attendees might re-generate the map with completely different categories out of the existing dimensions based on the conversations and discussions during the SIG. We acknowledge that completing a comprehensive map of foodHCI futures is beyond the scope of our SIG, our more modest goal is to encourage new ways of envisioning the possibilities for food practices that might be addressed by the incorporation of HCI. We anticipate that the foodHCI futures SIG will be of interest and value to experienced researchers who wish to advance the field, and to newcomers hoping to get a taste for the field. We also intend to make the SIG accessible to a general audience who wish to become acquainted with foodHCI and to support democratized collaboration between attendees. We hope to surface perspectives beyond those of the SIG's panel of leading experts in the field and encourage inputs from the broader community.

3 FORMAT

Attendees will be given a link to an online conference platform via which they can participate in the SIG. Upon commencement, the format will be as follows:

- Introduction (15 minutes): Organizers will briefly introduce themselves and present a short background of foodHCI and explain the SIG objectives.
- Discussion and map drafting (25 minutes): Using a premade skeleton map (refer to Fig. 1), organizers will invite attendees into breakout groups to conceive different ideas (e.g., sketches) and to add to this map via the online platform (e.g. Miro).
- Map re-organization and pruning (15 minutes): After the map is produced, attendees will attempt to organize and synthesize the map all together, as required, by moving topics around, collapsing related topics, removing redundancies, and so on.
- Final discussion and reflection (20 minutes): Any further adjustments to the map can be made during the final discussion and reflection. Organizers will provide attendees with permanent access to the online platform so that they might engage in further discussion.

4 OUTCOMES AND NEXT STEPS

The major outcome of this SIG will be a map of foodHCI futures developed collaboratively by the attendees and representing diverse perspectives. We hope that this map will clarify the variety of foodHCI topics and that it will benefit researchers in the field and others, outside the field, who hope to gain a better understanding.

We also hope that researchers will use the map as a reference tool to help them identify potential opportunities for collaboration in their areas of foodHCI interest. The final version of this map will be available online.

REFERENCES

[1] Symbol, *Food as*. Encyclopedia of Food and Culture (2021), from: https://www.encyclopedia.com/food/encyclopedias-almanacs-transcripts-and-maps/symbol-food.

[2] Andrew Adamatzky, Simon Harding, Victor Erokhin, Richard Mayne, Nina Gizzie, Frantisek Baluška, Stefano Mancuso, and Georgios Ch. Sirakoulis, Computers from Plants We Never Made: Speculations, in S. Stepney and A. Adamatzky, *Inspired by Nature*. 2018, Emergence, Complexity and Computation, vol 28. Springer International Publishing: Cham. p. 357-387. DOI: https://dx.doi.org/10.1007/978-3-319-67997-6_17.

[3] A. Alexiadis, A. Triantafyllidis, D. Elmas, G. Gerovasilis, K. Votis, and D. Tzovaras. 2020. A Social Robot-based Platform towards Automated Diet Tracking. *In Proceedings of the 2020 15th Conference on Computer Science and Information Systems (FedCSIS), 6-9 Sept. 2020,* 11-14. DOI: 10.15439/2020F146.

[4] Pollie Barden, Rob Comber, David Green, Daniel Jackson, Cassim Ladha, Tom Bartindale, Nick Bryan-Kinns, Tony Stockman, and Patrick Olivier. 2012. Telematic dinner party: designing for togetherness through play and performance. *In Proceedings of the Designing Interactive Systems Conference, Newcastle Upon Tyne, United Kingdom*. Association for Computing Machinery, New York, NY, USA. 38–47. DOI: 10.1145/2317956.2317964.

[5] Ferran Altarriba Bertran, Samvid Jhaveri, Rosa Lutz, Katherine Isbister, and Danielle Wilde. 2019. Making Sense of Human-Food Interaction. *In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, Glasgow, Scotland Uk*. Association for Computing Machinery, New York, NY, USA. Paper 678, 1-13. DOI: 10.1145/3290605.3300908.

[6] Ferran Altarriba Bertran and Danielle Wilde, 2018, Playing with food: reconfiguring the gastronomic experience through play. *Experiencing Food, Designing Dialogue; Bonacho, R., de Sousa, AP, Viegas, C., Martins, JP, Pires, MJ, Estévão, SV, Eds*: pp. 3-6.

[7] Adrian Bregazzi. 2014. Digital Gastronomy. In Proceedings of the Food & Material Culture: Proceedings of the Oxford Symposium on Food and Cookery 2013, Oxford Symposium.

[8] Mattia Casalegno. *Aerobanquets RMX*. Retrieved June, 2021, from: http://www.mattiacasalegno.net/aerobanquets-rmx/.

[9] Eduardo Castelló Ferrer, Jake Rye, Gordon Brander, Tim Savas, Douglas Chambers, Hildreth England, and Caleb Harper. 2019, Personal Food Computer: A New Device for Controlled-Environment Agriculture. In *Proceedings of the Future Technologies Conference (FTC) 2018,* Cham, Springer International Publishing. 1077-1096. DOI: https://doi.org/10.1007/978-3-030-02683-7_79.

[10] Dominique Chen, Young ah Seong, Hiraku Ogura, Yuto Mitani, Naoto Sekiya, and Kiichi Moriya. 2021, Nukabot: Design of Care for Human-Microbe Relationships. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems (CHI EA '21),* Yokohama, Japan, Association for Computing Machinery, New York, NY, USA. Article 291. DOI: 10.1145/3411763.3451605.

[11] Dominique Chen, Young ah Seong, Hiraku Ogura, Yuto Mitani, Naoto Sekiya, and Kiichi Moriya. 2021, Nukabot: Design of Care for Human-Microbe Relationships. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems,* Yokohama, Japan, Association for Computing Machinery. Article 291. DOI: 10.1145/3411763.3451605.

[12] Yoram Chisik, Patricia Pons, and Javier Jaen, *Gastronomy Meets Ludology: Towards a Definition of What it Means to Play with Your (Digital) Food*. 2018. 155-168.

[13] Jaz Hee-jeong Choi, Marcus Foth, and Greg Hearn, *Eat, cook, grow: Mixing human-computer interactions with human-food interactions*. 2014 MIT Press.

[14] Rob Comber, Jaz Hee-jeong Choi, Jettie Hoonhout, and Kenton O'Hara, 2014, Designing for human–food interaction: An introduction to the special issue on 'food and interaction design'. *International Journal of Human-Computer Studies*, 72(2): pp. 181-184. DOI: https://doi.org/10.1016/j.ijhcs.2013.09.001.

[15] Rob Comber, Jaz Choi, Jettie Hoonhout, and Kenton O'Hara, 2014, Designing for human–food interaction: An introduction to the special issue on 'food and interaction design'. *International Journal of Human-Computer Studies*, 72: pp. 181-184. DOI: 10.1016/j.ijhcs.2013.09.001.

[16] Jialin Deng, Patrick Olivier, and Florian 'Floyd' Mueller. 2021, Design of Cyber Food: Beginning to Understand Food as Computational Artifact. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems,* Yokohama, Japan, Association for Computing Machinery, New York, NY, USA. Article 293. DOI: https://doi.org/10.1145/3411763.3451687.

[17] Jialin Deng, Yan Wang, Carlos Velasco, Ferran Altarriba Bertran, Rob Comber, Marianna Obrist, Katherine Isbister, Charles Spence, and Florian 'Floyd' Mueller. 2021, The Future of Human-Food Interaction. In *In CHI Conference on Human Factors in Computing Systems Extended Abstracts (CHI '21),* Yokohama, Japan, ACM, New York, NY, USA. DOI: https://doi.org/10.1145/3411763.3441312.

[18] Markéta Dolejšová, Danielle Wilde, Ferran Altarriba Bertran, and Hilary Davis. 2020, Disrupting (More-than-) Human-Food Interaction: Experimental Design, Tangibles and Food-Tech Futures. In *Proceedings of the 2020 ACM Designing Interactive Systems Conference (DIS '20),* Eindhoven, Netherlands, Association for Computing Machinery, New York, NY, USA. 993–1004. DOI: https://doi.org/10.1145/3357236.3395437.

[19] Paul Dourish. 2010, HCI and environmental sustainability: the politics of design and the design of politics. In *Proceedings of the 8th ACM Conference on Designing Interactive Systems (DIS '10),* Aarhus, Denmark, Association for Computing Machinery, New York, NY, USA. 1–10. DOI: https://doi.org/10.1145/1858171.1858173.

[20] Rose Etherington. *Living Food by Minsu Kim*. deseen (2013), Retrieved December 2020, from: https://www.dezeen.com/2013/06/27/living-food-minsu-kim-synthetic-biology-royal-college-of-art/.

[21] Laura Forlano, 2016, Decentering the Human in the Design of Collaborative Cities. *Design Issues*, 32: pp. 42-54.

[22] Tom Gayler. 2017, Towards edible interfaces: designing interactions with food. In *Proceedings of the 19th ACM International Conference on Multimodal Interaction (ICMI '17),* Glasgow, UK, Association for Computing Machinery, New York, NY, USA. 623–627. DOI: 10.1145/3136755.3137030.

[23] Fernanda C Godoi, Bhesh R Bhandari, Sangeeta Prakash, and Min Zhang, *Fundamentals of 3D food printing and applications*. 2018 Academic Press.

[24] Andrea Grimes and Richard Harper. 2008, Celebratory technology: new directions for food research in HCI. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '08),* Florence, Italy, Association for Computing Machinery, New York, NY, USA. 467–476. DOI: 10.1145/1357054.1357130.

[25] Rohit Khot, Florian Mueller, and Damon Young, 2019, Human-Food Interaction. *Foundations and Trends® in Human-Computer Interaction*, 12: pp. 238-415. DOI: 10.1561/1100000074.

[26] Christian Østergaard Laursen, Søren Pedersen, Timothy Merritt, and Ole Caprani, 2016, Springer International Publishing, Cham, Robot-Supported Food Experiences. *International Workshop in Cultural Robotics*, vol 9549 pp. 107-130. DOI: 10.1007/978-3-319-42945-8_10.

[27] Zhuying Li, Yan Wang, Stefan Greuter, and Florian "Floyd" Mueller. 2020, Ingestible Sensors as Design Material for Bodily Play. In *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems,* Honolulu, HI, USA, Association for Computing Machinery. 1–8. DOI: 10.1145/3334480.3382975.

[28] Ying-Ju Lin, Parinya Punpongsanon, Xin Wen, Daisuke Iwai, Kosuke Sato, Marianna Obrist, and Stefanie Mueller. 2020, FoodFab: Creating Food Perception Illusions using Food 3D Printing. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, Honolulu, HI, USA, Association for Computing Machinery, New York, NY, USA. 1–13. DOI: 10.1145/3313831.3376421.

[29] Jen Liu, Daragh Byrne, and Laura Devendorf. 2018, Design for Collaborative Survival: An Inquiry into Human-Fungi Relationships. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18),* Montreal QC, Canada, Association for Computing Machinery, New York, NY, USA. Paper 40. DOI: 10.1145/3173574.3173614.

[30] Szu-Yu Liu, Shaowen Bardzell, and Jeffrey Bardzell, Symbiotic Encounters: HCI and Sustainable Agriculture, *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. 2019, Association for Computing Machinery, New York, NY, USA. p. Paper 317. DOI: https://dx.doi.org/10.1145/3290605.3300547.

[31] Dan Maynes-Aminzade. 2005. Edible Bits: Seamless Interfaces between People, Data and Food. *In Proceedings of*.

[32] Homei Miyashita. 2020, Norimaki Synthesizer: Taste Display Using Ion Electrophoresis in Five Gels. In *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems (CHI EA '20),* Honolulu, HI, USA, Association for Computing Machinery, New York, NY, USA. 1–6. DOI: 10.1145/3334480.3382984.

[33] Mako Miyatake, Koya Narumi, Yuji Sekiya, and Yoshihiro Kawahara, Demonstrating Flower Jelly Printer for Parametrically Designed Flower Jelly, *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems*. 2021, Association for Computing Machinery, New York, NY, USA. p. Article 166. DOI: https://dx.doi.org/10.1145/3411763.3451541.

[34] Moran Mizrahi, Amos Golan, Ariel Bezaleli Mizrahi, Rotem Gruber, Alexander Zoonder Lachnise, and Amit Zoran. 2016, Digital Gastronomy: Methods & Recipes for Hybrid Cooking. In *In Proceedings of the 29th Annual Symposium on User Interface Software and Technology (UIST '16),* Tokyo, Japan, Association for Computing Machinery, New York, NY, USA. 541–552. DOI: 10.1145/2984511.2984528.

[35] Evgeny Morozov, *To save everything, click here: The folly of technological solutionism*. 2013 Public Affairs.

[36] Florian Mueller, Khot Rohit Ashok, Dwyer Tim, Goodwin Sarah, Marriott Kim, Jialin Deng, Phan Han D, Jionghao Lin, Kun-Ting Chen, and Yan Wang. 2021, Data as Delight: Eating data. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems (CHI'21),* Yokohama, Japan, ACM, New York, NY, USA. DOI: https://doi.org/10.1145/3411764.3445218.

[37] Florian Mueller, Yan Wang, Zhuying Li, Tuomas Kari, Peter Arnold, Yash Mehta, Jonathan Marquez, and Rohit Khot. 2020. Towards Experiencing Eating as Play. *In Proceedings of the ACM Tangible, Embedded, & Embodied Interaction Conference*

(TEI'20), February 9–12, Sydney, NSW, Australia. ACM, New York, NY, USA. 239-253. DOI: 10.1145/3374920.3374930.

[38] K. Nakano, D. Horita, N. Sakata, K. Kiyokawa, K. Yanai, and T. Narumi. 2019, Enchanting Your Noodles: A Gustatory Manipulation Interface by Using GAN-based Real-time Food-to-Food Translation. In *2019 IEEE Conference on Virtual Reality and 3D User Interfaces (VR),* Osaka, Japan, 2019, 1339-1340. DOI: 10.1109/VR.2019.8798324.

[39] Takuji Narumi, Shinya Nishizaka, Takashi Kajinami, Tomohiro Tanikawa, and Michitaka Hirose. 2011. Augmented reality flavors: gustatory display based on edible marker and cross-modal interaction. *In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Vancouver, BC, Canada.* Association for Computing Machinery. 93–102. DOI: 10.1145/1978942.1978957.

[40] Nimesha Ranasinghe, Thi Ngoc Tram Nguyen, Yan Liangkun, Lien-Ya Lin, David Tolley, and Ellen Yi-Luen Do. 2017, Vocktail: A Virtual Cocktail for Pairing Digital Taste, Smell, and Color Sensations (MM '17). In *Proceedings of the 25th ACM international conference on Multimedia,* Mountain View, California, USA, Association for Computing Machinery, New York, NY, USA. 1139–1147. DOI: 10.1145/3123266.3123440.

[41] Nancy Smith, Shaowen Bardzell, and Jeffrey Bardzell. 2017, Designing for Cohabitation: Naturecultures, Hybrids, and Decentering the Human in Design. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17),* Denver, Colorado, USA, Association for Computing Machinery, New York, NY, USA. 1714–1725. DOI: https://doi.org/10.1145/3025453.3025948.

[42] Charles Spence, Maurizio Mancini, and Gijs Huisman, 2019, Digital Commensality: Eating and Drinking in the Company of Technology. *Frontiers in Psychology*, 10(2252). DOI: 10.3389/fpsyg.2019.02252.

[43] Charles Spence, Marianna Obrist, Carlos Velasco, and Nimesha Ranasinghe, 2017, Digitizing the chemical senses: Possibilities & pitfalls. *International Journal of Human-Computer Studies*, 107: pp. 62-74. DOI: https://doi.org/10.1016/j.ijhcs.2017.06.003.

[44] Ye Tao, Yi-Chin Lee, Haolin Liu, Xiaoxiao Zhang, Jianxun Cui, Catherine Mondoa, Mahnoush Babaei, Jasio Santillan, Guanyun Wang, Danli Luo, Di Liu, Humphrey Yang, Youngwook Do, Lingyun Sun, Wen Wang, Teng Zhang, and Lining Yao, 2021, Morphing pasta and beyond. *Science Advances*, 7(19): pp. eabf4098. DOI: 10.1126/sciadv.abf4098.

[45] Stanley J. Ulijaszek, Neil Mann, and Sarah Elton, Evolution of human diet and eating behaviour, in N. Mann, S. Elton, and S.J. Ulijaszek, *Evolving Human Nutrition: Implications for Public Health.* 2012, Cambridge University Press: Cambridge. p. 117-150. DOI: https://dx.doi.org/10.1017/CBO9781139046794.006.

[46] Carlos Velasco, Anton Nijholt, and Kasun Karunanayaka, *Multisensory Human-Food Interaction.* 2018.

[47] Carlos Velasco and Marianna Obrist, 2021, Multisensory Experiences: A Primer. *Frontiers in Computer Science*, 3(12). DOI: 10.3389/fcomp.2021.614524.

[48] 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, Brighton, United Kingdom.* Association for Computing Machinery, New York, NY, USA. 161–170. DOI: 10.1145/3132272.3134123.

[49] Chi Thanh Vi, Asier Marzo, Gianluca Memoli, Emanuela Maggioni, Damien Ablart, Martin Yeomans, and Marianna Obrist, 2020, LeviSense: A platform for the multisensory integration in levitating food and insights into its effect on flavour perception. *International Journal of Human-Computer Studies*, 139: pp. 102428. DOI: https://doi.org/10.1016/j.ijhcs.2020.102428.

[50] Wen Wang, Lining Yao, Teng Zhang, Chin-Yi Cheng, Daniel Levine, and Hiroshi Ishii. 2017. Transformative appetite: shape-changing food transforms from 2D to 3D by water interaction through cooking. *In Proceedings of the the 2017 CHI Conference on Human Factors in Computing Systems,* 6123-6132. DOI: 10.1145/3025453.3026019.

[51] 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,* San Jose, California, USA, Association for Computing Machinery. 409–422. DOI: 10.1145/2851581.2892570.

[52] M. Wiberg, The Materiality of Interaction: Notes on the Materials of Interaction Design. 2018 MIT Press.

[53] Mikael Wiberg, 2014, Methodology for materiality: interaction design research through a material lens. *Personal and Ubiquitous Computing*, 18(3): pp. 625-636. DOI: 10.1007/s00779-013-0686-7.

[54] Humphrey Yang, Danli Luo, Kuanren Qian, and Lining Yao, Freeform Fabrication of Fluidic Edible Materials, *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems.* 2021, Association for Computing Machinery, New York, NY, USA. p. Article 620. DOI: https://dx.doi.org/10.1145/3411764.3445097.

[55] A. Zoran, 2019, Cooking With Computers: The Vision of Digital Gastronomy [Point of View]. *Proceedings of the IEEE*, 107(8): pp. 1467-1473. DOI: 10.1109/JPROC.2019.2925262.