Reconnecting with Food Through Dining Play

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ABSTRACT

While the food production and processing are known to cause major environmental pollution, we as consumers have little awareness of the underlying processes that bring food from farm to plate. This lack of awareness influences our food related decisions and we end up following non-sustainable food practices. To create awareness on food related issues, we present two playful dining experiences: (1) *Caesar on a Skewer* that presents the hidden data about water consumption levels for different foods through a Caesar salad, and (2) *Chopstick Parfait* that visualizes the hidden data related to the food distribution channels through the Parfait dessert. We simulated the dining environment to evaluate these dining experiences. We present findings related to both dining play interactions and edible visualizations. To guide future technological development around food related issues, we discuss the implications of our work around three themes: food arrangement, playful discomforts and delayed feedback. Through this work, we aim to advocate and inspire the use of food for designing multisensorial serious play.

CONCEPTS

• Human-centered computing → Interaction design

KEYWORDS

Human-Food Interaction (HFI), Commensality, Food Play, Data Edibilization

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1 INTRODUCTION

Food preparation and consumption are some of the widely practiced activities in the lives of human being, yet these rudimentary activities have become increasingly complex in the current era of globalization. From our grandparents' era of eating mostly seasonal and locally produced food to the current era of eating imported food - the way we eat and what we eat have changed with time [90].

With the increase in global migration as well as growing population, there is an increasing demand for native and non-native foods all year around. The food distribution channels as a result, have now expanded from farms to cities and across continents to meet up with the demands. These distribution channels involve heavy expenditure of fossil fuels not only for transportation but also for preservation in cold storage, resulting in a significant carbon footprint [24]. Besides, there is an additional burden on agricultural practices requiring heavy water consumption to meet the demands of growing non-seasonal fruits and vegetables [39]. The water footprint of food production is although not new to the agricultural industry, but this issue remains mostly hidden from consumers [54,75]. As an example, 1 kilogram of beef uses a total of 15,455 liters of water, which includes the resources used to raise cattle in farms and power the processing units and slaughterhouses along with some other unseen consumption of water before it is served as a perfect steak in a dinner plate [64]. Saddest part of all is that many of such food items that cause significant carbon and water footprint do not even reach the supermarket and diners' plate. According to the Food and Agriculture Organization of the United Nation (FAO) report, one-third of food loss and food waste happens during its distribution [29].

It is about time we rethink our food consumption practices [81] and nurture a stronger affinity towards food sources, right from its movement from farm to plate and from plate to garbage bins [41]. According to the Future of Urban Consumption Prediction report [1], food insecurity is one of the prime concerns globally. On the other hand, Lancet report [67] details how our food consumption practices have a heavy impact on human health contributing to increase in obesity, type 2 diabetes, and other auto-immune diseases as well as the environmental impact in terms of pollution and climatic instability. The link between our food and the climate is undeniable in not just how our food system is put to test in this state of climate change, but also how our food consumption practices have led global food systems to a point of crisis [60].

All these issues, though extremely critical, have not yet caught the eyes of the general population. The journey of a food item from farm to plate is largely hidden from them [54,75]. Though we have food labels as a way to identify locally produced food from imported food [69], consumers find it hard to understand the

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amount of natural resources such as water, fuel, energy etc. that go into the production and distribution of these foods [37,77]. Campaigning, infographics and other visual communication methods [1,30,62,64,82] can be used to create mass awareness towards these issues. However, such methods can easily be overlooked, and consumers may find them difficult to interpret and to incorporate them in their everyday decision-making process [22,91]. For example, most people cannot easily make the connection between their own eating and its ecological footprint [59].

This paper explores an inventive playful approach to create awareness for two significant issues: water consumption levels and distribution channels involved in the food to be eaten. We present two commensal play experiences that can be played at the dining table. The first play experience is *Caesar on a Skewer*, where the ingredients of a Caesar salad are arranged on a skewer based on their water consumption levels. By arranging the least water consuming ingredient at the top to the most water consuming ingredient at the bottom of a skewer, the design allows participants to reflect and question the inconvenience caused. The second play experience is *Chopstick Parfait,* where the different food ingredients of the Parfait dessert are rearranged to mimic the food supply distribution channel from farm to plate. Participants compete to be the first in distributing all ingredients to every member of the team and through this act of play they experience the chaos that occurs during food distribution.

We report the design and study of these two play experiences. These play experiences are unique in a way that they present data about food through food itself, i.e., we use edible yet playful methods of visualizing data. Additionally, these experiences do not require any additional hardware, which is not typically a part of a dining experience. The pilot studies of these experiences reveal how edible modes of visualization brought awareness to underlying issues and how play contributed an engaging dining experience. Drawing on the study insights, we discuss the implications of our work around three themes: *food arrangement, playful discomforts* and *delayed feedback*.

This work contributes to the growing literature on Human Food Interaction within the CHIPLAY community [4,9,11,14,18,19,52,76,87] by presenting how edible methods of visualizations can be used to offer a playful yet educational experience of dining. We respond to Altarriba Bertran et al.'s [10] suggestion of designing and creating human-food interactions that work at the social level rather than at the individual level. Our work, however goes beyond the experiential social dining and provokes an implicit nudge towards complex issues such as hidden data behind the food we eat. Through this work, we also illustrate that in order to create meaningful dining play experiences, it is not necessary to bring interactive technology on the dining plate but rather the food and the existing dining setting can be repurposed and enriched with play to facilitate change. Ultimately, through this work, we aim to advocate and inspire the use of food for designing multisensorial serious play.

2 BACKGROUND & RELATED WORK

Within academia, there has been an increased interest around food ecological issues [15,16,18,38], commonly discussed under the broad topic of sustainable HCI. Existing works include field studies on this topic such as the one by Clear and team [17], who studied university students' food preparation activity and its relation to the greenhouse gas emissions and direct energy connected to the food and cooking. Technologies like RFID [3] and blockchain [56] have also been explored to trace the food back to its sources [66].

The main focus within HCI however, has been on developing 'eco feedback' technologies [31]. These technologies increase awareness by automatically sensing peoples' activities and feeding related information back through computerized means, to foster positive attitudes towards sustainability. For instance, Kalnikaite and colleagues [48] created a clip-on display for shopping carts that show information about the scanned products' origin (food miles, or how many miles has the item traveled to arrive at the supermarket) and whether the product is organic or not. Ecofriends [70] is a social media app that provides different information about a food product such as season, origin and popularity pattern throughout the year. GreenScanner is a smartphone application that allows shoppers to take a picture of an item's barcode and displays community generated information about its environmental impact [84]. FoodWatch is another online application that allows users to track their food flows from the purchase, to consumption, and waste [36]. The *Food Planner* system suggests alternative daily meals and offers direct environmental feedback for the household to negotiate food values [47]. Reitsma and colleagues [74] explored different modes of carbon footprint feedback and translated those into a network of objects such as jewelry, sole and clothing to enable a better understanding of such complex data. Finally, Lofstrom and Pettersen created three types of eco visualizations featuring a morally concerned teddy bear that cries when bad choices are made [57].

The digital and print media today also make use of interesting and innovative data visualization methods to educate and increase consumer awareness about food related issues such as hidden water consumption and carbon footprints. For example, SourceMap [80] is a system that promotes geospatial context awareness for food safety and minimizing food miles. The system produces carbon footprint receipts, showing total carbon footprint and carbon footprints of various stages of transport for constituent product elements. The Water We Eat [64] is an interesting interactive website that makes use of motion graphics to communicate data about water consumption to consumers. Similarly, Arup's report [1] illustrates the future of urban consumption using engaging illustrations and visual storytelling designs. Carbon.to is a web service by Zapica and colleagues [91] that presents carbon footprints of different everyday products and services to improve consumer understanding of carbon emissions. Footprint [30], on the other hand, is a browser plugin that describes carbondioxide footprint of recipes – one's own or taken from recipe sites. The aim behind this project is to offer customers

a clear and tangible overview about the effects their groceries have with the hope that it might prompt them to search and buy more climate-friendly options. There also exist online calculators such as footprint calculator [24] that let people calculate their overall footprint through self-reporting.

Not all works have looked at developing feedback technologies, some works also focused on infrastructural development. For example, the development of Civic Food Networks as an alternative infrastructure [72] to subvert and challenge the corporate food system is one promising step in this direction. However, most of these works and prior sustainability initiatives are primarily digital platforms and use engaging methods of visual communication to raise awareness. Although these methods of data visualization are useful in raising awareness, their overall impact on consumers and their behavior can be debatable because of the feeling of being distant from it. For instance, while the presented data is useful, it is not directly connected with one's own consumption and requires an intent and effort from a consumer to go to the website and learn more about the issue. To the best of our knowledge, little investigation has happened around non-digital or multimodal modes of communication. Similarly, little attention has been paid to dining settings and how it can be reconfigured to increase awareness and lower the impact of everyday food-related decision-making on the environment. Given that dining is activity that most humans engage in at least three times a day and a dining context is also known to spur conversation and support family-based reflection on diverse topics [35], we ask, "*how could we reconfigure food and dining setting to bring diners' attention to these issues?*" and "*how can we use food as a material to represent hidden data about water consumption and carbon footprint?*"

Our interest in using food as a method of representing data stem from prior works by Wang et al. [88] and Khot et al. [50,51], who mention the benefits of creating data edibilization, i.e., representing data in food. Wang et al. [88] wrote, "*When we cook food, we try to make the dishes enjoyable and nutritious. Similarly, when we "cook" data, we leverage the rich sensory experiences and the positive psychological effects that food entails to tell an interesting story with data, instead of merely showing numbers.*"

We also took inspiration from the recent trends and outlined benefits in constructing data physicalization that affords understanding of data through all senses [21,50,53]. Jansen et al. [46] argue that such modes of visualization benefit from the physical modality of the material, which makes the visualization easy to explore, handle, and manipulate in physical space, which in turn engage people for a longer duration and sustain their interest in exploring and understanding the captured data. Froehlich et al. [31] similarly argued for creating an emotional connection with the information in order to make it more meaningful.

We believe that food is an underutilized multisensory medium that can trigger more direct physical interaction with the problem through the medium in itself allowing diners to see, touch, taste and smell the issue and in doing so, it could contribute an embodied learning experience and help diners reconnect with food with another level of intimacy. However, incorporating data edibilization methods on a dining table are not straightforward as one must balance the act of eating with the act of learning. Therefore. to assist us in this inquiry, we looked at play as an approach.

Nurturing Play in dining settings

Play in common routines had long been explored in the CHI PLAY community, starting from the common use in crafting play through technology driven experiences [40,45,49,65,86,87], to situated and emergent play in mundane activities [10] where play is woven into the daily routine for creating an acknowledgment and call for action on a topic that is complex in nature. We agree with Altarriba Bertran et al. [10] when they mention, 1) Play brings joy to the mundane and serious scenarios; 2) Play allows us to have agency; 3) Play supports social interaction and interpretation. Let us look at each point one by one in relation to our work.

Bringing joy to the mundane and serious scenarios: When one is subscribed to the idea of a magic circle [23,63] within normal scenarios and mundane tasks, an out-of-the-box enjoyment can happen as seen in earlier works. For example, Street Pong [20], is a game played by pedestrians on a touch screen device on a cross light so that they do not feel the length of time while waiting to cross the road, by interacting with each other over ping pong. A sterile and payless situation as such can all of a sudden become an enjoyment and playful routine. Another example is Mood Squeezer [32], a playful interaction for workplace settings which encourages the communication of feelings and mood with simple color-coded balls responding to LED lit floors. These works show how play can be designed and introduced into mundane situations and serious context through simple and direct ways. They informed our design decision while creating playful dining scenarios to facilitate an awareness of hidden issues. We believed that the dining makes for a perfect setting to reconnect participants with food and what goes behind food as participants could relate to it in situ. Similar to how Mood squeezer acts as an 'ice breaker' in awkward situations [32], which sometimes can be a personal and sensitive topic to tackle, our work aims to support reflection on eating behavior and its ecological footprint in a social dining setting but in a playful and engaging way.

Supporting agency: Altarriba Bertran et al. [10] mention that play promotes critical thinking, encourages humans to explore, empower creativity and supports self-awareness. These four points describe how play can intervention and encourage human behavior while performing mundane tasks. For example, projects like SweatAtoms [50] and EdiPulse [53] present playful ways of supporting motivations for physical activity. In these projects, individuals' physical activity data is translated into 3D printed artifacts, allowing individuals to cherish and keepsake personal data which others is typically on screen in the form of numbers and graphs. By using a tangible and edible medium to represent data, these projects allowed participants to be self-expressive and also self-aware of their physical activity. In another project, Ava [2], riders' bodily posture is used to actuate different modes of an e-bike, giving riders a sense of agency and a feeling of having

superpowers to control the e-bike through their bodily exertion. Finally, Guts Game [55], a two-player game played with capsule endoscopy and medication monitoring pills, allow players to be self-aware of their body temperature and lead to a feeling of agency in controlling their body temperature. These projects helped us understand the importance of the tangible medium and how playful representations of data can contribute engagement and action towards a topic of concern.

Supporting social interactions: A variety of existing works illustrate how play leads to engaging social interactions in variety of context. Here, we focus primarily on social dining or commensality, i.e., the act of eating together [6,27,82]. For example, Ferdous and team [25,26] presented playful systems in TableTalk and Chorus that transforms personal devices into a communal shared display on the table to enrich mealtime interactions and experience. Mehta and colleagues [61] created Arm-A-Dine, a robotic dining system to encourage more face to face interactions amongst co-diners, whereas Arnold and team [4] created a virtual reality-based social eating experience. ActuEating is another system by Nabil et al. [68] that uses actuating, dynamic material to develop a dining table, which changes shape and color in response to diners' actions.

These works demonstrate that by bringing play to dining can promote coordination and meaningful social connection. These works however, make use of technology, which is not typically a part of a dining experience to facilitate play. In contrast, we are interested in repurposing the existing dining setting to facilitate meaningful play. We were inspired by the work by Huerga and team [43], where they reconfigured the existing hospital setting to facilitate play amongst hospitalized children. We also inspiration from the artistic works of Vogelzang [85] to acknowledge the power of food and play when it comes to addressing a problem or social issue. One of her iconic works involves a clever redesign of a table cloth making diners eat in a more inclusive manner poking only their heads and hand through the table cloth just like everybody else and thereby disregard how the person is dressed and increase a sense of equality when it comes to having dinner with strangers. Drawing inspirations from all these works, we next present our two case studies, each tackle an important ecological issue with a playful design.

3 CASE STUDY 1: CAESAR ON A SKEWER

The aim of this case study was to visualize the hidden data related to water consumption levels for different food materials as a dining experience. Utilizing data edibilization approach, we looked for ways to present this data through the same food that is served for dining.

Design Process

In the beginning of the design process, we considered common dishes like pasta and spaghetti to visualize the information of water consumption. We started by documenting a plate of spaghetti (for one person) that one prepares at home following a typical recipe and ordinary ingredients. For instance, to cook 125 grams of spaghetti, common ingredients include a clove of garlic, half slice of an onion, half tomato, 2 mushrooms, 3 basil leaves, 250 grams of minced beef and one tablespoon of butter. Using the data presented in [42], we then mapped each ingredient to the respective water consumption level. Figure 1 shows the ingredients of a plate of spaghetti with their respective measurements and water consumption. In total, preparing one plate of spaghetti at least requires 520 liters of water (this is exclusive of other ingredients like salt, pepper and oil, as they vary based on the individual's taste).

Figure 1: A plate of spaghetti cooked by using a traditional approach of cooking with different ingredients and their respective water consumption levels.

We, however, found several issues in visualizing the data through a plate of spaghetti. Firstly, cooking mixed up all the ingredients of the spaghetti and made it difficult to talk about individual ingredients. Additionally, even though the information of water consumption was present, users had little opportunities to reflect on the data and make any informed decision. For instance, users had no choice but to eat the spaghetti as the ingredients were all mixed. Finally, a plate of spaghetti was meant for consumption by one person, this further limited any opportunity to discuss and reflect on the data of water consumption that is possible with food items that can be shared. Hence, we discarded any cooked dish, and looked for a dish with ingredients easily separable.

In pursuit, we chose to use Caesar salad as the visualization medium. A Caesar salad is a Mexican dish that consists of vegetables like lettuce and tomato, croutons and animal products like eggs and meat added in raw form. The salad is typically served with a dressing made up of different ingredients like olive oil, egg yolk, lemon, mustard, garlic and pepper. To prepare our salad, we only used raw materials like lettuce, cucumber, avocado, tomato, chicken and bacon. We did not consider croutons for our data visualization, as bread is a cooked item and the amount of water consumption varies for different recipes and is not mentioned on the packets. Similarly, we also did not include the Caesar salad sauce to keep our design simple.

We then arranged the salad based on the water consumption levels of different ingredients. Although the salad is typically

served in a bowl, we chose to prepare the salad on a skewer as it makes all the ingredients easily noticeable. Using the data on water consumption presented in [42], we arranged the ingredients from the least (arranged on the top of the skewer) to the highest levels of water consumption (arranged at the bottom of the skewer). This arrangement on the skewer mandates individuals to first eat those food items that consume least water (and cause least environmental pollution), and gradually proceed towards those food items that consume high amounts of water (and cause high levels of environmental pollution). Figure 2 shows the arrangement of the salad with water consumption level mapped to each ingredient.

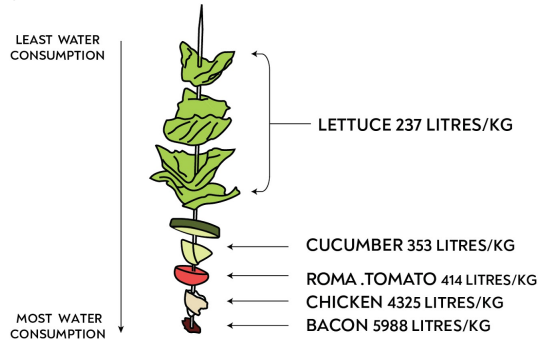

Figure 2: A snapshot of how different ingredients of the Caesar salad were arranged on a skewer around the information of water consumption levels.

Pilot Study

We conducted a pilot study to understand how participants interpret the visualization with regards to the presented information on water consumption levels, and how they find the dining experience. The study was conducted at the first author's home. Home environment (e.g., dining table, dining cutleries and utensils) was particularly important to create a regular and relatable dining setting, in which participants can naturally interact with each other as well as with the food. Six participants (2 males and 4 females) in the age group of 25-30 years participated in the study.

We created a playful social dining setting for conducting this study. We believe that the food problem is not an individual problem, rather it is a community issue. Understanding the community issues, therefore requires interactions and discussions among the community members. Hence, by creating the dining experience to be a shared one (i.e., social dining), it has the benefits to see people's interactions with the food as well as with each other on the same dining table. On the other hand, we considered creating a playful experience to investigate the effect of edible visualization because previous studies [78] have shown positive outcomes with playful approaches in raising awareness about serious topics like the one we explored.

For the dining experience, we used a large wooden plank that is specially designed to hold skewers, as shown in Figure 3. The Caesar salad skewers were manually prepared and placed on the wooden plank. The wooden plank was placed in the middle of the dining table to encourage sharing of the food amongst the participants. To make the dining experience playful, we also added randomization and created a varied arrangement of the salad ingredients on the skewers. For example, some skewers only had lettuce and nothing else; and some had lettuce and tomato pieces. Although croutons were not the part of data edibilization (refer Figure 3), we also added some skewers of only the croutons - this was done to distract participants from the main aim. Finally, we also drizzled some Mayonnaise (as Caesar sauce) on multiple locations of the wooden plank, as sauce also plays a key role in adding flavor to the salad.

Figure 3: Caesar salad skewers were placed on a wooden plank to support sharing of the food among six participants. Mayonnaise sauce was drizzled at different locations of the plank for flavoring the salad.

Study Procedure

The study was structured in three phases: pre-dining, dining and post dining.

Pre-dining phase: In the pre-dining phase, participants were welcomed at the home by the host (first author). They were invited to be seated on the dining table (in whichever seat they preferred) with Caesar salad already placed in the middle. Taking inspiration from the previous work by Vogelzang, *Sharing Dinner* [85], the host only described the gameplay to the participants but did not reveal the main purpose of the study. This was mainly done to keep participants' eating behavior natural throughout the gameplay as well as to create a surprise element in the experience. For instance, if the participants were told the purpose of our edible visualization in this phase, they could have demonstrated a fake liking towards eating vegetables or meat. Also, prior research [7,28,79] has shown that post-activity reflection creates a deeper understanding, as people can bring contrast with their just finished activity. The host also described the game rules and tasks to the participants.

Game Rules and Tasks: The main task of this experience was to finish the Caesar salad. All participants were encouraged to eat as much as they want. The wooden plank had 30 skewers - 5 skewers per participant (refer Figure 4). Every participant was provided with a plate, fork and a tong. The game involved the following five rules:

1. Participants can only use the given fork and tong to grab the food from the skewers.

Figure 4: Arrangement of the Caesar salad on the dining table. Participants were allowed to only use tongs to pick the food from skewers.

2. The food from the skewer should be consumed from the top to bottom.
3. Participants should finish the food on one skewer before moving to another skewer.
4. If any of the skewers fell off, participants should move on to the next skewers and start from top to bottom once again.
5. Participants should not pick any dropped food.

Dining: This phase was dedicated to the dining experience. Participants started eating the Caesar salad with the given utensils. The dining experience continued for around 30 minutes.

Post Dining: This phase aimed at discussing the participants' experience with the overall play and the presented visualization. Before revealing the game purpose to the participants, the host first invited them to describe their thoughts on the dining play and their assumptions on the game purpose. The host then revealed the purpose and described the water consumption levels for individual ingredients of the salad as well as the total amount of water consumed in designing this dining experience.

Data Collection and Analysis

We employed two methods to collect data from participants: participant observations and group discussions. We specifically chose these methods as they are non-intrusive and helped in keeping the dining natural for participants. During the dining, we conducted passive observations to understand the participants' interactions with the Caesar salad and with each other. In the post dining phase, we conducted group discussions to understand participants' reactions with the game play and the presented visualization. The host took handwritten notes on the observations and discussion points in the group discussions which were elaborated immediately after the study sessions for further analysis. Data collection and analysis was primarily done by the first author (while hosting the meal). The emerging themes were discussed with other authors to reflect upon the data. Inductive analysis was applied on the emerging themes. After the analysis, we structured the key ideas under two themes: *game play interactions* and *reflections on edible visualization.* Next, we discuss our findings.

Findings

Below we present the insights of this study across two themes: game play interactions and reflections on edible visualization. The findings under game play interactions are iterated as G1, G2 and G3, whereas the findings on edible visualization are iterated as V1 and V2.

Game Play Interactions

Below we present three findings related to game play interactions.

G1: Discomfort of picking the food

During the dining, participants started complaining about how inconvenient it was to eat an ordinary salad from the skewers. Questions like, "*Why are we eating it in this way?*", "*Why to make it so difficult?*", "*Why can't we eat it in a bowl?*" were commonly heard throughout the dinning play. Though not answered during the dining, these questions did not limit any participant in having the fun of eating the salad in a different way. This discomfort in fact made the play more engaging. Picking up the food items from the skewers through tongs or forks was not easy (refer Figure 5). Some food items like tomatoes and lettuce have a smooth texture, thus were slippery from the tongs. As a result, there were instances when participants accidentally dropped their food from the tongs before bringing it to the plate. These droppings brought laughter and participants also started to cheer each other.

Figure 5: A participant trying to get lettuce from the skewer by using tongs.

We also observed participants helping each other when it was difficult to get food from the skewer especially when they had to move the bottom bites all the way up on the skewer with tongs. For example, seeing one participant struggling in getting the last bite of lettuce with tongs from a skewer, another participant used his fork to keep the skewer stable (refer Figure 6).

G2: Stealing other's food

During the play, one common activity that we observed was stealing. Participants tried to steal the food from other participants' skewers. For participants, the best part of the salad was the egg and bacon, as the green leaves and other vegetables

were considered less flavorful. However, the only way to reach the egg and bacon was by finishing the vegetables first. Hence, stealing bacon bites from other's skewers seemed a quick way for some participants to enjoy the meat faster. For instance, when a participant was not paying attention to their skewer or were distracted in dipping the lettuce in the sauce, the neighboring participants attempted to steal the only meat bite left on the skewer. The participant whose skewer bite was stolen then had to start all over again from a new skewer in the hope to enjoy a bacon bite. Stealing other's food and protecting their own food went hand-in-hand and added more fun to the dining experience.

G3: Breaking rules to not waste food

Protecting the food from getting waste was found to be a common urge in all the participants. In pursuit, participants tried to break the game rules. For instance, they were not allowed to pick up the food or skewer that was dropped accidentally during the dining play. However, picking the dropped food was an instant reaction of everyone regardless of whether it was a vegetable or meat bite. To avoid any dropping, participants were very careful in using the tongs while also trying to be quick to pick the food. Figure 6 shows an almost finished meal with little waste on the wooden plank.

Figure 6: A participant helping another participant in getting the last bite of lettuce from the skewer.

Reflections on Edible Visualization

Below we describe the findings related to edible visualizations.

V1: Tackling the awareness gap

In the post-dining play, when the host described the purpose of edible visualizations, participants were confused and surprised at the same time. They mentioned having little to no knowledge of the information related to water consumption levels. Participants described that the salad arrangement made them assume that the purpose of the play was to promote vegetarian or vegan diet. Such an assumption was understandable as there was a distinct difference in the amount of meat in each skewer. One participant mentioned that he could never guess the goal of the visualization as water consumption level is a hidden data and never discussed or shown on the packaged food. Instead, water that is used in everyday activities like washing, bathing and drinking is more straightforward to relate with. Participants described that the spatial arrangement of different ingredients on skewers communicated a very clear message of the relative water consumption levels for vegetables and meat products. Participants also showed interest in seeing such edible visualizations more often for a wide range of topics related to their everyday life.

V2: Guilt on following the meat-based diet

After understanding the huge difference in the water consumption levels between vegetables and meat products, some participants confronted their strong likings towards meat in their everyday life. They even felt guilty of their food habits and showed keen interest in changing it. They described that they had read about environmental issues like water shortage and carbon footprints several times on social media. However, these issues always felt distant to them as they had little knowledge of their role on these big issues. Through the edible visualization of Caesar salad, they got a clear understanding of how their non-vegetarian diet is contributing to the environmental issues and what they can do to prevent them. They showed a strong determination to cut down their meat consumption and increase the amount of vegetables in their diet.

4 CASE STUDY 2: CHOPSTICK PARFAIT

The aim of this case study was to design an edible visualization that presents the hidden data related to food distribution channels involved in bringing a food item from the farm to our plate.

Design Process

To create a visualization for the food distribution channels, we applied some of the learnings from the Caesar Salad dining experience. For instance, similar to the Caesar salad, we looked for choosing a dish, where all the ingredients were separable. Additionally, we also looked for creating a shared dining experience to make the interactions playful and to support deeper reflections on the visualization. In pursuit, we chose to use the French dessert - Parfait for creating the edible visualization. Parfait is a custard-like puree, which is prepared from eggs, cream, sugar and syrup. The dessert is served in a parfait glass and also includes other ingredients like nuts, granola and fresh fruits.

Although the parfait dessert is served in a glass with different ingredients layered on top of each other, we separated the ingredients from its puree base for designing the edible visualization. The puree base was provided in a glass and the ingredients were placed separately on a long wooden plank (refer Figure 7). Each ingredient on the wooden plank represents a distinguished farm. As part of interacting with the visualization, an individual will prepare her parfait dessert by collecting different food items from the wooden plank in her glass through a faux chopstick. Here, the visualization mimics the distribution channel in the following ways: (1) The food items on the wooden plank mimic different food farms from where the food has to travel. (2) A faux chopstick for picking the food from the plank serves the role of trucks in the distribution channel, and finally (3)

Figure 7: The arrangement of Parfait based edible visualization: The puree base was given separately in a glass, and all the ingredients were served on a long wooden plank.

A glass with puree base for assembling the parfait dessert represents a consumer who needs to receive food items from different farms.

We carefully selected different ingredients to represent the distribution of different types of food. For instance, we included fresh foods like peach and strawberry, which are more likely to get spoiled during the distribution process. Transporting the food through faux chopsticks helped in mimicking the real-world scenario as their smooth texture made them difficult to hold with chopsticks. On the other hand, we also used processed foods such as macarons as they involve different kinds of distribution than raw fruits. For example, the processed foods involve a more complex distribution chain as they need several ingredients like sugar, flour and oil etc., all of which have their own distribution chain.

Pilot Study

We conducted a pilot study to understand how participants interpret the Parfait based edible visualization with regards to the presented information on the food distribution channel, and how they find the playful approach to present the data.

Similar to the first case study, this study was also conducted at the first author's home, as the home environment provided a comfortable dining environment. Ten participants (3 males and 7 females) in the age group of 25-30 years participated in the study. For the dining experience, we chose six ingredients: strawberry, blueberry, orange, peach, macarons and coconut shavings (refer Figure 8). Coconut shavings were specifically added to nudge participants into thinking creative ways of transporting them, as they are too difficult to hold with chopsticks.

Each participant was responsible to distribute one ingredient to all other participants, except for the factory produced processed foods - macarons and coconut shavings where only one participant was responsible for transporting both of them. This was done to distract participants from the main aim and to make

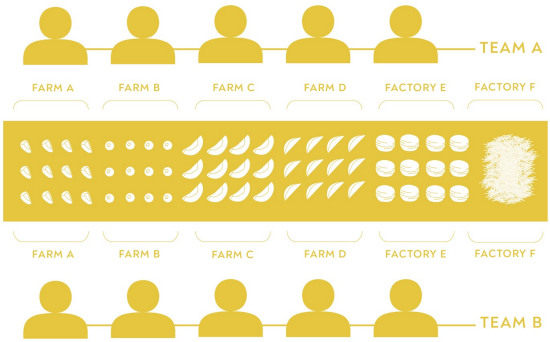

Figure 8: Infographics of the Parfait based edible visualization: Two teams sat opposite to each other on the dining table. All participants were required to assemble each ingredient from different farms and factories in their parfait cups as part of the dining play.

the experience more challenging. Each food item was arranged in three rows and four columns on the wooden plank. Thus, the plank had 12 pieces for each food item: 10 for the participants and 2 additional to allow accidental dropping.

Study Procedure

Similar to the previous case study, this study was also structured in three phases: pre-dining, dining and post dining.

Pre-dining phase: In the pre-dining phase, participants were welcomed at the home by the host (first author). They were invited to sit on either side of the dining table with the Parfait wooden plank placed in the middle of the table. Similar to the first case study, the host only described the gameplay to the participants but did not reveal the main purpose of the study. This was mainly done to keep participants' eating behavior natural throughout the gameplay as well as to create a surprise element in the experience. Participants were divided in two teams (five participants each) based upon how they were seated, i.e., participants sitting on the left hand-side formulated team A, whereas the right-hand side became part of team B. The host then described the game rules and tasks to the participants.

Game Rules and Task: The main task of this experience was to compete in two teams and assemble their parfait with all the ingredients as quickly as possible. Every participant was provided with a glass and a faux chopstick to assemble their parfait. The dining was timed to find the winning team. The game involved the following rules:

1. Participants can only use the given chopstick to grab the food from the plank.
2. Participants should remain seated for the whole dining and should not stand up or move their seats for the dining.
3. The food should be transported only through chopstick to chopstick.
4. Each participant is responsible for the ingredient placed in front of them. They should pass this ingredient to other

participants ensuring that everyone gets one of each ingredient for preparing their parfait.
5. A team will win if all its participants have assembled their parfait in their glasses.
6. Participants should not pick any dropped food.

Dining: This phase was dedicated to the dining experience. Participants started working in their teams to assemble their parfait with the given faux chopstick (refer Figure 9). The dining experience continued until one team won. After the play, everyone enjoyed their parfait.

Figure 9: Participants assembling their parfait dessert with the faux chopstick as part of the dining.

Post Dining: This phase aimed at discussing the participants' experience with the overall play and the edible visualization. Before revealing the game purpose to the participants, the host first invited them to describe their thoughts on the dining play, their teamwork to assemble all the ingredients and their assumptions related to the game purpose. The host then revealed the dining purpose to create awareness about the food distribution channel and how the design of the parfait visualized the distribution chain.

Data Collection and Analysis

We followed the same methods to collect and analyze data as followed in case study 1. During the dining, we conducted passive observations to understand the participants' interactions with the Chopstick Parfait and with each other. In the post dining phase, we conducted group discussions to understand participants' reactions with the game play and the presented visualization. The host took handwritten notes on the observations and discussion points in the group discussions which were elaborated immediately after the study session for further analysis. Data collection and analysis was primarily done by the first author (while hosting the meal). The emerging themes were discussed with other authors to reflect upon the data. Inductive analysis was applied on the emerging themes. After the analysis, we structured the key ideas under two themes: *game play interactions* and *reflections on edible visualization.* Next, we discuss our findings.

Findings

Below we present the insights of this study across two themes: game play interactions and reflections on edible visualization. The findings under game play interactions are iterated as G4, G5, G6 and G7, whereas the findings on edible visualization are iterated as V3 and V4.

Game Play Interactions

Below we present insights related to the game interactions.

G4: Team coordination was the game key

We observed that both teams employed a different strategy to play the game. The trick of the game was that every member can't distribute the food at the same time because the food can only be distributed through chopsticks. Rather team members were required to take turns to distribute the food. Team A quickly realized this trick and started discussing on how to work together. They came up with a systematic way and assigned every member a turn to distribute the food. This team took some time in the beginning, but their systematic approach not only resulted in less food waste (they had very little food dropping accidents) but they were also the winners of the game.

On the other hand, team B did not focus on teamwork. Every member tried to distribute the food they were responsible for, which resulted in a lot of chaos. Members were shouting at each other to go first in distributing their food. This lack of communication caused several food droppings and resulted in a lot of food waste. The team struggled to finish their task.

G5: Competition made the dining play engaging

Participants appreciated the competitive element of the game, as it created an intense play environment. Due to the time constraints of the game, participants were required to make spontaneous decisions and to clearly communicate with their members to finish the task. During the post-dining conversation, participants mentioned that although it was a simple task, the game rules made it challenging. As one participant described that though she was familiar with chopsticks, the ticking clock made it a difficult task and she accidentally dropped the food a couple of times.

Participants also mentioned that the social element of the game was the key highlight as they were required to work with other members to finish the task. One participant mentioned that he felt responsible for his team and successfully passing the ingredient was his main goal throughout the game. Another participant said that synchronization was important in the game to avoid creating chaotic situations while passing the ingredients. A member of the winning team also added that it was fun to see how the other team was struggling while they had already finished their task and started enjoying their parfait.

G6: Strategy to distribute food through chopsticks

Sharing food through the faux chopstick was a challenging task. Texture, shape and size, all defined the ease of picking food through the faux chopstick. Consequently, participants found it

challenging to use the chopstick to transfer the selected food items. For instance, while the peach slices had smooth texture, the blueberries were both small and smooth. The most challenging food to distribute was the coconut shavings since it was too small to pick. However, team A utilised an efficient way to distribute it. The participant who was responsible for both macarons and coconut shavings distributed both of them together, i.e., the coconut shavings were placed on the macarons for distribution. On the other hand, team B could not come up with such efficient strategies. Consequently, the members wasted a lot of coconut shavings in the distribution attempts.

G7: Ignoring food waste during play

We found that participants did not want to waste any food. During the game play, no one attempted to pick up the dropped food due to the time constraints. However, when the game was over, participants ate the dropped food from the plank. Later in the post-dining discussion, participants mentioned that they did not want to waste any food. One participant showed empathy towards the dropped food by saying, *"What a waste of peaches"*, while picking it up from the tablecloth to eat it. Interesting to note was that participants mostly picked those food pieces that they had dropped during the play. This behavior shows individuals feeling responsible for the food waste they created and taking actions towards it. By the end of the post-dining session, the wooden plank was completely empty as participants ate all the dropped food.

Reflections on Edible Visualization

Below we describe the findings related to edible visualizations.

V3: Competitive game play created greater awareness

During the post-dining session, when the host described how the visualization represents the real-world food distribution channel, participants could easily understand the purpose behind the play. Participants started reflecting upon their activities of the dining play and started relating them with the real-world scenario. They found that the representation of farms through different food ingredients and participants being the transporters of the food made the working of the distribution channels very clear to them. They described that the competitive element such as working in teams and time constraints in the play helped in bringing greater awareness on how different food distribution channels work in the real-world. Additionally, playing in teams provided extra benefits as participants could learn from both the success and mistakes of each other. For instance, a participant from the winning team described that seeing the chaos in the opposite team made him realize the importance of effective coordination and communication in the real-world supply chains. Another participant described that while she felt guilty of not attending the food waste at the time of play, she could bring the analogy with the real-world scenario, where distributors may ignore the food waste due to the limited time they may have to finish the order.

V4: Confronting the habit of consuming imported food items

Through the discussion on how food distribution channels work, participants understood that imported foods involve a longer supply chain and hence contribute more towards environmental issues. Participants confronted their habits of buying international foods particularly their native country foods, as all of them were migrants. Some participants described that they buy international food because the locally grown food items often taste and look different. Other participants mentioned that many of their native spices and other food items like snacks and lentils are not available locally, hence they buy it from the international supermarkets. Participants also described that price is another factor due to which they end up buying imported food. One participant described that she often buys canned tuna as they are cheaper than the local brands. To which another participant mentioned that the food packaging does not mention anything about the issues related to importing food except from its country of origin and price; She would rather prefer to have some information on how many places or storage houses the food had been, to make informed decisions.

5 DESIGN IMPLICATIONS

Based on the learnings from our two case studies, we present three design implications to guide the development of technologies around designing playful dining experiences for creating awareness of food related issues.

Visualise through food arrangement

Arrangement of food ingredients plays a key role in describing a food. For instance, a takeaway food consists of different layers placed on top of each other in a manner that one can eat it on the go without special table or cutleries. On the other hand, a three-course meal follows a scattered arrangement, where different food items are served in different utensils; the food is typically consumed through defined cutleries and in a relaxed environment. In Asian culture, the arrangement of food is an important factor to support visual satiety and to determine the order in which different foods should be consumed, for example Indian Thalis or Korean BBQ. As such, our mind is wired to perceive the meaning of different arrangements. Our studies also highlighted that even though the participants did not know the purpose of different arrangements of Caesar salad and Parfait dessert, they formulated assumptions on why the dishes followed a different arrangement than the standard. Also, when the purpose was revealed in the post-dining session, participants found it easy to correlate the hidden data presented through the food arrangement (V1). Similarly, the arrangement of individual food ingredients presenting food distribution channels from farm to consumers provided a clear mapping to the participants (V3).

In our case studies, we manually arranged the food around the hidden data however, technologies can be designed or repurposed for this purpose. For instance, as robots serving frozen yogurts are already popular in the US [73], these robots can easily arrange different ingredients of the yogurt around the given data.

Similarly, appliances used for preparing coffee, mocktails and ice-creams can be repurposed to vary the arrangement of different layers. For example, a strawberry ice cream scoop made with local ingredients can become a top scoop, whereas a chocolate ice cream having imported cocoa beans can become the bottom scoop. Moreover, mobile apps can also be designed to facilitate the food arrangement around different data such as carbon footprint and water consumption levels. The apps can present different visualisation schemes for different contexts like home or restaurant dining. This knowledge can also be made accessible through food packaging. The person cooking the food can utilise this data to arrange the food on the plate or in the lunchbox of the kids or on the dining table. The different arrangement could in turn, also trigger interest and curiosity of people even if they are eating the same food for multiple meals.

We also anticipate different challenges in visualising data through food arrangement. Firstly, not everyone will have skills as well as time to rearrange food items. However, these issues could be tackled with guiding mobile apps and automated tools as discussed above. A bigger challenge would be with food items that cannot be arranged in the desired order. For example, cooked foods like a vegetable curry or spaghetti are difficult to arrange as all the ingredients are mixed up - a lesson that we learnt during the design process of our first case study. Similarly, designing with viscous foods or liquids may also be challenging as the arrangement would not be visible. As such, we would need to carefully consider food pairing of different food items to define their arrangement around the given data.

Another important point to consider would be which arrangement to follow for creating the visualisation. For example, while *Caesar on a Skewer* followed a vertical arrangement to present the data, *Chopstick Parfait* followed a spread-out visualisation. Different arrangements would offer different meanings and would support different interactions, as we also found in our case studies. Paay and colleagues [71] have looked into f-formation to understand and define the spatial arrangement of people while cooking. Drawing on this, further studies are needed to unveil 'what' forms of arrangements are possible for 'which' food items. Finally, time and temperature are also critical factors with food as food items are perishable and their taste and appearance may vary with time, making them less appealing to the audience. For example, apple slices get quickly oxidised whereas blueberries remain good at room temperature for a long time. Therefore, determining placement of different food items based on their shelf life or temperature setting would be critical.

Support Playful Discomfort in Dining

Benford and colleagues' seminal work on uncomfortable interactions [8] put forward the benefits of physical, psychological and sensory discomforts or as the authors refer to it as "*dark side of fun*" for creating engaging play experiences. In both the case studies, we introduced *physical discomfort* for participants by introducing certain ways to collect and eat food that were different from traditional social norms or etiquettes around dining. Firstly, they were given non-traditional cutleries like tongs and faux chopsticks to pick the food. Both the cutleries were challenging to use. The texture, size and shape of different food items further added to the difficulty of using them. Consequently, participants accidentally dropped the food in their attempts to pick the food or distributing it to others. Secondly, participants were also asked to eat the food in a way that is not a norm like picking salad ingredients from a skewer instead of eating it from a bowl. Moreover, they were asked to pass the food around using faux chopsticks - which is also against the social norms. All these factors although caused discomfort to the participants, they increased the fun in the game and made the play immersive. As such, *physical discomfort* was seen as a pleasurable experience by the participants.

On the other hand, we also found that the food-based visualisation caused an emotional discomfort, where participants felt guilty of their eating practices. For instance, participants of the *Caesar on a Skewer* study felt guilty of their high meat intake as they were contributing more to the environmental pollution. Similarly, participants of the *Chopstick Parfait* confronted their habit of consuming imported food items due to their lower price. Similar effect was also observed in earlier edible visualization works like EdiPulse [53] and TastyBeats [51], where seeing sad emoji or less-flavoured drink made participants realise the realities of their sedentary life and these representations became motivational anchors for change. We think that this emotional discomfort was the outcome of the physical discomfort because it was only due to the physical discomfort that participants got engaged in the dining experiences and hence, got a better understanding of the hidden data presented through the food.

Within CHI PLAY community, using uncomfortable interactions for creating playful experiences is not a new concept [34], rather several works have explored its potential previously. For example, Byrne and team's work [13] on digital vertigo experiences utilise sensory discomfort to create social play. Musical Embrace [44] is another social game that tackles social awkwardness by promoting physical proximity through the use of a novel pillow. Brown et al.'s [12] VR game that is played inside a coffin, and Mehta et al.'s work [61] that uses robotic arms for social dining are other examples of playful uncomfortable interactions. Similarly, iScream is another playful system [87,88] that creates sensorial discomfort by producing different sounds when people eat different foods. As such, designers can utilize the multisensorial and social aspects of dining to create uncomfortable and yet playful dining experiences.

Our findings also speak to the strategies related to 'making eating challenging' and 'challenging the cultural norms' around eating that Mueller et. al [65] suggested for designing playful experiences around eating. Lucero et al. [58] also talked about creating negative playful experiences using Cruelty, Subversion and Suffering to make the subsequent experience feel stronger [5]. Drawing on this, subverting the social norms around eating and making diners struggle by not giving them the easy or standard option to eat (for example, using a vertically arranged food vs. all mixed in food) can have stronger impact on individuals. Cutleries can also be augmented to behave weirdly if bad choices are made such as the SWAN spoon [49] that drops food from the spoon if

diners do not eat mindfully. However, one critical point here is that while creating discomfort, it is important to create same experience for all participants so that there is no public embarrassment or shame. For instance, in both the case studies, all diners were together in the experience and had similar rules and tools to work with. Consequently, there was no embarrassment and despite the challenge and discomfort, participants enjoyed the experience.

Design delayed feedback

When it comes to offering eco-feedback about food and its ecological footprint in a dining setting, there are three possible options: before, during and after the meal. Providing feedback before the meal may make people less interested in the food. For instance, it could happen that the information presented in advance may cause emotional discomfort to participants for contributing to the environmental pollution without giving any opportunity for proper reflection on the issue and an urge for a call for action. On the other hand, without any interaction or exploration, people may not be able to relate to the data, as also emphasized by [59].

Providing the feedback while dining may be a feasible option. For instance, one way could be to reveal the feedback gradually as the dining proceeds. However, the feedback would need to be properly weaved in the dining experience (like a story) so that the feedback does not divert the diner's attention or interfere with their act of eating. Designers could also take inspiration from the fortune cookies, where the message is revealed while dining. Another possibility would be to design a jigsaw puzzle with food or a treasure hunt where the diner collects different bits of information while eating the different food items. The diner would keep playing until all the jigsaw pieces are arranged properly or the treasure is found. More research is required to explore the potential of giving feedback while dining.

The final option is to provide the feedback afterwards, which we explored in our case studies. As found in our studies, at first, participants were able to enjoy the experience as the underlying meaning was hidden from them. However, after knowing the meaning of the visualizations post dining, participants started reflecting on the activity they just finished to understand its purpose. They could easily relate to the issues of water consumption and distribution channel by being a part of the game play. As Sproedt [83] stated, play gives people the power to be critical and imaginative. Since play is not about certainty as there is uncertainty in the outcome of play it allows more exploration [83]. In case study 2, participants were able to compare each other's performance to understand the different possibilities of how distribution channels work in the real-world scenario. Participants learnt from the success and failures of both the teams. Moreover, the play experience brought mixed feelings, and participants felt both guilty and empathetic towards the issues.

Food arts can also be explored to provide the feedback post dining. For example, as in a latte art, the information of carbon footprint can be visualised in an abstract form; Here, instead of drawing the information at the top, the drawing could be created at the bottom of the cup which is revealed only after one has finished the coffee. Designers could also explore a hybrid form of feedback, where bits of information are provided in the beginning through food art for example, and other bits are revealed gradually or at the end. These pieces of information revealed at different times will help in triggering the diner's curiosity. The important aspect here is that all types of feedback with food will come under the diner's notice, as we always pay attention to our food. However, one key point to consider is how to include play - when and how the diner could play with the food as it would support reflection on the underlying issue through exploration.

5 CONCLUSION

"*Socialization, eating and play are core activities that make us humans*" [89]. By designing and evaluating two playful social dining experiences – *Caesar on a Skewer* and *Chopstick Parfait*, we attend to these three core activities. Our case studies demonstrated that the combination of dining and social play can be a perfect duo when it comes to communication of the complex food related issues in situ. The duo can offer opportunities for exploration, engagement and reflection when put together in a dining setting at a place where it matters, and a place that can facilitate a change in attitude and behavior towards these issues. Our work contributes to the field of play and HFI by presenting novel edible visualizations for two food related issues (i.e., water consumption levels and food distribution channel), and by discussing ways to facilitate play in a dining setting. We discussed the implications of these case studies through three design implications that talk about visualizing the hidden data through food arrangement, designing playful discomforts for dining and providing delayed feedback on eco-data.

While humans need food as a form of nutrients, socialization and growth, we also need some form of play to cater to our emotional wellbeing [33,89]. The overlap of dining and play bring forward interesting opportunities to explore. We are concerned that sometimes the potential of play is overlooked because of other priorities and mannerism in adulthood. However, it is also a potential call for participants to playfully engage in their mundane activities such as eating and use dining table a potential podium or magic circle [23,63] for play. This we believe will allow participants to step out of that common routine behavior and step into the in-situ reflection and experiences, which could bring a more memorable intent that is otherwise sterile at most times.

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