# No Pie in the (Digital) Sky: Co-Imagining the Food Metaverse

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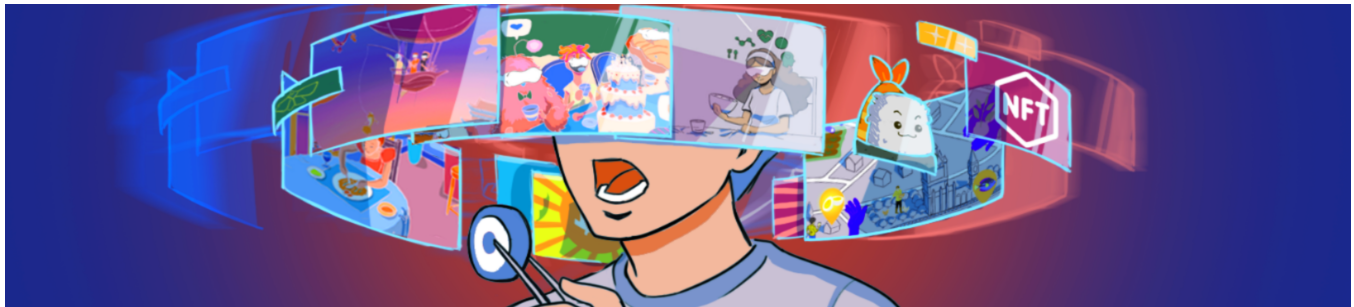
**Figure 1: How can we shape our relationship with food in the metaverse in a meaningful way?**

## ABSTRACT

Human behaviour and habits co-evolve with technology, and the metaverse is poised to become a key player in reshaping how we live our everyday life. Given the importance of food in our daily lives, we ask: how will our relationships with food be transformed by the metaverse, and what are the promises and pitfalls of this technology? To answer this, we propose a co-design study that reveals the *important elements* people value in their daily interactions with food. We then present a speculative catalogue of novel metaverse food experiences, and insights from discussing these ideas with food designers, anthropologists and metaverse experts. Our work aims to provide designers with inspirations for building a metaverse that: provides inclusive opportunities for the future of food; helps re-discover the forgotten or lost knowledge about food; facilitates the exploration, excitement and joy of eating; and reinvigorates the ways that food can soothe and heal.

## CCS CONCEPTS

• **Human-centered computing** → **Participatory design**.

## KEYWORDS

metaverse, food, human food technology interaction, speculative design, co-design

## 1 INTRODUCTION

Recently, interest in the idea of metaverse has leapt. However, the metaverse is not totally a new concept. Following the previous three major technological innovation waves (i.e., the introduction of personal computers, internet and mobile devices), the metaverse bridges the connectivity of social media with the unique affordances

of existent spatial immersive technologies [49] such as Virtual, Augmented and eXtended Reality (VR/AR/XR) and promises to develop as an *interconnected, shared and limitless persistent world* where our physical and digital lives converge. Although still fuzzy, this perspective seems to fit our continuously evolving habits, which outgrow the bounds of the internet as it was first created. People are now used to customising avatars or virtual homes, to foster virtual relationships, to meet friends in virtual spaces or to collaborate in holographic work meetings. The increasing appeal of replicating physical daily habits into the virtual realm is supported by data reported by the Wunderman Thomson agency [73], which indicates that 74% of people consider that metaverse is the future and 1 in 2 respondents see it as a part of their daily life. While the virtualisation of certain daily activities (e.g., employment and work, entertainment, retail) is easier to foresee, more *sensory* and *intimate* habits – such as eating – appear at first glance to have little in common with the digital realms.

However, this apparently unlikely pairing seems to go together like chocolate and chilli for food-brands and restaurants, who are all making moves within the metaverse, establishing a presence on platforms such as Roblox, Fortnite or Horizon Worlds [14, 26, 35, 56], ready to capitalise on the idea that eating is more than gustatory delight – it is, at heart, a social activity. Their approach is to build virtual versions of their physical restaurants, where users represented by avatars play, and earn benefits, unlock premium access or consumer loyalty in physical locations. In imagining and experimenting with food in the metaverse, we observe that most existent solutions are carving out space to recreate virtual eateries as gathering places for avatars, replicating what is already existent in social media. **The first steps into the food metaverse neglect the complex social and cultural systems in which food is embedded – they are fast and careless, just like *fast food*.** The risks associated with these approaches and with the massive adoption of these technologies cannot be underestimated – they could exacerbate existing issues in our relationship with our bodies and with the food. This could have an impact on further detaching us from our food lives, in a context where the acceleration in our lifestyles and in globalisation (in both geographical and digital sense) is already alienating us from food and damaging our relationship with our food practices – bodily, socially, culturally, and environmentally [27, 33, 66]. The metaverse could add to these problems by increasing the disconnect from the real world, impacting body dysmorphia or exacerbating eating disorders, to name just a few. **Now**, that the metaverse is at a nascent stage, **an opportunity emerges to understand and rethink how technologies could intervene in our food lives, and to get people together to reflect on and imagine if and how our experiences with food can be meaningfully translated or enhanced in the metaverse**.

Here, we focus on the potential positive aspects of the metaverse and we start a process (that should remain ongoing), where we do not design for communities, but **we co-produce with them our future digitised experiences with food**. We claim that by following principles of collaboration, shared ownership, and an iterative process of action and reflection, we, designers can build a humane and human-centric (food) metaverse that can lead to a (more) positive food future where we can go beyond consumption, by learning to value food and by engaging with it in more mindful,

joyful, exploratory and sustainable ways. In this paper, we start mapping this type of metaverse by capturing the different important aspects of the relationship between people and food – the inherent things they value and that bring joy in their day-to-day food lives. We then take participants in a speculative co-design exploration of the potential of the metaverse to elevate, enrich and help us reclaim and reconnect with our food practices.

Our research questions are:

**RQ1:** What are the elements people find important in their day-to-day food related experiences?
**RQ2:** How can we shape our relationship with food in the metaverse in a meaningful way?
**RQ3:** What are the potentials and challenges in building a food metaverse?

Our contribution is three-fold: First, we provide a list of **elements people value in their day-to-day food related experience** (Section 4.1). Our second contribution is an annotated portfolio (Section 4.2) in the form of a catalogue of speculative design concepts, covering food-related experiences in the metaverse. **The concepts featured in the catalogue build on, embody, and instantiate the aforementioned *elements* and have as starting point ideas imagined by users as meaningful and desirable technological interventions in their food lives**. Finally, our third contribution is the learnings from discussing our catalogue of speculative ideas with food anthropologists, food designers and immersive technologies experts (Section 5). The insights from those conversations allow us to indicate potential directions for developing **a food metaverse, which is sensitive to people's nutritional, social, emotional, and cultural needs**. Overall, we believe our work provides both inspiration and guidance to designers to explore new food metaverse ideas, taking inspiration from the interaction between people, food and environment.

## 2 BACKGROUND

### 2.1 Food and us

Eating is 'fundamental, fun, frightening and far-reaching', as stated by [57], this quote encapsulating the breadth of influence food has on us. These influences are recurrent, sometimes unpredictable and always – although often neglected – about intimacy. When we eat, the outside world is internalised and with that, comes the adage 'we eat what we are' [55] – culturally, emotionally, politically and environmentally. Our relationship with food is ancient and continues to form extremes from conflict and hunger to identity and satisfaction [37]. Eating – this thrice daily intimate happening – is more than introducing food in our bodies. From a very young age, we learn to associate food with soothing and we understand that sharing food can be a way to show empathy for other's distress [30]. Eating serves important social functions by providing a means for identity construction, a context for social engagement, and a shared experience for strengthening social ties [60]. Eating with others in a group, commensality, is fundamental to social bonding through the collective sensory experience of how we transform ingredients into meals and how meals transform us [25].

However, the reign of convenience in our globally interconnected lives has shifted how we prioritise our time and effort – and with

that convenience, commodification and consumption have overtaken production. Food has become abundant for the rich[1], lying attractively at our disposal, for us just to pick it from the shelf or to have it home delivered. We put it in our wheeled trolley or we click an online button, without having harvested or grown anything. These practices are convenient, but at the same time, they make us lose touch with food and grow distant to our food practices [21]. Detaching ourselves from our food lives brings about a whole set of issues, at different scales. For example, it damages: (1) *the environment*, as we are less and less aware about the origin and ecological impact of the foods we consume [66]; (2) *our bodies*, as we pay less and less attention to how we nourish it [33]; (3) *our social relationships*, as we no longer have time to cherish the social dimension of dining; (4) *our culture*, as we forget about countless food-related traditions and rituals that have been key to our society for centuries [27]. Far from addressing those issues, technological innovation is sometimes contributing to these ailments. More and more, we see new gadgets and services that cook for us, order our food based on our preferences, or distract and entertain us while eating. While on occasion those technologies can be useful, they also come with side effects [11, 40, 45] – they are smart and efficient, but do not make us feel more connected to, or appreciative of food. Thus they damage different aspects of the relationship we have with our food practices.

## 2.2 Human-Food-Technology interaction

Humans, food and technology are at the centre of the Human-Food-Interaction (HFI) research field, which presents an ongoing interesting challenge to the HCI community, attending to a broad range of disciplinary interests and concerns such as the pervasive nature of food, the socio-cultural differences in food practices, and the global foodscape situated in a continuous state of flux [28]. Gaining visibility in the CHI 2012 workshop on Food and Interaction Design [18], HFI proposes a dynamic and heterogeneous design space characterised by a dominance of *techno-solutionist* [46] approaches, as found in an excellent systematic mapping study of HFI research proposed by Altarriba Bertran et al. [5]. According to Altarriba Bertran et al. [5], contributions in this field are mostly focused on optimising, speeding up, fixing or making our interactions with food more efficient, while the social, playful and cultural aspects of our food practices are less researched. For instance, some of the directions Grimes and Harper [29] identified and recommended for future work on designing technologies in the area of HFI were rarely explored – e.g., using celebratory technology for applications that put focus beyond the individual such as for supporting social bonding around food [3, 6, 20, 24]. As pointed out by Comber et al. [19], social practices around food could also be looked at from the lens of collectivism and community. However, the way in which technology can enable collective action and advocacy – although important – was rarely investigated [10, 32].

Not only the change of focus from functionality to experience requires more exploration, the interplay between humans and technology when dealing with food is also under-researched. On the

spectrum between automating our relationship with food – through intelligent technology, with a high degree of autonomy from humans (e.g., [51, 74]) – and empowering people to conduct food-related practices themselves [54]), it is important to look into the different ways in which technology can enhance user agency, particularly in less investigated food practices such as *sourcing, producing* and *tracking* as outlined in [5]. By engaging individuals in critical reflection and action on a variety of food practices along the food system – ranging from production and transport to purchasing, preparation and consumption – we could create new design spaces for promoting an "environmentally aware, socially inclusive, and healthier behaviour" [16].

## 2.3 Into the (food) metaverse

Some of the open challenges and opportunities of HFI (as outlined above, in Section 2.2), can be justified by the fact that existent HFI solutions work in isolation, usually involving only one platform, which could limit user's agency, the focus of the experience, and the domain of intervention (i.e., the food practice addressed). The metaverse can change this by enabling the creation of an interconnected and limitless world where our digital and physical lives fully converge. A platform agnostic spatial web based on the blockchain technology, the metaverse promises to bake the virtual into the fabric of reality and create a social place where users represented by avatars can meet new people, strengthen existing relationships, and build new communities. Among its key features we note here that the metaverse is *interoperable* (not tied to a specific platform), *reactive* (people will be able to engage and interact in real time in virtual worlds), *persistent* (a place that continues to exist whether people are online or offline), *user-defined* (owned and shaped by people), decentralised (ownership is distributed), and *everyday* (seamlessly woven into daily activities) [73]. Ready to capitalise on its potential, companies are already starting to dip their toes in the metaverse, by developing applications which cover many of the day-to-day aspects of life, such as real estates, work, entertainment, gaming, shopping, travel, health or marketing [8, 15, 36, 65]. However, no daily activity has a greater impact on us and our society than our interactions with food: how we grow, gather, prepare, consume and share food. Although people are not able to eat or drink digitally, restaurant and food brands have started to experiment with the idea of experiencing food in virtual worlds. The first steps in this space are made (ironically, but also not surprisingly) by fast-food restaurants such as McDonalds, Wendy's or Chippotle and are focused on encouraging consumption and marketing, not on (re)connecting us with and through food. The metaverse will transform things further, as it will go one step above our real and our social media lives, extending them into the virtual realm and augmenting our abilities. This poses the risk of transforming us in tourists of our own reality. We thus see **a need to rethink how technology impacts our food lives** and intervene from day one in **designing a metaverse that should not push us further away, but help us reshape our relationship with food**. Given the importance of food in our lives, we argue that there is a need for a different type of intervention – where we enable people to act as *food citizens*, to reclaim the importance of food in their lives beyond pure survival, to be more mindful and more invested in all their food practices,

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[1]We note here that in this paper we focus on saturated markets that are not determined by deprivation or social norms, where individuals represent a viewpoint of privilege, and could have the freedom and comfort to imagine food alternatives beyond being nutritionally essential.

and to find joy in leading food lives that are sustainable, healthy, and socio-culturally rich.

As a concept the metaverse has existed since the early 1990s, however it has gained traction in recent years, further accelerated by the rapid technological advancements resulting from the COVID-19 pandemic. This was made possible due to the fast development and exponential popularity of cutting-edge technologies, namely Artificial Intelligence, Blockchain, Augmented and Virtual Reality, digital twins and the Internet of things. Nowadays, the Metaverse is slowly also becoming a part of consumers' daily habits, with many companies (big or small) starting to exploit its potential by developing applications covering many aspects of life, such as real estate, work, entertainment, gaming, shopping, travel, health or marketing [8, 15, 36, 65].

Since interest in the Metaverse is leaving no industry untouched, food companies are also starting to get involved. At the moment, metaverse food-related initiatives are dominated by restaurants and fast food chains tapping into play-to-earn, an emerging engagement model in this space. For example, Wendy's built a virtual location (Wendyverse) in Facebook's Horizon Worlds where people can eat virtual food and play minigames with a real world tie-in too - food offers, and Coca-Cola sponsored the first Indian wedding to take place in the metaverse where guests left with Coca-Cola discounts and gift cards to use in the physical world. Other ventures include Chipotle's Roblox virtual burritos, the first NFT restaurant called Flyfish and Miller Lite's metaverse bar. Nevertheless, the main driver for current food brands dipping their toes into the virtual realm is marketing; metaverse provides a way of earning in-universe rewards, and further interweaving those rewards with existing loyalty programs for physical products or services.

Existing ventures are mainly business-centred and commercial in nature, hence they do not always connect users with food practices that are important to their lives. Even in OneRare, which is considered the first food metaverse (foodverse), most of the activity and interactions are virtual or marketing-oriented, therefore there is a lack of meaningful connections established with and through food for the users themselves. Since the development of the metaverse is still in its early stages, there is a need to suitably design the human side of it before the technology rapidly develops and further promotes consumerism. Food experiences (because of their characteristics) are a very good point to start with.

## 3 METHOD

### 3.1 Our aim

With this study, we explore what and how different activities in our food lives can be designed and reshaped using metaverse technologies and how this might transform the relationship between humans and food. For this, we take inspiration from other work proposing bottom-up speculative inquiries, which involve people in the design process (e.g., playful urban technology [4], playful HFI [6], or privacy futures [72], etc). In this project, we followed a co-design research approach [47], where we included – as creative partners in our design process – participants representing diverse demographics. Designing for food related experiences in the metaverse is a multidimensional and complex problem consisting of technological, social, psychological, behavioural, cultural and

economic aspects. Thus, the purpose of our co-design engagement was **to: (1) tap into the individual knowledge**, to discover their unique perspectives; (2) **facilitate the emergence of a collective, multidimensional perspective** through collaboration between possible users in framing problems and exploring solutions and, (3) **arrive at design ideas or solutions, which when implemented, may be accepted more readily by the end users** as they were based on collective needs and desires.

### 3.2 Methodology in a nutshell

Our approach consisted of several phases (illustrated in Figure 2). We began with the aim of identifying the things people value in their daily interactions with food. For that, **in Phase 1, we conducted six co-design workshops** (two online and four face-to-face), where we **explored what people find desirable or undesirable in their daily eating experiences**, to identify a set of recurrent elements with inspirational value for designing metaverse food experiences. **In Phase 2, these activities surfaced a list 18 *elements* (clustered in four wider areas) of people's food lives** (Section 4.1) – i.e., *we call these elements important as they refer to the things people identified as valuable in their everyday food interactions, and we consider that in today's 'always on' society, these interactions could be mediated in a way or another by technology.* **These elements were clustered in four wider areas and used together with a set of 85 half-baked ideas imagined by participants** for **identifying five desirable design directions for metaverse food interventions**, in Phase 3. **Each design direction was then illustrated through two design ideas in our catalogue** based on observations of the enactments and the ideas proposed by participants themselves (Section 4.2) meant to inspire the embedding of metaverse technologies into our daily food practices. We then **used the catalogue of ideas as a provocative conversation prompt**: we did eight online interviews, where we invited food designers, food culture researchers, food business owners, and people working in the metaverse development to identify the critical lenses and perspectives that we are missing and the different views on the potentials and dangers posed by the metaverse to our food lives. We incorporate the main insights of these conversations in Section 5 as advice for designers with an interest in building a meaningful human-centric (food) metaverse that can help us all to become (more) conscious consumers.

### 3.3 Methodology in detail

Our approach consisted of several phases (illustrated in Figure 2. The study protocol was approved by the Faculty of Sciences Research Ethics Advisory Group of the University running the study (ref: CREAG051-03-22).

*3.3.1 Phase 1 - Co-design workshops.* Through this initial phase, we aimed to: (*A1*) gain an explicit, trustworthy understanding about people's current experiences with food; (*A2*) identify gaps and opportunities that might emerge when introducing metaverse technologies to food practices; (*A3*) get people to imagine desirable interventions of the metaverse in their daily food lives.

**Participants.** We recruited participants for the co-design workshops via Instagram and Facebook social media platforms and university mailing lists, with announcements inviting to co-create
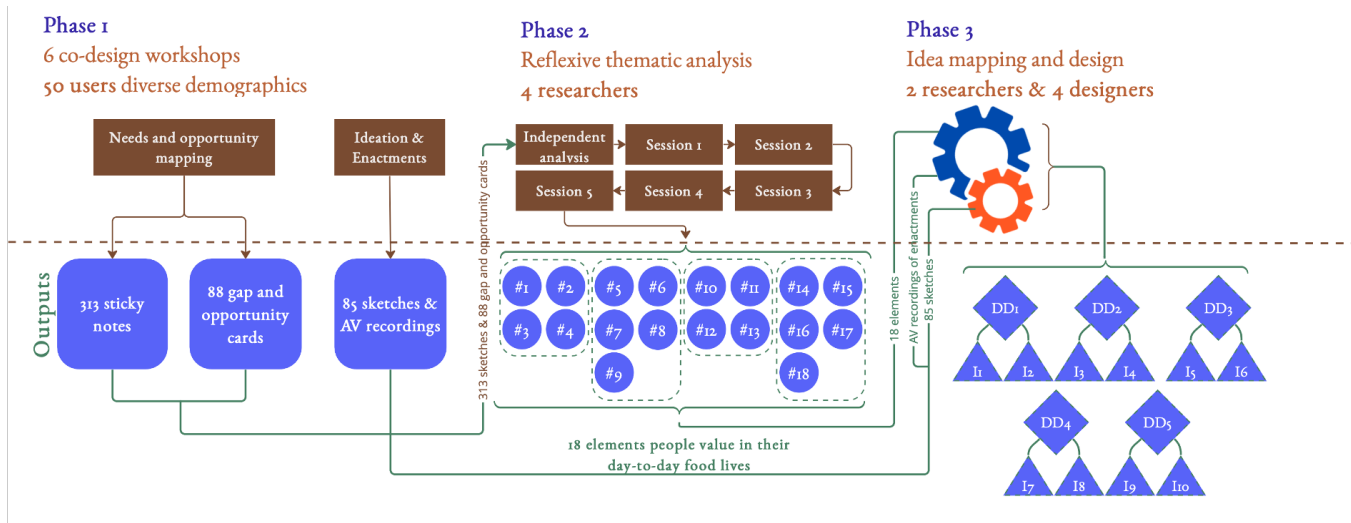
**Figure 2: To generate the catalogue of ideas for eating in the metaverse we went through three phases: in Phase 1 we gathered data through co-design workshops; in Phase 2 we analysed the data and identified 18 elements people value in their daily food lives; in Phase 3 we used these elements and the ideas produced by participants to propose five design directions for this space and we illustrated each direction through two ideas.**

"exciting, meaningful, fun, mouthwatering eating experiences for the metaverse". A total of **50 participants** of diverse demographics, backgrounds and household configurations attended our workshops. These were 33 female and 17 male, aged 18-24 (32%); 25-34 (52%); 35-44 (6%); 45-54 (2%); 54-74 (8%). They represented six countries from Europe (42% –with 28% from the UK; 4% from France and Spain and 2% from Italy, Cyprus and Portugal); four countries from the Middle East (38% – with 26% from Bahrain; 6% from Jordan, 4% from Iran and 2% from Algeria); five countries from Asia (12% – with 4% from Hong Kong; and 2% from Russia, South Korea, Taiwan and Bangladesh); one country from Africa (6% from Zimbabwe) and one country from North America (2% from Canada). 46% of our participants were living with their family, 26% with housemates, 12% with a partner and 16% were living alone. All participants had previous experience with metaverse technologies such as blockchain, artificial intelligence, AR and VR, robotics and sensors, with 24% using VR more than once a week. All participants signed informed consent forms before taking part in the workshops.

It is important to note here that despite the diverse demographics we tried to engage with, our participants were adults embedded in western contexts with reasonable access to, and familiarity with, digital technologies, part of so-called affluent societies, that are not determined by deprivation, but where abundance motivates individuals to explore. Therefore, the ideas and concerns that have emerged from the workshops are a reflection of their socio-economic privileges. At the same time, we acknowledge that these are the people more likely to have access to and be willing to explore the (food) metaverse first.

**Sessions and data collected.** We carried out **six co-design workshops** (two online and four face-to-face) consisting of **four**

**activities** focused on our aims, as described in Table 1. All activities were followed by reflective discussion which was audiovideo recorded[2].

*3.3.2 Phase 2 - Thematic analysis.* Data collected during co-design workshops (see Table 1) was transcribed and gathered on Miro and analysed through an inductive reflexive thematic analysis process [12, 13]. Four researchers started by reading and re-reading the entire dataset to become intimately familiar with the data and identify relevant information for our research questions. Next, each researcher undertook an independent coding process, working systematically through the entire dataset and identifying preliminary codes. The resulting codes (which were both semantic and latent) were further refined and redefined in later iterations of coding, during two sessions of two hours, where all the four researchers were present, discussing and reflecting on their codes. After all the relevant data was coded, we shifted towards the interpretation of the aggregated meaning of our dataset. This happened over three two hour sessions, where the four researchers involved in the reflexive thematic analysis process, produced: **a list of 18 food-related elements clustered in four areas, based on similar underlying features**, which reflect the salient features emerging when thinking about food, as indicated by participants in our co-design workshops, but also the perspective shift brought by technology. These range from participants' desire to build a culinary collectivity beyond commensality to an interest in getting engaged in playful activities or enhancing their food literacy. We present all these themes and sub-themes in detail in Subsection 4.1.

*3.3.3 Phase 3 - Idea mapping and design.* Next, two researchers **examined the collection of 85 half-baked ideas produced by**

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[2]The ideation cards used in the co-design sessions were designed based on cards from https://sadiemaystudio.com//

| Activities | **Icebreaker** participants got familiar with each other and got into the mindframe of thinking about food and eating through playful activities. | **Need and opportunity mapping** participants wrote down the desirable and undesirable elements of their food experiences in various setups – at home, at work, in a restaurant – and identified opportunities for technological intervention | **Ideation** and sketching participants generated and sketched ideas exploring the use of metaverse technologies for food related activities and experiences. | **Enactments** participants used props and performances to elicit more details around their ideas and the interactions which could occur. |
|---|---|---|---|---|
| Data collected | – | **313 sticky notes** participants used to describe their likes, dislikes and wishes of their daily eating experiences and **88 gap and opportunity cards** where they identified desirable uses of technology in a food context. Used in **Phase 2**. | **85 sketches** illustrating participants' ideal eating experiences in the metaverse. Used in **Phase 3**. | **Audiovisual recordings of the enactments**. Used in **Phase 3**. |
| Aims addressed | – | *(A1)* and *(A2)* | *(A3)* | *(A3)* |

**Table 1: Co-design workshops: activities, data collected, aims addressed**

| ID | Profession | Nationality | Age range | Gender |
|---|---|---|---|---|
| E1 | PhD fellow in sensory and consumer science | Nicaraguan | 25-34 | M |
| E2 | Architect and PhD candidate in multiscalar food systems | Peru | 25-34 | F |
| E3 | Digital product designer for the Metaverse / Entrepreneur | American | 25-34 | M |
| E4 | Chef / Restaurant owner / Metaverse technology entrepreneur | Emirati / British | 45-54 | M |
| E5 | Expert in thinking for innovation and service design | British | 35-44 | M |
| E6 | Professor in multisensory experience design | Colombian | 35-44 | M |
| E7 | Food and eating designer | Dutch | 35-44 | F |
| E8 | Public food anthropologist, consultant and writer | French | 55-64 | F |

**Table 2: Experts interviewed to reflect on our catalogue of ideas. None of these experts were part of previous phases.**

**our participants** as part of workshop activities (see Table 1) and **the audiovisual recordings of the enactments**, to identify the types of interaction participants envisage around the dinner table and their behaviour in imagining that context. We then **mapped these ideas and notes about participants' interaction to the 18 elements discovered in Phase 2** to validate that **our list is exhaustive**. Then, together with four designers, **they examined the collection of early ideas produced by participants to identify recurrent themes and settled on five design directions** that (1) they found interesting and (2) represented all the participants' ideas. Next, **to explore the inspirational value of our approach**, four designers produced **two ideas illustrating each design direction** in four two hour-long sessions. **We made sure that the final collection represented the breadth of our research and all participants' ideas** by keeping track of how each concept evolved in relation to the *elements* we uncovered in our study and the related literature. The 10 resulting speculative food metaverse concepts were finally mocked up into a *catalogue of speculative food-centred ideas for the metaverse*. These were presented in the form of an annotated portfolio [43], highlighting desirable technology-mediated food experiences for the metaverse. Our speculative approach does not mean that our ideas are far-fetched, rather, using a similar approach to [4, 39, 42], we used speculation to bring some light on the features of the metaverse, which is still a fuzzy concept, not

yet a commonplace part in people's imaginary. The original catalogue can be found here[3]. We detail the design directions and the corresponding ideas in Subsection 4.2.

*3.3.4 Interviews with experts.* We used **the catalogue as a conversation prompt for interviews with the experts** presented in Table 2, with the aim of gathering their insights into the potentials and pitfalls of the metaverse in our food lives (RQ3), as well as to further understand the implications and limitations of our work. The interviews lasted between 30 - 45 minutes – the catalogue and the list of questions were sent to the interviewees one week prior. We recorded the interviews on audio and made transcripts, which were analysed by a team of three researchers. We incorporate the main insights of these conversations in Section 5, as advice for designers with an interest in building a meaningful human-centric (food) metaverse that can help us all to become (more) conscious consumers.

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[3]https://bit.ly/metafoodcatalog

# 4 RESULTS

## 4.1 Result 1 - A list of food-related elements for designing the food metaverse

With our analysis, we aimed to answer (RQ1) and (RQ2) by: (1) synthesising our findings into a list of elements – which emerged as salient for participants – that is manageable and actionable and can be used as starting point for ideation; (2) focusing on the findings that were more inspirational to orient designers towards those forms of digitally enhanced eating. With this in mind, we generated 18 *important elements* and clustered them by affinity in the themes described below.

*4.1.1 Connecting with others over food.* Part of the data collected from participants in our study points to the individuals' fundamental need to belong [9]. When writing about their wants and needs around mealtimes, they often mentioned seeking love and community through food, this being reflective of a sense of social connectedness [68] around the dinner table. Under this theme, we identified four *important elements*, which we present in Table 3. These can inspire features of metaverse-based applications aimed at single-person households, families living apart, migrants which seek to connect with their new country, or people looking for a partner.

*4.1.2 Connecting with the self.* Our relationship with food is increasingly unbalanced. With one in two Europeans obese[4] and millions suffering from anorexia and bulimia, participants in our study sought to improve the quality of their (food) lives and talked about technology that could enable them to engage entirely, and involve all their senses in choosing, preparing and enjoying their food. Under this theme, we identified elements #5 - #9 (see Table 3), which are focused on the desire for an inner experience of food. These present an inspirational value for experiences which can foster the improvement of our relationship with food by bringing change from the inside [70].

*4.1.3 Getting our food systems right.* The global food situation is facing unprecedented challenges tied to fragile food systems that degrade the environment and undermine public health [66]. Meeting the problem posed by our food future through production alone is not enough, as other alternatives that focus on reducing demand for food by changing our diets, reducing food waste and loss should be explored. However, this is difficult to achieve, as people are growing increasingly distant to their food practices [21]. Elements #10 - #13 (Table 3) point to participants' desire for experiences centred around different aspects of food literacy. By considering them, designers can enable us to re-gain our connection with the environment and our bodies, to cherish the social dimension of eating and to engage in the countless food-related traditions and rituals [64, 66].

*4.1.4 Comfort and indulgence.* Although research suggests play can be an influential factor in the eating experience, playing or other activities that distract us from the act of eating are considered a taboo [67]. Participants in our study mentioned that they often perceive day-to-day food-related experiences as monotonous and

boring, expressing an intense desire for change and variety. Engaging in cooking, playful activities or other distractions may prove to be therapeutic. The meditative qualities of a trance-like state can nurture peaceful detachedness that enables calmness around food. Elements #14-#18 (Table 4) aim to provide inspiration to designers about how to embed comfort into everyday food activities.

*4.1.5 On the 18 important elements of our food lives.* Previous work proposes taxonomies of food practices, eating experiences or food consumption behaviour[19, 28, 62] based on contextual inquiries or on previous related work. However, the factors of these taxonomies are often too broad to be directly actionable by designers interested in building food-related experiences, or too focused on specific food practices (e.g., eating, shopping), thus not offering a complete picture of different opportunities for intervention. The 18 *elements* we identified are supported by the generic determinants of the taxonomy of food consumption behaviour proposed in [62]. Moreover, they enrich the previous work through their practical value – they offer insightful and actionable information about users that could be easily considered by food-related experience designers. Additionally, our list of elements could be used to explore the integration and interactions of determinants from several different categories.

## 4.2 Result 2: Five design directions and a catalogue of metaverse food-centred ideas to illustrate them

Following the methodology described in Subsection 3.3.3, we identified five design directions. Below we show how these design directions were supported by participants' sketches and how the two ideas we designed to exemplify them: (1) are rooted into participants' half-baked ideas; (2) incorporate at least one of the 18 elements identified in Phase 2. We summarise this information in Figure 3.

*4.2.1 DD1: Mee(a)ting - hybridised spaces of food and togetherness.* Our first design direction focuses on the social and communicative significance of activities around food and it is **motivated by the social dimension displayed by the majority of our participants' ideas**. As illustrated by our participants' ideas, food was often seen as a social act that can strengthen ties, a universal language that connects us beyond borders and cultures, fostering positive emotions. Through their half-baked design ideas, participants imagined the metaverse could **connect them with their loved ones who are not in the same space** by: (1) supporting conversations while eating in a possible (i.e., on the beach) or impossible (i.e., under the water, on the moon) immersive space ; (2) enabling them to attend remotely family events or celebrations; (3) engaging them in playful activities around their meals (i.e., compete by controlling the speed of virtual race horses with the speed of chewing); **facilitate breaking bread with strangers** by creating the context where: (1) food is the starting point of the conversation; (2) conversations are supported and enhanced by the system; (3) knowledge is exchanged; (4) they can open up while remaining anonymous; (5) they can co-create eating experiences matching their interests; (6) they can interact with different generations. **DD1** proposes to leverage the community connecting abilities of the metaverse for

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[4]https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Overweight_and_obesity_-_BMI_statistics

| Important element | Example quotes from participants | Designers could think about how to use metaverse technologies to... |
|---|---|---|
| **#1 Culinary collectivity beyond commensality** People seek to share with others, food-centred moments beyond eating. | *"It can be very enjoyable to share food with my family"*; *"I like cooking or grilling with my special friends".* | afford distanced social experiences that cover our different interactions with food - from farming to gathering, cooking and eating. |
| **#2 Searching 'my' food community** Being part of collectives or food communities gives us a sense of identity and belonging. | *"(I like) Meeting foodies, getting together to make, eat, and rate food"*; *"(I wish) I could reflect my enthusiasm of food to more people".* | create gathering spaces that incorporate both physical and virtual elements and that connect the virtual and the (local) real world food communities. |
| **#3 Stimulating mealtime conversations** Conversations around the dinner table are highly valued by people, who see technological advancements as a potential for enhancement. | *"Having a wonderful conversation during a lovely meal"*; *"I would be interested in a topic generator over my meals".* | enhance mealtime conversations by engaging with many of the modalities people utilise such as speaking, physical interactions, emotion, speed of chewing. |
| **#4 Seeking surprise encounters over supper** Mealtimes are good contexts for gaining insights into the life ways and worldviews of others. | *"I like being around random people"*; *"Sharing eating experiences with strangers should be normalised".* | facilitate social bonding with strangers through social eating. |
| **#5 Celebrating being alone** Solitude around meals appeared to be sometimes preferred, not enforced to our participants | *"I don't like to invite people. I love having my own space"*; *"Having a vanishing button - make everyone disappear"* | enhance the user experience of solo diners during the food preparation and consumption processes. |
| **#6 Engaging in mindful eating habits** Eating and cooking are seen as a mindfulness exercises people want to practice. | *"Eating is my getaway trip"*; *"I spend more time cooking healthier"* | afford a mindful experience by creating worlds where people can exercise their minds and senses. |
| **#7 Making and breaking habits** Technology is an enabler for improving eating habits and reinforcing new eating patterns. | *"Eating healthier food by manipulating the visuals"*; *"Change the taste through the colour or sound"* | provide support for people who have a conflicted relationship with food through the stimulation of other senses. |
| **#8 Food memories represent a sense** Food is a trigger for re-living memories through all our senses. | *"Recording all the good memories and tastes in a particular meal and be able to re-live it."*; *"Documenting food moments"* | afford new forms of food-centred narratives for preserving, remembering and recreating our food lives. |
| **#9 Pay attention to your senses** Sensorial attunement around the dinner table is important. | *"I would like to control the music and lighting"*; *"I would like a smell or flavour changer"* | make people excited and attuned with their food and eating environment by stimulating all senses. |
| **#10 From farm to fork: getting involved in the food system** There is something exciting about learning the stories behind our meals. | *"Journey to see how the vegetables were planted and cooked"*; *"Quest for food: interactive recipes. Can be fun, mysterious, gamified."* | transform contemporary human-soil affections by telling stories that encourage love for soil and for the people who produce our food. |
| **#11 Food choices with an eye on sustainability** People look for products that can help them live a more sustainable, socially responsible life. | *"(I would like) to use more veggie than meat"*; *"I don't like wasting food"* | help people assess the environmental sustainability of the foods they buy. |
| **#12 Searching for food literacy** People want proficiency in food related skills and knowledge. | *"Teach you about food in a fun way (reward system)"*; *"Learning about how certain foods affect my body"* | empower people with knowledge, attitudes and skills about food. |
| **#13 The cultural significance around food** The heritage and rituals that surround food should be kept alive | *"Keep the heritage alive: how people used to eat, what, how, where?"*; *"loss of culture and rituals that surround food"* | allow people to create repositories for preserving food heritage, but also tools to build new food culture. |

Table 3: *Important* elements emerged from Phase 2, clustered under the *Connecting with others over food, Connecting with the self*, and *Getting our food system right* areas

the next generation digital commensality [61] and collectivity platform, fostering more authentic and immersive social experiences around food.

**To illustrate this design direction**, we propose two ideas which **combine and refine a set of ideas produced by our participants**. *Knock-knock* (see Figure 4a) is a XR application where users can create new digital spatialities and socialities around the idea of homes as public-private spaces. Homes are not seen here

as fixed territorial places, but as "transitory, multisited and open ended" [34]. In *Knock-knock*, users can create virtual homes or transform their physical homes and re-scale them seamlessly from private sites into public arenas, where strangers and friends are invited. These spaces can be built around the guests who partake in the food related experiences, so that they enable performative acts, active participation and forge relationships. *Light up* (Figure 4b is a social Augmented Virtuality eating experience allowing users to

| Important element | Example quotes from participants | Designers could think about how to use metaverse technologies to... |
|---|---|---|
| **#14 The comfort of home** People want occasionally to avoid the hustle and relax in their familiar surroundings | *"The comfort of my own home"; "The feeling of comfort and the options I have at home to prepare my own food"* | transform people's kitchens - allow people to connect with others from the comfort of their home. |
| **#15 Variety is the spice of life** People enjoy change and variety around their meals. | *"We literally just eat to live. We need experiences, entertainment.."; "I don't like the routine of eating experiences..even the restaurants are the same."* | provide variation (in both food and environment) around our daily interactions with food, in all contexts. |
| **#16 Embracing constructive distractions** Being detached while eating is not necessarily a bad thing | *"I enjoy watching films while eating"; "Immersive ASMR where we can interact with the food"* | allow people to relax, while still paying attention to both hunger and eating. |
| **#17 Please, \*do\* play with your food** People enjoy engaging in playful activities while eating | *"Create a food character to go on an adventure.."; "introduce taste to gaming to enhance the connection between players."* | allow people to become more than passive observers – for instance they can have exploratory roles or interact with food as a diegetic component. |
| **#18 The magic of cooking** Learning, experimentation and performing while cooking is fun. | *"Smart annotations for cooking"; "Cooking with celebrities (i.e., virtual Jamie Oliver)"* | enable the practice of cooking skills, experimenting with ingredients, co-creating recipes or perform from their kitchens. |

**Table 4: *Important* elements emerged from Phase 2, clustered under the *Comfort and indulgence* area**



**Important elements**

| Design directions | Ideas | #1 Culinary collectivity beyond commensality | #2 Searching 'my' food community | #3 Stimulating mealtime conversations | #4 Seeking surprise encounters over supper | #5 Celebrating being alone | #6 Engaging in mindful eating habits | #7 Making and breaking habits | #8 Food memories represent a sense | #9 Pay attention to your senses | #10 From farm to fork: getting involved in the food system | #11 Food choices with an eye on sustainability | #12 Searching for food literacy | #13 The cultural significance that surrounds food | #14 The comfort of home | #15 Variety is the spice of life | #16 Embracing constructive distractions | #17 Please, *do* play with your food | #18 The magic of cooking |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DD1: Mee(a)ing – hybridised spaces of food and togetherness** | Light up | | | x | x | | | | | | | | | x | | x | x | x | |
| | Knock-knock | x | | x | x | | | | x | | | | | x | x | x | | x | |
| **DD2: Meet food – challenging conversational mainstream food systems** | ingredientGO | x | x | | | | x | | | | x | x | | | x | | | x | |
| | The hands that feed us | | x | | | | | | | | x | x | x | x | | | | | |
| **DD3: Re-imagining the aesthetic of eating practices** | The im:possible food | x | x | | | | | | | x | | | | | | x | | | |
| | Food repository | | | | | | x | x | x | x | | | | x | | | x | | |
| **DD4: Community is a (food) journey** | Hot air balloon | x | | x | x | | | | | x | x | | x | x | x | x | | x | x |
| | Kitchen collective | x | x | | | | | | | x | | | x | x | | | | | x |
| **DD5: Escapism dining – metaverse as an escape parachute from reality** | Microdosing | x | | | | x | x | x | | x | | x | | | | | | x | |
| | Homestaurant | | | | x | x | | | | | | | | | x | x | x | | |

**Figure 3: Summary of ideas (and underlying design directions) included in our catalogue, linked to the *important* elements they respond to. In highlighted cells, we show the primary predominant important elements under each idea. Cells with x which are not highlighted indicate that those elements are also considered but they are secondary.**

join a dark virtual space where everything they see are the meals of all the people present in the same virtual space (this would be possible through a system like [50]). Thus, the food becomes the starting point of a conversation and a possible connection that is further supported by an intelligent system, which reacts and brings the environment to life based on the interaction, interests, physiological signals or discussion between the users.

*4.2.2 DD2: Meet food - challenging conventional mainstream food systems.* **Several ideas proposed by participants** in our study reflected a desire **to challenge the alienating consumer-producer relationship and to experience food beyond consumption**. People imagined scenarios where they **connect, cooperate and engage in an adventurous co-production alongside those working in the agri-food sector**. They were ready to (1) go on a quest for the ingredients of their meals, (2) help the hunter, farmer and chef to gather ingredients and cook a meal in a virtual reality setup,

(a) With *Knock-knock* users create virtual kitchens as public-private spaces for connection.



(b) *Light up* - an XR social application where the conversation and connection are triggered by food.

**Figure 4: Mockups of "DD1. Mee(a)ting - hybridised spaces of food and togetherness"**



(a) With *ingredientGO* urban communities co-design, co-produce, and connect in liminal spaces facilitated by the metaverse



(b) *The hands that feed us* - an immersive application that allows consumers to connect and collaborate with food producers

**Figure 5: Mockups of "DD2. Meet food - challenging conventional mainstream food systems".**

(3) find out about the origin and the producers of what they eat, (4) become a virtual chef helper in the kitchen of different restaurants across the globe, (5) select digital ingredients from digital twin markets and experience their adventure from farm to fork. Two participants saw value in **exploring the issues of the agrifood sector** responsible for their meal (i.e., child labour, gender inequality, exploited migrants, poverty). These serve as inspiration for **DD2**, which points to the **necessity of using metaverse technologies for establishing new forms of agency within the food chain**, which could be rooted in collaboration and foster solidarity. The blockchain, digital twining solutions and immersive technologies could be used to enhance food traceability, provide consumers with a story of the adventures their meal had along the way or allow them to connect and co-produce with producers by

configuring from home the mode of production, the size, flavor, and temperament of vegetables that will be delivered to them.

**To exemplify how designers could build on this design direction**, we propose two ideas with slightly different flavours. *ingredientGO* (Figure 5a) imagines a community-driven solution for food sovereignty, where consumers and producers are co-designing and co-participating in spaces around urban agriculture. With gamification at its core, *ingredientGO* empowers the entire community to take charge of the food dimensions of their cities. Making use of liminal spaces - which employ XR technology to transform physical spaces for blended activities, built equally around digital and physical elements - people are able to co-configure their cities according to their food needs, culture and resources. This will cover several aspects such as production (e.g., vertical farms, aquaponic systems,

**(a)** *The im:possible food* - a VR application that allows anyone to create and co-create new types of food and eating experiences.
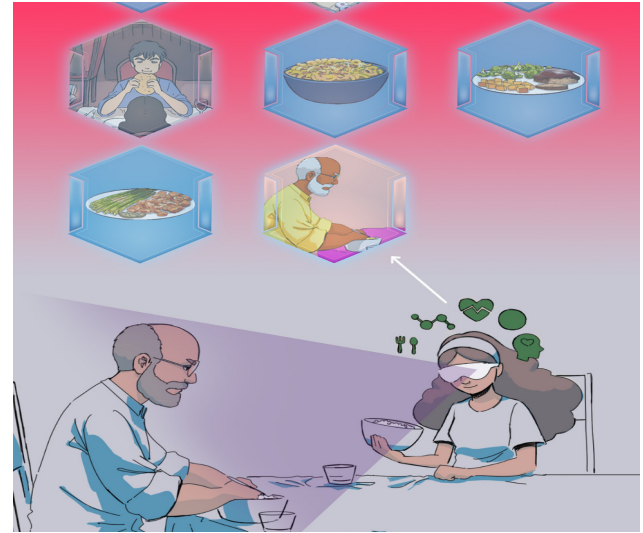


**(b)** With *Food repository* users can document, deposit and re-live their food memories.

**Figure 6: Mockups of "Re-imagining the aesthetic of eating practices"**

vertical mushroom production, urban gardens, damp cellars), collection (e.g., farmers' market, pick up points, exchange stations, drone delivery), but also education (e.g., farming, sustainability practices, nutrition), social life and leisure (e.g., community kitchens and gardens), which are important for connection. These spaces can gradually expand and adapt over time based on the community's evolving needs and activities. The second idea, ***The hands that feed us*** (Figure 5b) is a multisensory XR application, where consumers can visualise, experience and interact with the journey and the stories related to their meal. People can see, hear, smell the atmosphere of the production facilities, meet and connect with the producers, talk to them and get insights into their work through tours, demonstrations, sessions of digital farming or participation in the preparation and cooking process. These interactions can also enable consumers to become co-producers by influencing the mode of production and creating greater value for other consumers.

*4.2.3 DD3: Re-imagining the aesthetic of eating practices.* **Many of the half-baked ideas produced by participants in our study revolved around leveraging digitalisation for transforming our aesthetic experiences around food**. Through these ideas, participants seemed to perceive food replete with symbolic content, similar to fine art [2] - for example they imagined ingredients assembled in unexpected shapes and constructions; they correlated food with emotions or with expressions of care such as "soothing" and "comforting"; they talked about sensory remembrance, catching and keeping the intensity of past experiences as triggered through their taste sensation. More specifically, their ideas involved **changing the food's appearance**: (1) via voice or emotion control; (2) create imaginary characters from food as company during meals; (3) manipulate food's colour or shape; (4) synchronise the look of the food with the environment; **involving all the senses**: (1)

transform any food in a *comforting food from home* through magical spices or smells; (2) share a multisensory (temperature, smell, sound, touch) eating experience with someone who is not in the same space; (3) boost the taste of food and the eating experience to suit and support their mental and emotional; **supporting creative practices**: (1) experiment with digital simulation of taste – users can develop, send, exchange, and download different flavours; (2) attend immersive autonomous sensory meridian response (ASMR) Mukbang and cooking shows; (3) imagine new types of food - for instance edible clothes; **saving, reliving, extracting data and emotions from food moments**: (1) store and reproduce favourite tastes; (2) store food related memories and emotions associated with them; (3) recreate and relieve the bodily experience of food memories; (4) leaving a legacy of food memories; (5) preserve the past through food communion; (6) understand how food eaten over a longer period impacts the body. **DD3 refers to building features for a user-defined metaverse, which is owned and shaped by its users**. Users should be empowered with tools to actively create and engage with content, rather than passively consuming it. This should cover the sensory, emotional, performative, communicative, and temporal aspects of eating experiences.

We exemplify this design direction through two ideas. *The im:possible food* is a multisensory XR design tool that involves the eating human in the process of creating and bringing to life aesthetic food experiences which have at the core the sensorial system. With *the im:possible food*, users are given the power to (co)-create the food experiences of the future and to take interactivity to a greater inner level of sensorimotor immersion (see Figure 6a). Users have limitless options - they can manipulate shapes, colors, environments or can unlock new dimensions that go beyond physical limitation (e.g., no gravity, smoke, light, etc.). This will allow people to become more than passive consumers, but creative agents who can (digitally) craft aesthetic food centred experiences that at the same time can bring

(a) *Hot air balloon* takes remote users on a virtual culinary journey of ingredients, recipes and rituals.

(b) *Kitchen collective* is an AR app that connects you with the local community.

Figure 7: Mockups of "DD4. Community is a (food) journey"

alternatives, enhance our connection with and appreciation of food and enable radical thought in a world where food is dominated by economy. The second idea, *Food repository* (Figure 6b) branches from the concept of *food selfies* – a dominant form of representation of food in social and digital visual media, perceived by users as an engaging experience, which helps them sustain their interests and keeps a record of what they eat [17]. We link *Food repository* with the fact the metaverse could store large amounts of data about everything. We combine this with reflexes we all have already acquired in the digital age, to build up a bank of everything we have ever eaten. Users can choose what aspects (i.e., the metadata) of their meal to save in their metaverse food space (e.g., is it a recipe, the food, its taste, the surrounding elements, who they are eating with, how they were feeling, the nutritional information, their body's physiological response to the food, etc.). Then, whenever they do not know what to cook, want to understand how the food eaten over a period of time impacted their health or performance, or want to relive in an immersive setup certain food-related memories, they can travel through their food repository. This solution could be used to tackle health problems, strengthen cultural identities, experience joy and a feeling of belonging [48].

*4.2.4 DD4: Community is a (food) journey.* **Interest in discovering new cultures, people, and places was often embedded in the ideas produced by participants in our workshops.** They imagined metaverse applications that would enable them to be co-located with people from different cultures in matching virtual environments, where they can **connect with, share and learn from, the global community**: (1) go on a journey to find out how raw ingredients (e.g., fish) are cooked in other cultures; (2) learn from other cultures how to prepare different dishes (e.g., sushi); (3) share their local dishes and recipes with someone abroad; (4) practice tea rituals; (5) being introduced to uncommon dishes from all over the world; **connect with, learn from and support, local communities**: (1) invite immigrants to talk and exchange recipes; (2) eat with residents in local care homes; (3) co-cooking with locals and participating in immersive cooking shows. This shows **participants perceived metaverse technologies around food as enablers of rich cultural experiences, which connect across**

**cultures and generations. DD4** proposes to leverage immersive technologies to take people on journeys of discovery which empower them to learn from others and better understand the world. By integrating food within the metaverse, we can ease the understanding of different societal groups in their historic cultural context, and develop our social empathy [59] abilities, which is essential for our individual and collective well-being [22].

**To demonstrate how this design direction could be implemented**, we present two ideas. *Hot air balloon* (Figure 7a) is a social VR application that enables users to connect with the global community in an act of discovery of the world through their food. With this application, remote people will be able to connect over meals and embark together on a culinary journey. During this adventure, they can get involved in different traditions, play, learn about tools, recipes or legends by interacting with the environment and with the others. The journey can be based on participants' meals (i.e., as illustrated in Figure 7a) that can be prepared by them or delivered by cloud kitchen services across the globe. The second idea, *Kitchen collective*, looks into connecting local communities, by creating a space of care through collective cookery (Figure 7b). Via AR technology, users can connect while cooking from their own kitchens and become part of *culinary* support system. This can lead to strengthening community bonds through recipe exchange or co-creation, storytelling, performance, by challenging each other or swapping ingredients via drones. Boundaries of public and private become thus blurred and merge into new hybrid typologies. Sharing a (digital) space where food is involved might encourage people to retake an 'earthly rhythm' of food consumption, while amplifying a sense of empathy.

*4.2.5 DD5: Escapism dining – the metaverse as an escape parachute from reality.* **Escaping the immediate reality** – both spatially and temporally – w**as one of the possibilities that animated our participants when imagining ideas for the food metaverse**. They manifested interest in becoming part of larger things and **accessing inaccessible places** like: (1) famous venues (e.g., the Colosseum); (2) expensive restaurants (e.g., the French Laundry); (3) the space or underwater; **time travelling**: (1) eat with people who have died; (2) attend amazing royal banquets (e.g., organised by

**(a)** *Homestaurant* **brings the buzz of any virtual or physical restaurant in users' home.**



**(b)** *Microdosing* **is a multisensory VR app for those moments when you want to disconnect from others and connect with food.**

**Figure 8: Mockups of "DD5. Escapism dining – the metaverse as an escape parachute from reality"**

Henry VIII); **becoming part of something iconic**: (1) a painting; (2) a movie (e.g., Roman Holiday, Alice in Wonderland). However, participants were also focused on their inner selves and perceived the metaverse as an opportunity to **isolate themselves from the stress of the everyday life** and: (1) enter an isolation bubble; (2) relax in multisensory environments; (3) become more mindful about food; (4) avoid situations that can cause social anxiety by customising the elements they allow in they meals. These inform **DD5**, through which **we propose designers to create microdoses of escapism from the dullness and the stress of our daily lives that allow individuals to recharge**. These bite-sized solutions for people to exercise their minds could be experienced during a launch break or instead of watching a show in the evening and should allow users be in the centre of attention or just disappear and be incognito.

To exemplify this design direction, we propose two ideas and we illustrate them in Figure 8. *Homestaurant* is a XR application, which enables users to access – from the comfort of their own homes – the buzz of any restaurant (Figure 8a). Via digital twins technology, these virtual dinners are combined with physical spaces (i.e., real life restaurant venues), offering both virtual and physical diners a personalised social, immersive and interactive experience. Everyone can choose their appearance and the degree of interaction with the others - they can observe, engage in conversation or become part of an artwork. *Microdosing* (Figure 8b) is a multisensory VR application which allows people to isolate and relax during their lunch break. The system detects what the user is eating and displays visual, audio and smell information that are harmonised with the taste (following crossmodal correspondences principles [38, 63]). This experience invites the user to reset and savour the food and the moment.

## 5 DISCUSSION, REFLECTION, CONCLUSION

We want to clarify here that we see technology (and the metaverse) as a tool. Using an analogy – a hammer is a tool, it can help build or destroy. It is not the hammer who decides its function. Similarly, we think that human-centric design can make technologies behind the metaverse build a better connection with food, rather than destroying what we currently have. With this paper, we look into this positive future that could enable new ways for people to feel connected to food again, to appreciate it and to want to make their diets more sustainable and this is what we are trying to show in this paper. For this, we use co-design methods to co-imagine with our participants how to shape our relationship with food in the metaverse. We start by taking as creative partners in this process, people from all walks of life, who identified a set of 18 *important elements* – aspects they value in their daily food practices (RQ1) and imagined possible desirable metaverse interventions. Their ideas were further refined by us in a catalogue of speculative ideas (RQ2), used as a conversation prompt with experts (see Subsection 3.3.4 for details on this) to gather their insights into the potentials and pitfalls of the metaverse in our food lives (RQ3), as well as to further understand the implications and limitations of our work. By involving a broad range of participants in our research, we wanted to further explore the value of our early, speculative ideas and their underlying design qualities. Through this process, we could get a rich understanding of what both average citizens and experts in different relevant domains think about the transformations the metaverse will bring in our lives and what are the emerging opportunities for designing a meaningful (food) metaverse. However, we acknowledge that there are several risks to watch out in this space, thus we also discuss concerns, which were supported by our conversations with experts.

## 5.1 Food is physical, the metaverse is digital, rich storytelling could bridge these worlds. Or should it?

Food is pleasure, visually yes, but also multisensorially and so, it is soothing and heals because our bodies and minds can feel nurtured. So how can we translate this into a metaverse where we are not able to eat or drink digitally? Or should we? *"I think that the key challenge that many people are trying to address is how do we integrate those other senses that are difficult to integrate? Because to be honest, I personally don't buy digital taste or smell, you know, just controlling the sense of taste or smell with something that is based on current. I think it's going to be quite challenging unless you go to human brain interfaces, I guess (E6)."* The perspective of digitising our eating experiences seemed problematic for some of the experts we interviewed, as this might disconnect us further from food, accentuating problems described in Section 2.1: *"I feel that at the end, eating requires the body. And the body requires the land. I don't feel that the metaverse will be the answer to the question of eating in a holistic way. Indeed, it can be linked to the social aspects and the knowledge aspects, but eating is nutritional and nurturing and nurturing comes from a connection to nature to land, to things that are not virtual. And if we forget that, we're kind of missing the question (E2)."*

Historically and culturally there are some interesting differences in sensory approaches – for Aristotle, touch was the primary sense and taste was perceived as a form of touch, whereas Plato ignored the sense of taste and only considered temperature. Farrell [23] looks into the *virtual lifeworld* of Instagram food imagery and proposes that sound and vision have a major role in the co-construction of the sensorial methods of our 'eating bodies': "it's weird how sometimes we associate food with sound (E4)". *"You think that you do not have your senses in the metaverse, but you are the one experiencing the metaverse. And you do have your senses. So I think when you aim for really convincing storytelling, and when you really, help people to activate their imagination, when you are seeing a good movie, and in the cinema, you do cry when something happens, right? I mean, I cry all the time. And so we are capable of experiencing things only when they are meaningful. And so **we can experience flavour without actually eating when we see something so convincing that it actually brings us this feeling (E7).** Seeing* is more than looking, as we only truly see when our socially constructed eating sensory memory and cultured taste buds are at work [23]. Our memory and the multimodal work of the senses can give "understanding, appreciation and emotional pleasure to the visual representations of food" that is not dependent on taste stimulation [23, 58, 71] and this can only be enhanced with rich storytelling. The metaverse can offer a chance for re-minding us what analogue reality is, because it is about how the mind can be stimulated to remember and connect, to feel affinity with the gift of the everyday, the natural, the uncelebrated, perhaps the neglected.

## 5.2 But food is also not physical and this is what the metaverse can expand on

*"Food itself, the eating experience is physical. But on the other hand, food is also not physical. Because if you would look at the political part of food, for example, like who owns what and who has sovereignty,* *like maybe an algorithm can also be the owner of food instead of human beings. And I think if you see food as more than only the eating experience, then I think you can really create very interesting things with the metaverse that you wouldn't be able to create in real life. It is good to kind of make this distinction – is it really about the eating experience? I think the metaverse could be much more interesting when it comes to looking at more  political, cultural, social aspects of eating instead of the physical experience (E7)."* The opportunity to look at food in a broader way, beyond eating experiences, was emphasised by all experts we interviewed, who saw the metaverse as an accessible and responsive place that holds the promise of democracy and the welcome for digital food activism. *"I don't think that the metaverse holds the governing answer to change, but a creative and inclusive opportunity for the future of food (E8)."*; *"And that is the power of the metaverse – that you can actually connect and give also the person, or the groups, or the communities that are invisible in these systems, a chance to be visible to have a voice, to represent themselves and not be represented by XYZ chef that cooks with the their knowledge but doesn't acknowledge them. So I think that could be super interesting (E2)."*

As an answer to people's increasing desire to move beyond consuming food, metaverse technologies can be thus leveraged to challenge the traditional binary view where producers and consumers are situated at opposite (somewhat disconnected) ends of a value chain. In the food context, the distributed ledger and immersive technologies can create relationships and develop a web of trust and accountability between all involved actors in the food system, which is important in supporting its sustainability [53]: "*It has the ability to bring consumers closer to both their enjoyment but also bring them closer to the action, see what they're doing and how we can improve, and also for sustainability reasons (E1)."* The metaverse could provide ways for people to o regain a sense of closeness to the environment, the products we are eating, as well as to all those who produce and process them: *"I would love to be able to really speak to someone as well, to really know like, how was it to produce this, not just knowing where something comes from. Knowing that doesn't really get me involved, I really need to emotionally feel involved and I think speaking with someone could do that (E7)."*

A good place to start experimenting with this approach are cities (as illustrated in ingredientGO), which usually act as epicentres of food trends. Following recent initiatives, which counteract the increased globalisation and anonymisation of food by amping up the volume on local food, community gardens and urban agriculture [7], the metaverse could increase citizens' participation in the design of their urban agriculture spaces [32] or in the various phases of their food journey, where they can decide how to act based on their needs, culture or resource availability (for instance, they could use digital twins to configure from home the mode of production, the size, flavor, or temperament of vegetables; or they can get hands-on farm training in immersive spaces). *"You can also make a shift in power, you can be involved in a way so that financially you become a part owner of a local farm and also feel more involved with that and then de-centralise power perhaps (E7)."* According to Adams [2], by considering the otherwise overlooked intrinsic value of local food, we can enable people to become more socially and environmentally responsible. In doing so, the metaverse will not only contribute to

the transformation of the food systems, but can foster the social and communicative significance of eating and enjoying.

## 5.3 Take users on a journey and give them agency!

*"A big thing with the metaverse I find, is that things come across as a gimmick. So how do you add real substance to this? What you want to make sure is that there's a real compelling hook to whatever you're building (E3)?"* Gimmicks are a specifically capitalist aesthetic phenomenon, eliciting both charm and suspicion [52]. To avoid them, experts talked extensively about expanding the utilitarian value of the food experiences we are considering. *"I mean, again, things that either have a real journey or a spectacle, that's, you know, gives you a different perspective on things. Or also, if it's actually practical. You know, that recipe creator finder .. you can actually create a recipe and then save it or send it to yourself (E3)."* Value could be added by **giving the users the agency to re-calibrate forgotten or lost knowledge, to reinvigorate the ways in which food soothes and heals, to discover, preserve and create new cultures.** However, this does not mean *magic* becomes less important: *"But if you offer them something unique, something that you wouldn't otherwise be able to try.. that's going to be the catch, you know, so I would say this is where the possibility of creating experiences that go beyond our physical worlds are beyond our, or beyond our imagination (E6)"*

The act of exploration, of discovery of knowledge, culture or of others is made possible via immersive technologies – the metaverse can take us anywhere imagination and memory chooses – we can travel in space and time to discover what our ancestors ate, and open up understanding of why they ate certain things and not others. An exploration of food past, present and future widens food vocabulary, taste perception and stimulates a realisation that context matters. Concepts like *Hot air balloon*, *Kitchen collective* and *Meet food* (to some extent) appeared to animate the people we interviewed, who engaged with the idea of becoming part of hyperlinked journeys, and learning in the process: *"I want to go deep into the ingredients, [..] getting to know them, and then having the opportunity or kind of more guidance on how to use them (E1)."* ; *"Can this journey (i.e., Hot air balloon) take us somewhere deeper? Can I keep going down a wiki rabbit hole: what is the origin of this recipe, what are the related things (E3)."* In the metaverse, distances travelled could look at how, when food is explored, the outside world enters inside – ultimately our discoveries fundamentally change us for ever. Just like the very first exploratory taste of a ripe sweet apricot, we cannot unmake its impact.

## 5.4 The downside of the metaverse

There's also a downside to the metaverse and we need to consider numerous challenges as we move into a more immersive world, as they threaten privacy, security, mental health, and more [31, 65, 69]. These concerns could be fundamentally distinct from those associated with other technologies and can alter a user's perceptions and interactions with the analogue world [41]. We highlight here several challenges that were brought forward by our experts. **People losing their connection with the real world and becoming attached to their virtual world** was flagged as a key concern for the metaverse [41, 44, 65]. *"That's the part that is a bit problematic –*

*we become tourists of our own reality"* (E2). Additionally, the filters and features provided by these immersive platforms could have an opposite effect to what we are trying to achieve with this study, disconnecting further the user from their meal *"Do we distance ourselves from our food when we use certain kinds of filters?"* (E7); *"And then to there's a question of personalisation as in everything. The more you start personalising your experiences and enhancing them to the maximum, there's a question of, when will that lead us as a society? Are we going to essentially [...] become addicted to the goods. And are we not going to find join in other things?"* (E5). Exciting opportunities and unique experiences could be afforded by the metaverse as discussed above, however the **overexposure to virtual content might diminish the value and appreciation of real-world experiences**? *"People get bored, you know, you always see people skipping, skipping, skipping through their songs. I wonder how it is going to play here if you have access to almost any experience that you want?"* (E6). This can lead to **technology dependency and addiction** *"I can also see how addictive and powerful this can be as a tool, just by looking at how powerful the simple screen is right now in social media and how it affects your global life. So the biggest concern is the unethical usage of these technologies and the potential that they have"* (E5). Spending hours and days in a virtual world without being physically active or engaging in social activities can lead to **social anxiety, eating disorders, increased feelings of loneliness, and other psychological effects** [8, 31]. Moreover, the **information overload** that comes with the technology integrated in all our daily activities can exhaust and demoralise us *"I do have concerns about information overload and commercialisation"* (E5).

Data collection and sharing with other parties has wide implications in regards to **privacy**, as highlighted by experts: *"Today, there are things about me that not everybody has. The minute when everything becomes digital – the control of it, is gone."* (E4). Considering the additional data layer brought by the metaverse, cybersecurity presents a significant threat [41]. Thus, it is essential to determine **who is responsible for data security**, who will protect it from cyber attacks, and what happens in the event of a data violation incident [1, 69]. However, managing and controlling virtual content is more complex and challenging in the metaverse due to the vague line of boundaries between the analogue and the virtual world [1, 69]. *"Ethical aspects in who manages the data might become a concern"* (E1).

**Cybersickness** is yet another problem which might affect one in two VR users, making these solutions uncomfortable and unusable *"What is the best technology to be used in these scenarios? How do you eat with a headset on? How to design these avatars and visuals without losing the connection and the engagement of seeing the real portion of the food and the hand gestures of your co-diners? Hearing somebody chew into a mic..basically, it's like a nightmare."* (E3). This points to the need of conducting various design investigations in this space, which go beyond paper prototypes, looking into how people perceive these technologies and how they can or cannot be integrated in various food-related activities.

## 5.5 Conclusion

In this paper, we took a generative approach, where we focused on the positives of the metaverse – negating physical distances, providing immersive experiences, catalyst for creativity and inspiration, etc. – to discover new opportunities and indicate possible directions in this space. Our findings point to elements and design directions, which we hope, could provoke designers to create humane solutions for the (food) metaverse. We see value in sharing this work now, when the metaverse is still nascent. However, we also discuss some of the risks associated with the massive adoption of these technologies, which cannot be underestimated. Various issues could range from an exacerbated misperception of one's body to an increase of an already rampant phenomenon of social withdrawal. There is therefore a need for further investigations into the opportunities and risks of the metaverse in light of the individual differences, considering cognitive, affective and social purposes and the specific aim people pursue in virtual worlds.

## ACKNOWLEDGMENTS

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