Exploring Food based Interactive, Multi-Sensory, and Tangible Storytelling Experiences

Saumya Gupta
Department of Informatics, University of California, Irvine
saumya@uci.edu

Ferran Altarriba Bertran*
Social Emotional Technology Lab, University of California, Santa Cruz
faltarri@ucsc.edu

Oğuz 'Oz' Buruk*
Gamification Group, Information and Technology Communications, Tampere University
oguz.buruk@tuni.fi

Sara Milkes Espinosa*
Digital Media, Georgia Institute of Technology
milkes.sara@gmail.com

Theresa Jean Tanenbaum*
Department of Informatics, University of California, Irvine
ttanen@uci.edu

Minerva Wu*
Department of Informatics, University of California, Irvine
minniew@uci.edu

ABSTRACT

Much work has been done on the design of both interactive narratives and food-based interaction systems, however their intersection has received little attention within the design research community. We took the relative dearth of food-based interactive storytelling systems as an opportunity to explore a compelling design space for multisensory interactive narratives, given these few systems often position people only as passive observers. We report the results of a design workshop conducted among the authors who are design researchers in interactive narratives and food-based play. In the workshop, we discussed existing works, asynchronously brainstormed new food-based interactive storytelling systems, and then reconvened to discuss our ideas. We present the portfolio of designs that arose from this workshop, and the design themes that we synthesized from the portfolio. We recommend how to position people not just as observers, but as active participants in the interactive food-based storytelling system.

CCS CONCEPTS

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

KEYWORDS

interactive narratives, diegesis, human-food interaction, lived body, tangible

ACM Reference Format:
Saumya Gupta, Ferran Altarriba Bertran, Oğuz 'Oz' Buruk, Sara Milkes Espinosa, Theresa Jean Tanenbaum, and Minerva Wu. 2021. Exploring Food based Interactive, Multi-Sensory, and Tangible Storytelling Experiences. In *Designing Interactive Systems Conference 2021 (DIS '21), June 28–July 02, 2021, Virtual Event, USA.* ACM, New York, NY, USA, 15 pages. https://doi.org/10.1145/3461778.3462006

*These authors contributed equally to this research.

DIS '21, June 28–July 02, 2021, Virtual Event, USA

ACM ISBN 978-1-4503-8476-6/21/06.
https://doi.org/10.1145/3461778.3462006

1 INTRODUCTION

Food is not just a source of energy but is a hedonic life experience that can nourish the body and soul through its multi-sensorial and visceral qualities [31]. Food brings people together, ties generations through stories and family recipes, takes us back to memories, and is an essential part of unique cultural traditions and various celebrations.

The combination of food and technology has opened a new space in HCI called Human Food Interaction (HFI). A dominant trend in this space is to use technology to optimize food practices, easing, scaling up, automating, or making otherwise more efficient those practices [3]. In response to that trend, recent works argue for the importance of studying food and play in order to engage with and cultivate the social, emotional, cultural and hedonic dimensions of food [3, 31]. Such works encourage a positive relationship with food through play that emphasizes food appreciation, social interactions, and even encourage mindful eating [31]. We believe interactive narratives can elicit many more positive benefits as well, however, the intersection between food and interactive narratives has received much less attention.

Many memorable scenes in narratives have elaborate and tantalizing descriptions of food. Besides exploring fictional worlds, interactive narratives with food can help explore many topics such as eliciting new ways of experiencing and appreciating food [31], engaging people in gastronomy [48] , turning one's attention to their own body [30], experiencing different cultures through food [2], and engaging with the nostalgic and emotional experiences around food.

The visceral and bodily [30] quality of consuming food makes a case for interactive multi-sensory narratives that go beyond the screen and engage our bodies, leading to pleasurable performative experiences [44]. In fact, it is not only the act of eating, but also surrounding elements such as food aesthetics and color, the ambience, and the utensils that can add to the experience [39]. Apart from the digital-only experiences, the narrative experiences around food can benefit greatly from using these intrinsic and cultural qualities of food by exploiting design opportunities brought by using real food as part of the interaction, tangible interfaces (e.g., interfaces around utensils) or multisensory environments (e.g., dynamic ambiences around food). Such design concepts would possibly position food as an integral and central part of the narrative experiences, as tangible and bodily interfaces that are a part of the participant's physical

environment can blur boundaries between the real world and the fictional world [27, 28, 37, 42].

While food and interactive narratives have not received much attention, existing works position participants in passive roles: they experience the story world through sensory information and are often situated as outside observers to the events of the story world [13, 45, 46, 52]. This trend is not only seen in food-based narratives, but also more broadly in multi-sensorial bodily experiences [1, 13, 50, 57], with a few exceptions [18, 24]. We consider instead making people 'active participants' where they are positioned inside the story world (internal) [17] and feel they can impact or explore the story world (ontological / exploratory) [17]. This is important because enacting and having stake in the story world rather than passively witnessing can help people internalize and personalize the story, reflect on their own beliefs, engage creatively, and broaden their world views by experiencing different perspectives [14]. This can enable us to not only sensorially experience some of our most cherished narrative worlds, but also be a part of the story itself. This may also help us explore topics of food around family stories, culture and food, ingredients and cooking, hedonic qualities of food, degustation, gastronomy, and open doors for new ways of dining.

To explore interactive narratives with food, we reviewed existing work in Food and Play Design, and Tangible and Multi-Sensory storytelling, and found design concepts such as the 'lived' body [30], food and diegesis [7], and cross-modality [33] can be applied to interactive narratives with food that go beyond the passive experience model. To explore food based interactive narratives further, the first author conducted a brainstorming workshop with the other authors who are design researchers in Food and Play Design, and Interactive Storytelling. We then did a thematic analysis of the workshop activities, conversations, and outcomes that allowed us to identify recurrent design mechanisms. We contribute:

- A portfolio comprising a set of design ideas that emerged from the workshop on food and interactive narratives that position people as active participants.
- Design themes that we identified emerging across these various ideas, which we frame as early inspirational starting points designers can use to ideate food-based interactive narratives.

We do not present completely drawn-out narrative systems in this paper, nor do we claim generalizability on our emerging design concepts. We give a glimpse of the rich possibilities that food and interactive narratives can offer, moving beyond passive experiences - a particularly relevant contribution given that, to our knowledge, no research has explored interactive narratives with food where people are active participants. Our contribution can be useful to Playful HFI and the tangible and interactive narrative domain as we explore this multi-sensory space of food.

2 BACKGROUND

2.1 Existing work in food and interactive narratives position participants as passive observers

In existing food-based narratives, most experiences position participants in passive roles, where they are observing the events of the story. For example, in Gustacine, viewers eat popcorn that changes flavor while watching a movie. The flavor is based on the emotions expressed in the movie such as sweet-cinnamon for joy and bitter-mustard for grief [22]. In an edible cinema experience based in London, viewers eat chocolates while watching Charlie and the Chocolate Factory [52]. The makers do say that they are not just copying what is on screen but aim to emphasize emotions and humor. In another food-based experience, a London restaurant used digital projections on food and crockery to tell the story of the chef [45]. An exception to this norm of passive experiences is the Mad Hatter dining experience where a group of people take different roles and venture into a world based on Alice in Wonderland [4]. This is an early exploration that turns dining into a narrative, challenge-based social experience in a restaurant setting. Gingerline, an interactive dining company, has also been exploring food based interactive narratives ranging from dinging and story performances, to administering food in unique ways [53]. While these works start to investigate how foods and props from a narrative world can be integrated into a dining experience, they are highly contextualized in a restaurant setting. Furthermore, they do not draw upon design principles from the interactive narrative community (see below). We use multiple design concepts from interactive narratives and Food and Play and explore various contexts beyond a restaurant setting.

We see an opportunity to explore the design space for food and interactive narratives as there are very few works in exploring this intersection. Velasco et al. give an overview of interactive narratives using taste and smell and urge designers to move beyond using these senses as mere add-ons, because food can be connected to many other things like culture, emotions, and a person's status [46]. We encourage leveraging these various aspects of food alongside its multi-sensorial qualities to position people as 'active' participants rather than just observers.

2.2 'Active' Participation in Interactive Narratives

While the word 'active' in interactive storytelling has many meanings, the most common being making choices and exploring branching pathways. We follow Tanenbaum and Tanenbaum's definition that focuses on the intention that underlies the person's choice in a narrative, and receiving a satisfying response to their action [41]. We also closely follow Harley et. al's work where they analyzed 21 tangible narrative systems and identified common themes and gaps in existing literature. They defined two dichotomies for positioning participants in interactive narratives [17]:

- Internal vs. External: Internal participants see themselves as situated within the world of the story while external participants are outside of it.
- Exploratory vs. Ontological: Exploratory participants observe and might reorder events of the story, but make no changes, while ontological participants may impact outcomes within the story world.

Their literature review gives an overview of the different roles participants take in various tangible interactive narratives. They identified that very few works position participants in internal - ontological roles, which we observed in food-based narratives and more broadly in multisensorial storytelling experiences as

Figure 1: a) Flatland [49] b) The Breathtaking Journey [24]

well. Internal-ontological roles can allow people to participate in the narrative and take responsibility for the consequences [16]. Exploratory roles in food-based narratives may help people explore different ingredients, different dishes, or various ways of cooking. Some forms of 'active' participation that we work with in this paper include - positioning people in internal, ontological, or exploratory roles, taking intentional actions where participants feel they have an impact on how the story unfolds, and receiving a satisfying response to one's action.

'Active' participation is important as interactive narratives can impact self-growth, reflection, change behavior, broaden one's world view by seeing different perspectives, and possible selves [14]. This is because participants may feel responsible for outcomes and character well-being if they have an impact on the story [43]. Enacting or roleplaying rather than witnessing can allow the person to integrate character perspective in their own lives, understand their goals, and internalize and personalize story [14, 32]. Given these benefits of interactive storytelling, the intersection between food and interactive narratives can help us explore many topics of food.

Looking at the interactive storytelling literature, one way to position participants in internal roles is through roleplaying [16, 43]. This can be in the form of behavioral mimicking [43] where participants mimic the actions of the character. In Ontological roles participants leave an impact on the story world. This can be achieved by not only giving them plot-centric choices which lead to multiple branching pathways in a narrative [8, 24], but also influence on how an action is performed, a character's personality or attitude, or the emotional affect of the story. Participants could also explore various character's perspectives or dive into deeper story arcs. [6, 15, 27]. An example of an internal-ontological system is The Breathtaking Journey (a VR experience), where the player takes the role of a refugee trying to escape [24] (Figure 1b). As the protagonist hides in a truck, the player's breath is tracked and if the sound level of the breath is above a certain threshold, the protagonist is captured. In this way, the player's breath (a bodily sensation) is used to drive the narrative. Exploratory roles can be given to participants by enabling them to explore different parts of linear / non-linear stories through props. For example, Wiseman et al. introduced the audience to the story world called Flatland, a 2D world with only sound and touch. People explore the space through sound and tactile feedback and hear narratives about the story world [49] (Figure 1a)

We found the concept of 'diegesis' in tangible narratives to be useful for active participation [10, 15, 18]. Diegetic components are "things that exist within the world of the film's narrative" [11]. Perhaps the earliest example of a diegetic system in the tangibles field is Genie Bottles [28], where participants open glass bottles and hear different genies come out to tell their stories (Figure 2b). The bottles are diegetic as they exist in the participant's physical world and are homes to the genies in the story. The Reading Glove uses diegetic objects to traverse through a detective investigation [42] (Figure 2a). Diegetic objects can connect people to the story world, position them inside the narrative and maybe even enable them to impact the story through the objects [16]. In food-based experiences, one's cutlery, the way the food is administered, or the food itself could be diegetic.

While we can take inspiration from these few design concepts in interactive storytelling (diegesis, internal, ontological, exploratory roles, behavioral mimicking), it is also worth looking at playful experiences with food that are not necessarily narrative but provide design concepts that can be applied to interactive narratives.

2.3 Food and Play Design

While there are many design concepts in the field of playful HFI [3, 31], we concentrate on 'lived' body [30] and cross-modality play [26].

Mueller et al., inspired by Merleau-Ponty's phenomenology, use the German terms 'Korper' (corpse) and 'Leib' (lived body) for bodily play [30]. They give examples on how to treat the body as a 'lived' body through which people can experience the world rather than just treating the body as an interface. Many social experiences with food apply this concept. Arm-a-dine is a two-player experience

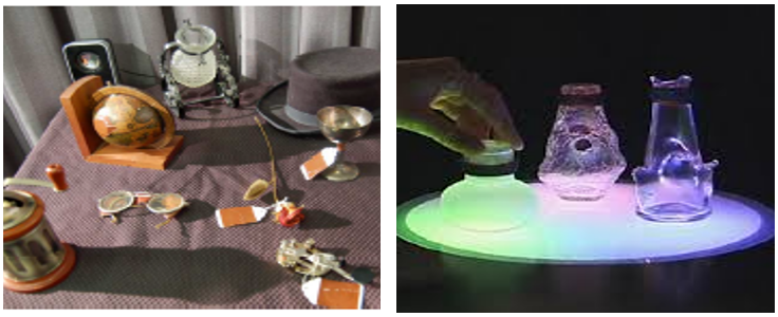

Figure 2: a) Reading Glove [42] b) Genie Bottles [28]

Figure 3: a) TastyBeats [21] b) Mad Mixologist [54] c) Arm-a-dine [31]

where prosthetic arms strapped on the player's waists, feed the players based on their facial expressions [31] (Figure 3c). In Mad-Mixologist, players need to mix ingredients for a potion together, but their visions are swapped through their headsets [54] (Figure 3b). TastyBeats is a playful fountain installation where players get a customized cocktail based on their heart rate data from physical activity [21] (Figure 3a). In the Guts Game, players eat ingestible temperature sensors and compete with each other by changing their body temperature [25]. In all these examples, playing with food brings one's focus to the lived body. We can use this lived body concept in interactive narratives for roleplaying and bringing attention to the body.

Cross-modality is a common thread that we have seen across many works. While multi-modal sensory experiences involve more than one sensory modality layered together, in cross-modal interactions the perception of sensation through one sense changes by stimuli received through other senses simultaneously [26, 34]. Spence et al. describe the challenges in digitizing taste and smell [40] and elaborate that rather than digitizing, it is worth modifying people's experience of actual food/beverage stimuli by stimulating the other (more dominant) senses – like modifying visual experience of food or sounds created. This concept of modifying multi-sensory experiences has been applied in various projects with food for play, social performances, education, health, and aesthetics. Chewing Jockey is a technical investigation where different sounds are played while one chews food, to see if the flavor profile changes [23]. In one of their examples, the authors mention how users found it fun and amusing when they chewed on jellybeans that made screaming noises. Obrist et al. presented a design framework by connecting taste to temporality, affective reaction, and embodiment [35]. For example, sweet is mapped to positive affect while bitter is mapped to negative. In this way, food and taste can be mapped to the affect of the story and characters in interactive narratives.

A few examples focus on how food and sound can be connected for playful experiences. Educatableware comprises of a fork and cup that emit sounds while eating to teach children better eating habits such as chewing enough [20]. The Drink Up Fountain by 'Yes Yes No' starts talking to people when they drink water from the fountain, telling them facts about water in a quirky way [55]. Lickestra is a musical performance where users lick ice creams to make different instrumental sounds [56]. Inspired by the same, Iscream is a project where the user licks an ice cream and hears different sounds – roaring, crunching, giggling, burping [47]. The authors confirmed that different sounds can bring about mental images of being in certain settings (roaring sound transitioned people into a fantasy world). This is a finding that can be extended to position participants in story worlds.

In this paper, we use these design concepts of cross-modality and lived body as lenses and combine them with concepts from interactive storytelling – diegesis, internal, ontological, and exploratory roles - to explore the space between food and interactive narratives that position people as active participants.

2.4 Aesthetics of Food in Art

We can find numerous references to the usage of food as an interactive device in the arts, including the diffusion of evocative smells in theatre, the use of food as a material because of its physical or metaphorical qualities, and the creation of social spaces where

food-sharing plays a central role. The concepts used by the arts to understand the cultural and aesthetic characteristics of food are generally different from interpretations in HFI, interactive narrative, and food and play, but they can nevertheless be informative and inspirational in this exploratory process. The metaphorical and cultural dimensions of food and art use food elements to play with interpretations and poetic meaning. For example, in Feliz Gonzalez Torres's piece called "Untitled (Portrait of Ross in L.A.)", he piles 175 pounds of candy on the floor [58]. Museum goers are encouraged to take candy as they come and go, the result being that the candy slowly disappears. The candy represents his partner Ross' body weight as it started slowly "disappearing" with AIDS. This food piece has a social component, but the strongest aim is to use food as a metaphor. Some works focus on the participative, social and cultural dimensions of food. For example, Allyson Knowles "Make a salad" explores the cultural aspects of food and collectivity to evidence the rituals of domestic practices. In this performance, participants and the artist collectively make a gigantic salad (with dressing) for all participants [59]. These examples show how the aesthetic, metaphorical, cultural, and social dimensions of food can be incorporated in a participatory experience.

3 METHODS

We present a portfolio of conceptual designs [29] that foregrounds different ways in which interactive food-based narratives may encourage active participation. Design portfolios have been used in the past to illustrate emerging design spaces [11, 12, 29]. Given that the design of interactive narratives considers various aspects such as the participant's role, interaction with the narrative and the interface, alongside delivering a coherent story; design portfolios can help explore emerging concepts. This portfolio is a result of multiple online brainstorming sessions between the authors, who are design-researchers (4 PhD students, 1 postdoc, and 1 professor) in the areas of interactive narratives, HFI, tangible and embodied design, and play design. The first author recruited this group through posts on Facebook and moderated 2 online sessions. In the first one-hour session the first author introduced the above-mentioned research concepts to provide a scoped lens to the work in food and play – existing works, lack of active participation, and design concepts in food and play. The first author also introduced one of their ongoing works in this area to inspire design ideas (The *Talking Gummy Bear* - section 4.8). We then brainstormed ideas individually for the next few days to come up with narrative experiences with food positioning participants in active roles. The prompts for the design exercise given by the first author were: Select a scenario based on what they wanted participants to take away about food (family stories, gastronomy, ingredients, fictional worlds, etc.). Think about:

- The participant's role
- The narrative (setting, plot, character)
- How participants would interact in the story (tangible, body, etc.)
- Role of food in the story and interaction

To explore the range of concepts, we did not consider the technical details. We did not plan to design fully-fleshed narratives, and so narratives were loosely defined as an experience including a plot, character, or/and setting [17]. After a week, we reconvened for a second 2-hour session to document and discuss ideas, recognize potentials and limits, and identify core design concepts. A set of 12 ideas came from this workshop, we present seven of the more polished ideas below. We then did a thematic analysis of these ideas through open coding followed by axial coding to identify common design concepts [9]. The first author conducted open coding on the portfolio by identifying how food was used for interacting with the narrative in different design ideas. The first author later created themes from these codes by finding overlapping concepts between the ideas such as anthropomorphizing food, actions with food that gave ontological roles, and bringing focus to one's body through food, among others. The initial results of the analysis were opened up to two other authors during a one-hour discussion where we further developed the themes. For example, we identified design themes to bring focus to one's body - such as non-normative ways of eating and tapping into the visceral qualities of food. The themes were brought to its final form by the first author (section 5). We do not claim generalizability through these design themes, but rather produce intermediate level design knowledge by raising design directions that have inspirational value and support design practice [60]. Although the design ideas in the portfolio are not designed end-to-end, this portfolio and emerging design themes show the potential for interactive narratives with food.

4 PORTFOLIO OF FOOD BASED INTERACTIVE NARRATIVES

Given below are seven design ideas from the workshop. We describe the premise of the design, the experience and the narrative, design concepts, how participants take an active role, and where this design may be situated.

4.1 The Amnesiac Wine Connoisseur

This design concept introduces participants to the subtle nuances between different wines, whiskies, and rums, encouraging people to know about and appreciate these beverages. The participant takes the role of an amnesiac wine connoisseur who remembers bitter-sweet memories and tracks down how he lost his memories.

The participant is presented with various real alcoholic beverages. When they select a beverage, for example red wine, they can select from a flight of various flavors of red wines (sweet, earthy, bitter, sour, etc.) (Figure 4). When the wine is sipped, the amnesiac connoisseur / participant immediately remembers an event where he is sipping red wine, shown through digital video or sound. He sees / hears different shades of that event ranging from the sweet memories to the bitter ones based on the wine selected. The taste of the wine selected is mapped to the affect of the event in the memory (Figure 4). For example, while tasting sweet red wine (Merlot) the connoisseur remembers a date with his wife where the evening started with good food, wine with sweet flavors of raspberry, and music, but turned sour as they started fighting, which is revealed when sour wine is sipped. The connoisseur is left thinking about bitter memories (when the bitter wine is sipped) of his divorce and his broken relationship. Whisky, known for its smoky earthy flavor, takes the connoisseur back to a memory of having whiskey with his friend on a cold, foggy evening in their backyard. In this way, the environment is also mapped to the taste of the alcohol. Soon the

Figure 4: Taste of wine is mapped to the affect of the event

connoisseur remembers the web of conspiracies and the event that led to losing his memory. Participants are hinted towards different beverages in the narrative to help them uncover the mystery.

In this idea, the participant takes an internal role by playing the amnesiac wine connoisseur. They explore different shades of each event through different alcoholic beverages which positions them in an exploratory role. The flavor they choose shapes the way they see the events in the narrative, which makes them active participants. Moreover, they explore different drinks to uncover how the connoisseur lost his memories. This design builds upon the nostalgic properties of food and how food items can take us back to memories (in this case the amnesiac connoisseur's memories). This design also maps taste to the emotional tone [35] of the narrative, while the multi-sensory environment mimics the properties of the alcohol. Different actions with the glass of wine such as swirling and smelling the wine could also be mapped to actions one would need to take in the story world to explore the narrative further. This experience could be a part of restaurant dining or wineries offering tasting services. However, the design is currently limited to engage a single person and can be improved by thinking about how it could be extended for a social setting.

4.2 Princess Fiona's Reflection

This experience is based on the movie series Shrek by DreamWorks [61] where participants play the role of princess Fiona. The movies are about two ogres whose worlds are intertwined with classic fairytale characters. This design creates an immersive experience where people can take a role, actively participate, and be a part of a popular story world.

In the movie, Fiona is introduced as a human princess who turns into an ogre at night due to a curse. Later on, she decides to live life in her ogre form alongside her love interest, Shrek. In this narrative experience, a magical potion has gone terribly wrong, and Fiona is back in her human form. She is trying to turn herself into an ogre once more. Participants take the role of Fiona and are bestowed with the task of creating a potion that turns them into an ogre. The participant sees a variety of magical foods that Fiona has gathered different fairytale characters – an apple pie from Snow white, a pumpkin gravy from Cinderella, a pea soup from a princess who has trouble sleeping (Princess and the Pea), magic colorful beans from Jack (Jack and the Giant Beanstalk), a gingerbread man, and rose water from Belle. Each of these ingredients have magical properties from the story worlds they come from. The participant, as Fiona, must use them to turn back into an Ogre. Participants see their reflection in a plate (digitally enhanced), seeing how these food items impact their visual appearance (Figure 5a). For example, when they eat the magic beans, their reflection becomes big and tall (inspired by Jack and the beanstalk) but does not give them the desired result of turning into an ogre. The pea soup gives the participant dark circles in their reflection, as it prevents them from a good night's rest (princess and the pea). The pumpkin gravy turns their reflection into an ogre (as it turns into what Cinderella needed – a carriage) but only for 12 seconds. The gingerbread man is alive and starts talking (audio clips are played) as soon as the participant tries to eat it. As the participant starts mixing ingredients, different effects can be seen. For example, the rose water (Beauty and the Beast) gives the gift of time, when combined with the pumpkin gravy, finally shows a lasting reflection of the ogre. Participants constantly hear Fiona's voice as an inner monologue, describing how and why these magical foods may be affecting her, and what could be done next.

This experience places participants in an internal-ontological position as they take Fiona's role, and their choices have an impact on their reflection. This design uses diegetic food items from various story worlds to help participants experience the narrative world as they consume and experience the effects of these magical food items.

This experience could be a part of an amusement park or a mixed reality space. However, this design again is limited to a single person, and an unaddressed challenge here is making it scalable for a wider audience.

4.3 The Journey of Disasters

This experience introduces participants to the medicinal world of Ayurveda, particularly a few herbs and spices that alleviate symptoms of common ailments. Participants are positioned as children of medics in a story world where Ayurveda is the prominent medicinal system. They have been endowed with the task of bringing back medicinal ingredients to their medic parents, but their journey is long and difficult, and they keep landing into health troubles like having a sour throat, bad stomach, etc. They need to find and eat the right Ayurvedic ingredients to alleviate their health problems.

Participants put on wearables on their bodies – neck (for throat), shoulders (signifying stress), stomach, and chest. When they have a health ailment in the story, for example, a bad throat due to a cold night, their wearable applies slight pressure on their body (neck in this case). They must eat/drink/brew the right ingredients (ginger in this example), insinuated in the story, to alleviate the pressure from the wearable, and to move ahead in the narrative. These wearables could be designed as aesthetic jewelry that the characters wear in this story world, to make the wearables feel like they are a part of the narrative. Participants would see these ingredients spread out on a table, strap on their wearables, and play along as they hear the story through audio (Figure 5b).

A few examples of Ayurvedic ingredients [36, 62] that could be used in this story experience are –

- Ginger that can help ease throat pain (ginger tea brewed and taken when they experience a sore throat on a cold winter night in the story)

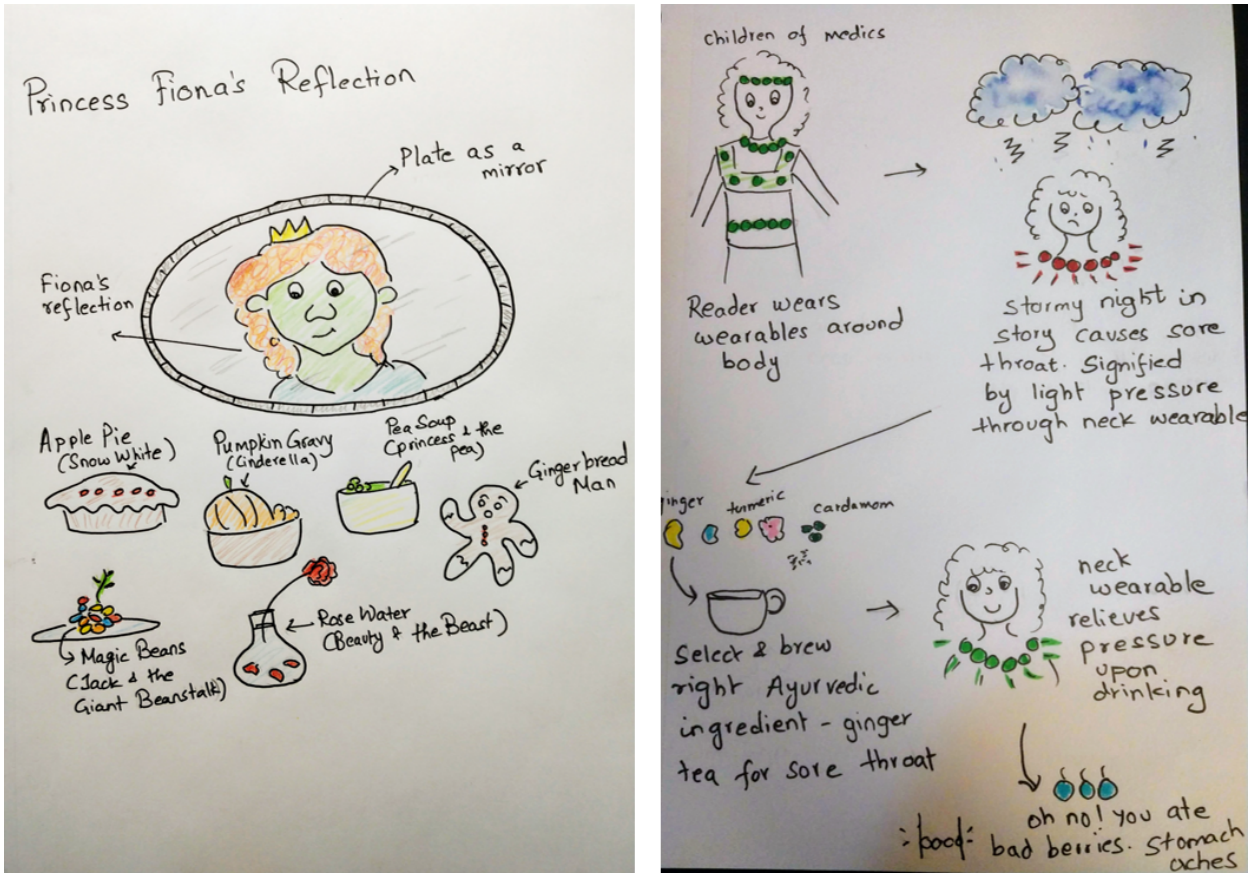

Figure 5: a) Princess Fiona's Reflection b) Journey of disasters

- Turmeric has antibiotic, antiseptic, and anti-inflammatory properties that could be positioned as a health drink in the story
- Cumin provides some protection from food-borne illnesses (taken when they have stomach problems by eating something bad in the story)
- Cardamom improves breathing (taken when they have breathing issues due to allergies in the story)

This design positions participants in an internal-exploratory role as they explore how different ingredients would alleviate their narrative health issues while being a part of the story world. This design also positions the participant's body in a diegetic and 'lived' role as they feel pressure from the wearables and release the pressure by eating different things, bringing their focus to how food impacts the body. Through this experience, participants would learn how different Ayurvedic ingredients impact the body and would engage with a different cultural practice. A cautionary message should be attached to such experiences, as designers would not want to overclaim and give people the message that Ayurveda can cure these health problems instantly. This experience could be a part of a museum exhibit on health or culture or could be positioned in an educational setting.

4.4 Typical Spanish Chorizo

This experience engages people in Spanish culture through plating and eating chorizos. It is also a playful reflective experience on culture and politics of the story world. A typical Spanish Chorizo is a pork sausage seasoned with paprika and garlic [51]. Chorizo also means 'thief' in Spanish. Based on this play of homonyms, participants are positioned as policemen in the story world who catch thieves (a Chorizo) through the act of making a Chorizo.

This dining experience, designed as a digitally augmented tabletop, shows the story world on the tabletop, with multiple characters such as dancers, singers, politicians, etc. As police of the story world, participants must catch the characters who they think are thieves when the characters appear on the digitally augmented screen. They do so by splashing a cherry tomato on the character - which culturally signifies throwing a tomato on a person looked down upon, and topping it with slices of chorizo. The participant then adds thin slices of bread on this mixture, which signifies that the character captured has now been sent to jail (Figure 6). They can add toppings like lemons and onions that signify the amount of time spent in jail. The story world changes based on who the participant sends to jail. For example, if the musician is sent to jail, there would be no more music in the story world (that the participants would have been hearing). If the politician is sent to

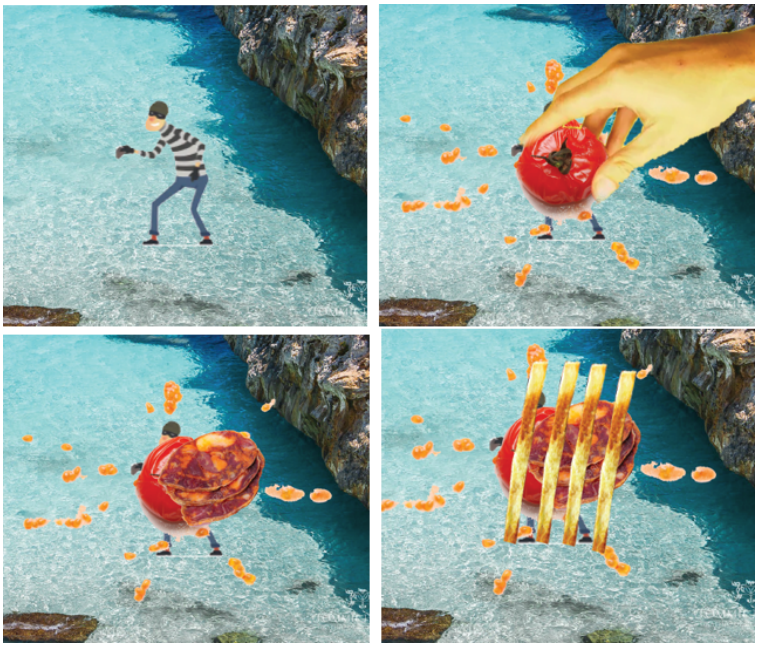

Figure 6: Making a Chorizo and catching a thief

Figure 7: Catching thieves in the story world

jail, there may be chaos, or the world may flourish based on how corrupt he was. If participants do not arrest the 'right' thief, things may keep disappearing from the story world. If too many people are arrested, nature would start taking over and more animals and greenery would be seen. In this way, participants engage in the act of plating a chorizo and reflect on how the story world changes based on who they arrest (Figure 7).

This experience positions participants in an internal-ontological role. Although not physically present inside the story world, they still have a role to play as the police. Their actions of catching a thief through plating has consequences on the story world, making them active participants. In this design, the play of the word 'chorizo' has been used to engage people in a cultural food experience. Actions taken to plate the food, that is adding tomatoes, bread, and toppings, are actions that hold meaning and significance in the story world. In this way, the act of plating the chorizo has been integrated into the narrative. This experience foregrounds the act of making / plating food as compared to eating it.

This design could be a part of a social dining experience at a restaurant. An unaddressed challenge here is thinking about other stakeholders such as the chef, their needs, and how they could be involved in the design process.

4.5 Dinner in the Dark

This design explores eating without sight, relying more on smell, sound, and touch while exploring a narrative world. The participants are lost travelers wandering in a strange new world where they have no vision. They eat the food in this land to know more about its history and to find a way to get out.

This experience starts with participants sliding into a dark room, as if they have fallen into a new world without light. They are told that they have been in this world for hours and now must forage for food to survive. Participants are drawn by delicious scents and stop to eat when they find something that smells right. As they eat, their awareness begins to expand, they hear more about the strange land they are in. The more time they spend chewing and eating, the deeper they go into this world's stories. Soon they find that they have fallen into the belly of a creature from an interdimensional world and what they are eating are perhaps the remains of what the creature once consumed. An omniscient voice guides them on what they may eat next to help them find a way out, "perhaps something slimy" or "something with a pungent and fruity smell". This gives participants guidance on what to do next, provides continuity to the narrative, and gives a sequence in which the meal is to be consumed – like starting with a salad, and ending with dessert.

Participants take an internal-exploratory role as they are positioned inside the story world, finding their way out, while exploring more about this land. This experience encourages participants to focus on the visceral properties of food by taking away their sense of sight. They are encouraged to concentrate more on scent and textures as they rely on these senses to follow the voice and find their way out. This design guides participants through a multicourse meal by giving them narrative clues to find what to eat next. The design also brings focus to the act of chewing, as the more participants chew, the deeper they go into the story. The way food changes taste while chewing could also be taken account into the narrative. This design could be situated in an amusement park, a mixed reality space, or a dining in the dark themed restaurant [63].

4.6 Foodies

Foodies explore the emergent narratives that can be created through game mechanics designed around food. The experience is set in a virtual reality environment where the inside of the player's mouth is the game world where "foodies" live. The food items are objects that make modifications in this world and help Foodies navigate. The aim here is to use emergent narratives to change how people behave with their food and how they experience it.

In Foodies, each food item has a different effect on the world. For example, if a player eats something spicy, it heats up the world as long as they keep it in their mouths. Or if they eat something frozen, it freezes Foodies who live in the mouth of the player. In Figure 8, Foodies need to reach the door at the top of the wall. The player needs to find a way to raise them to the level of the door. The player first tries to eat the hot food item. However, Foodies, who have their own personalities, panic when they touch hot food. They need to spit the food back or swallow to remove it from the game area. The player then tries to keep a frozen item in their mouth to freeze Foodies. After they are frozen, they take water to their mouth and Foodies start floating without reacting to water. By tilting their head, the player navigates Foodies to the door.

This experience leads people to interact with and taste their food in a non-normative way. It drives players to hold different types of food in their mouth in various durations, direct it to different parts of the mouth, and also move their body at the same time. Since the story world is inside the player's mouth, they are positioned in an internal role. They impact the state of the story world (their mouth), and the foodies by eating, holding, and moving various food items in their mouth, making them active participants. This experience allows people to focus on the taste changes over time, what different foods feels like in the mouth, focus on their 'lived body', and experience eating as a playful activity. This design assumes food abundance and an unaddressed challenge here is minimizing food wastage.

4.7 The Anosmic Cadavre Exquis

This design was inspired by one of the author's own anosmia, an invisible disability that severely limits their sense of smell and therefore, sense of taste. Many people assume that eating food is an intrinsically sensory and pleasurable experience due to taste and smell. Anosmic people have a different experience, finding pleasure in alternative aspects of consuming food such as emphasizing the food's texture and socializing tips and tricks. Anosmic people actively seek to intensify sensations and mindful playfulness to enrich their eating.

The *Anosmic Cadavre Exquis* is a design meant to playfully complement the eating process in a way that builds on anosmic people's experiences to create a composite meal and a collective record of how the participants experienced it. A "cadavre exquis" is a method invented by the surrealists to collectively assemble words or images. On a blank piece of paper, someone draws part of an image or writes a sentence, folds the paper to hide what they just did, and passes it to the next person. By this method of drawing/writing and folding, people may create a surreal collective final image or poem. The Anosmic Cadavre Exquis leverages this method utilizing food instead of words or images (Figure 9).

Around five participants sit at a round table where many kinds of foods are set. The ingredients can be single items like berries, cheese, chocolate, or more complex but uniform foods. They must have various textures and sizes. The players cover their eyes when it is not their turn. The player in the role of the 'poet' uncovers their eyes and creates a combination of flavors by picking ingredients in any quantity they want. But they don't get to eat it! Instead, they pass 'the verse' in an enclosed container to the player sitting next to them in a clockwise direction. The next player eats the enclosed verse without knowing what is in it and must creatively verbalize the experience, focusing on textures, feelings, and thoughts they have. This interaction does not seek to reproduce the sensorial experiences of a person with anosmia, but rather be inspired by their assets and capacities to expand the aesthetic paradigms typically surrounding food. A computer registers their verbalized descriptions, which other participants are also able to hear. Everyone is encouraged to name this verse based on the description. Then the player becomes the poet and turn-taking continues. The next participant should try to create something that they think will convey parts of the previous verse, but not fully, ensuring continuity and change.

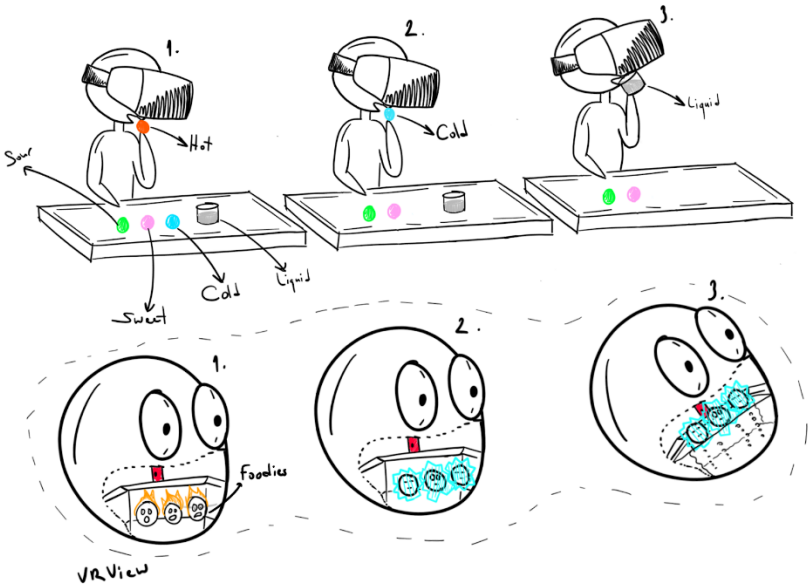

Figure 8: Behavior of Foodies depends on ingestion of different food items

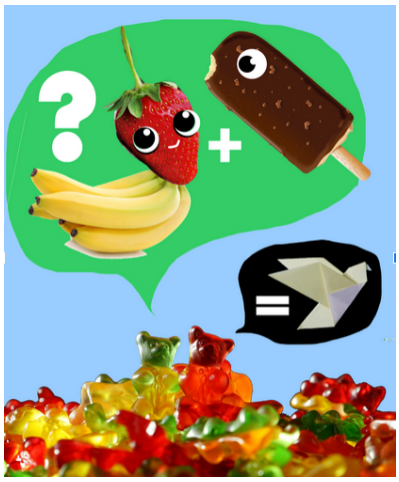

Figure 9: Conceptual art for Anosmic Cadavre Exquis

Different from the other pieces in the portfolio, rather than experiencing a narrative, this design focuses on creating one, by crafting a collective poetic register of combinatorial bites. This design also encourages participants to focus on the textures and feelings that food evokes as they verbalize their experience of eating in a social setting.

4.8 The Talking Gummy Bear

The *Talking Gummy Bear* is an ongoing piece of work by the first author and was designed before the workshop. It was used as a probe to initiate the analytical reflections and inspire the workshop attendees. We included it in our thematic analysis to provide robustness by including more developed examples of food and interactive narratives. Motivated by Chewing Jockey [23], in this concept the participant eats a talking Gummy bear that interacts with them through the experience. This idea encourages healthy eating, raises awareness, and self-care for the body through a fun and humorous experience.

This project has been implemented using the Makey Makey [38], and conductive spoons and forks as shown below. Participants wear a belt with vibration motors (Figure 10a), connected to an Arduino Flora [19]. They hear the gummy bear through audio. They see a spread of healthy and unhealthy food items such as raspberries, spinach, carrots, chips, chili pickle, chocolates, coffee, ginger tea, coconut water, gummy bears, etc. (Figure 10b)

The experience starts when the participant eats a Gummy bear. They hear the Gummy bear scream as it is alive, and once swallowed, it stays in the participant's stomach. The participant must help the Gummy bear move through their stomach by eating the food spread in front of them. As the participant eats, the cynical Gummy bear tells them how their body reacts to different food items, and how the gummy bear is impacted by their food choices. The Gummy Bear moves down when the participant eats something high in fiber, and it complains when they eats spicy and oily food.

For example, when the participant eats carrots, the Gummy bear says, "*This is making everything here move down smoother, keep crunching, feel me go*!" Here the participant feels vibrations on their stomach (through a wearable with motors), signifying the gummy moving down. When they eat something oily, the gummy bear complains saying "*ouch! I keep slipping on all that oil you keep eating*." When the participant eats something spicy, the gummy bear starts panicking as the acid in the stomach starts rising. Here, they must drink water or ginger tea to calm down their stomach acid. If they do not, the gummy bear gets more distressed as his limbs start burning in the acid. In this way, participants learn about different food items and how they impact the body, and subsequently the gummy bear.

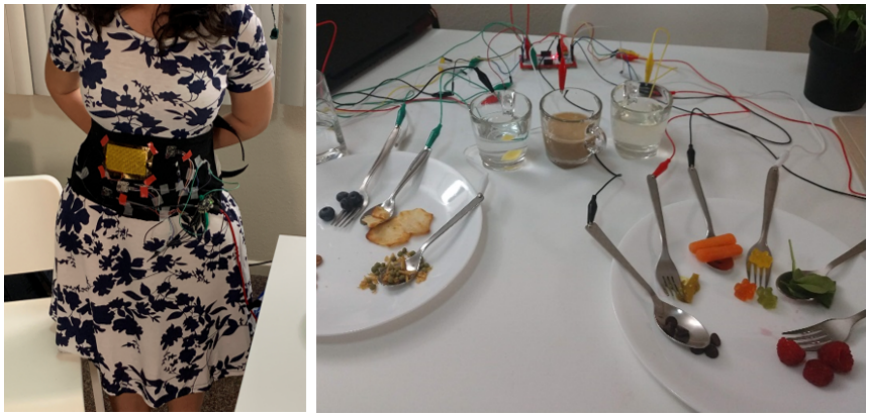

Figure 10: a) The belt b) Food spread with forks hooked to Makey Makey

Whatever participants eat impacts the gummy bear and their narrative body, giving them ontological roles. Moreover, the story takes place inside their bodies which puts them in an internal role. The design positions the participant's body and the food items in a diegetic role, as they are a part of the real world and story world exists inside their body. The design also makes the participant focus on their bodies through the Gummy bear's visceral dialogues and the heat and vibrations belt, positioning the body as a 'lived' body [30]. The vibrations also add a layer of cross-modality to the eating experience. This work can be used in educational environments. Given the complex setup of this system, the experience is relatively short. This work can be improved upon by thinking of longer narratives that can last multiple meals.

5 DESIGN THEMES - DESIGN INGREDIENTS FOR IDEATING FOOD BASED INTERACTIVE NARRATIVES

We highlight the key inspirational design themes we identified in the design ideas and discussion from the workshop. We frame them as design ingredients that storytellers and designers can build on to integrate food and other related components around it as an interactive component of the narrative.

In the following sections we elaborate design themes from these ideas that address the follow question - **how can we design interactive narrative experiences with food where people are active participants** (internal, ontological, exploratory, roleplaying)? We hope that our set of ingredients shed some light on how one may approach thinking about food and interactive storytelling.

5.1 Ingredient #1: Leveraging lived experiences with food as interactive components in the narrative

In tangible interactive narratives, often participants interact with different objects in the story world [28, 42]. We recommend leveraging different properties of food to experience food not just objects in the story world but as mediators of nostalgic, emotional, cultural, visceral, social, and educational experiences. Our design ideas explore how different properties of food can enable these lived experiences by giving participants active roles.

Nostalgic properties of food can be integrated in storytelling by having people relive different memories of a character and exploring deepening arcs of a narrative by eating or drinking (*Amnesiac Wine Connoisseur*). Taste of food can be mapped to emotions [35] in the story, enabling people to explore or impact different affective components of a narrative. For example, in *the Amnesiac Wine Connoisseur* the taste of wine determined the emotions displayed in the scene of the story (sweet-positive, bitter-negative).

Cultural traditions and rituals can be integrated as ontological actions in the story world. For example, in The *Typical Spanish Chorizo* the semantic and cultural meaning of food was mapped to the story world ('chorizo' meaning food and to steal). The *Journey of Disasters* highlights how cultural knowledge can be disseminated through storytelling as different foods impact different parts of the diegetic body.

Nutritional value of food can be disseminated through the story by positioning the participant's body in a diegetic role. Participants can impact their diegetic body in the story based on the nutritional value of the different food items they consume (the *Journey of Disasters* and *Gummy Bear*).

The visceral and physical elements of food can create novel narrative experiences. For example, eating something that was once narratively consumed by a creature (*Dinner in the Dark*), eating something that is alive (*Gummy Bear* and *Foodies*), eating foods with varying temperature (*Foodies*), and creating a story based on food texture (*Anosmic*), can create visceral and interactive experiences. Visual properties of food can also be leveraged as actions in the story world. For example, in *Typical Spanish Chorizo* splashed tomatoes look like blood and slices of bread look like prison bars.

Social experiences with food can be created by decentralizing food items or giving people different roles and responsibilities in the story. Different parts of a story can be explored / created based on every person's unique experience with food (*Anosmic Cadavre Exquis*).

5.2 Ingredient #2: Defining key food interactions as diegetic meaningful actions in story world

5.2.1 Selecting, plating, mixing, chewing, sequencing as part of the narrative. In tangible interactive narratives, it is common for participants to interact with the body and objects to impact or explore the story world [16, 17, 24, 42, 49]. How can this be applied to food? Through our design explorations, we recommend that different actions with food (selecting, plating, mixing, chewing, sequencing) can be mapped to actions in the story world to give participants ontological or exploratory role.

One obvious way to achieve this is by eating different foods to explore or impact the story world in different ways. For example, participants impact the characters in *Princess Fiona's Reflection*, The *Talking Gummy Bear,* and *Foodies* through different food items. They impact their own narrative bodies in The *Talking Gummy Bear*, and *The Journey of Disasters.* They explore different parts of the story by consuming different items in the *Amnesiac Wine Connoisseur*, and *Dinner in the Dark.*

Another way to give internal roles is through behavioral mimicking [5] where participants take the character's role by mimicking their actions [16]. In food-based narrative experiences, participants can take the character's role by eating diegetic food that the character consumes. *The Amnesiac Wine Connoisseur* uses behavioral mimicking as participants drink what the character drank in the story. In these ways, food selection can be used to navigate and impact the narrative.

Besides selecting food, making / mixing, plating, and other rituals with food can also be integrated as ontological or exploratory actions in the story world. In *Typical Spanish Chorizo*, the actions of plating (splashing tomatoes, adding chorizo, and bread) are mapped to actions in the story world (catching a thief, sending them to jail). In *Princess Fiona's Reflection* participants mix ingredients as part of the story to create different potions. In *The Amnesiac Wine Connoisseur* we discussed how rituals such as swirling and smelling the wine could be incorporated as actions to explore different arcs in the narrative.

Prolonged chewing can also be integrated in the story as chewing food overtime changes the taste and texture of food. We recommend integrating these changes in the story to impact the character / story in different ways. For example, in *Dinner in the Dark* participants explore deepening arcs of the story by chewing more, and *Foodies* encourages people to hold food in their mouth for various durations to help the Foodies.

Lastly, participants can be guided in the story to maintain a desired sequence of food consumption. For example, In *the Amnesiac Wine Connoisseur,* and the *Talking Gummy Bear,* participants are given hints on what to eat next not only to give some guidance to participants, but also maintain a sequence in which the meal is served.

In the above-mentioned ways, actions such as selecting, plating, mixing, prolonged chewing, and sequencing can be mapped to meaningful actions in the story world. This can place participants in ontological/exploratory roles, making them active participants while experiencing the pleasure of interacting with food.

5.2.2 Exploratory or Ontological actions. In tangible narratives, participants are often given exploratory roles by allowing them to explore different objects and hear different parts of the story [17, 28, 42]. They are given ontological roles if their actions with the objects impact the story world [16, 17]. We recommend how participants can explore or impact the story world through food using different actions – selecting, mixing, chewing, etc.

Selecting different food items to explore different affective parts of the story (*Amnesiac Wine Connoisseur*), guiding people on what to consume through different cues in the story (*Dinner in the Dark*), and chewing more to go deeper into narrative arcs (*Dinner in the Dark*), are a few ways in which participants can be given exploratory roles. On the other hand, representing food as a character (*Talking Gummy Bear, Foodies*) and impacting the character's well-being through nutritional or physiological qualities of food (*Talking Gummy Bear, Journey of Disasters, Foodies*) can give participants a stake in the story world, placing them in ontological roles.

5.3 Ingredient #3: Using Food as a diegetic character

Giving life-like characteristics and positioning food as a character can give participants an entity to interact with in the story world (*Talking Gummy Bear, Foodies*). Moreover, if the participant's actions have an impact on this food-character, they can be endowed with the responsibility of this food-character's well-being, giving them ontological roles. For example, In the *Talking Gummy Bear* participants impact the Gummy Bear based on the nutritional qualities of food. In *Foodies,* food can melt or freeze the characters based on the taste, state, and temperature of food. These food-based characters can also express their personalities, needs, and emotions by reacting to food. For example, *Foodies* express their dislike for water by drowning or popping out of the mouth and the Gummy Bear expresses how he feels based on what the participant consumes and how it impacts the body, and subsequently the Gummy Bear. In these ways, anthropomorphized food can be positioned as a character in the story world, making food a part of the story. We found this as a unique design concept as not many existing works in tangible narratives give life-like characteristics to inanimate things.

5.4 Ingredient #4: Engaging the lived diegetic body through food consumption and modifying bodily experiences

Very few works in tangible narratives position the participant's body in diegetic roles [24, 37]. We recommend using the concept of the 'lived' body [30] so participants can engage with the 'lived' experience of the body in the narrative. Our designs explore how food can position the body in a diegetic lived role through food consumption and by modifying bodily experiences.

One way to position bodies in a diegetic lived role, is by bringing the participant's focus to how different food items impact their bodies nutritionally (*The Talking Gummy Bear* and *The Journey of Disasters*). Another way to create experiences for the lived diegetic body is by directing the participant's focus to the visceral qualities of food. For example, in *Foodies,* characters bring focus to how food feels in the mouth, challenging how we behave with and perceive

food. *Anosmic Cadavre Exquis* encourages people to focus on textures and verbalize how food makes them feel. The participant's focus can also be directed to their body and experience of food through visceral dialogues from the character. For example, in the *Talking Gummy Bear,* the *Talking Gummy Bear,* the gummy bear complaints about slipping on the 'oil' from the oily food.

Sensory augmentation, deprivation, and challenging normative ways of eating can modify the bodily experience of food, again positioning the body in a lived role. For example, wearables can be used to bring attention to the body through pressure, vibrations, or heat based on what the participant eats (*Talking Gummy Bear, and Journey of Disasters*), augmenting the sensory experience of food. Moving away from normative ways of eating such as eating in the dark (*Dinner in the Dark*), keeping food in the mouth for longer times, and moving it around in different ways (*Foodies*),) are some other ways to experience one's body in an interactive narrative. Breaking cultural norms and making eating challenging has also been recommended by existing works in Food and Play design [31].

5.5 Ingredient #5: Beyond food – using food-related objects and environment as interactive components of the narrative

An experience with food is not just about eating, but also about the ambience/space and dining props. Just as diegesis can make food a part of the story world, representing characters and other narrative elements as food and dining props can bring the story world closer to the dining experience. For example, in *Princess Fiona's Reflection*, the plate is represented as a mirror through which participants see how the magical foods impact them. The space and ambience of where food is eaten can also be included in the story. For example, in the *Amnesiac Wine Connoisseur* the multi-sensory environment mimicked the flavor of the alcohol (smoke ambience while drinking whiskey). The space in *Dinner in the Dark* represents the belly of a creature, placing participants inside the story world. Through this design concept, we encourage the traditional use of tangible objects and physical spaces alongside food in the narrative to provide a richer story experience.

6 HOW CAN WE APPROACH DESIGN FOR FOOD-BASED NARRATIVE EXPERIENCES?

In this section we elaborate on our take-aways on how one may go about designing for food and interactive narrative experiences where people are active participants.

We encourage designers to think about the context and what they want people to take-away from the experience. For example, our designs could be useful in educational environments, museums, mixed reality spaces, thematic restaurants, food producers, and amusement parks. We designed for participants to experience degustation, plating, enacting in a story world, experiencing unusual ways of eating, and learning more about food and the body. It is useful to think about the participant's role in the narrative based on the context and goal of the experience. Participants could be positioned in internal / external or ontological / exploratory roles [17]. For example, in the *Talking Gummy Bear* they were positioned in an ontological role as we wanted them to have an impact on the gummy bear so they could feel responsible for it and hence their own bodies. Whereas in *Dinner in the Darkness,* the aim was to explore different foods without the sense of sight, and hence participants were positioned in exploratory roles.

Designers can also think about how food could be an interactive component in the story world. We explored how diegetic anthropomorphized food and the diegetic body could place participants in the narrative world. We also explored how nostalgia, emotions, and cultural aspects of food could be incorporated as a way to interact with the story while bringing focus to the lived experiences offered by food. We encourage the use of utensils, ambience, and other objects included in a dining experience as interactive components in the narrative experience.

We explored how selecting, mixing, making could be mapped to actions in the story world. We also investigated how the narrative could highlight different ways to experience food, such as sensory deprivation, sequencing, and chewing for longer times. We encourage designers to think about the various activities around food (apart from eating) they want people to experience.

7 LIMITATIONS

While this early work consisting of designs aims to spark conversation on interactive storytelling with food, we recognize its limitations. We have not directly engaged with professional story writers and professionals in the food industry such as chefs. Future explorations can be more participatory and include multiple stakeholders [48] beyond design-researchers such as chefs and storytellers. We have focused mainly on a few design concepts to scope our design brainstorms, but many other concepts from storytelling, play for body and food can be applied to this domain. We have also not explored technical options for this kind of work, but our presented designs are feasible through technology that is currently available (Makey Makey, Arduino, capacitive touch sensing, etc.). While we have focused on active participation, it is worth exploring the scenarios where positioning people as observers would be preferable. For example, amusement parks and museums may benefit more from active participation than movie theaters. It is important to explore scalability issues with this works as well. How would we ensure that a large group of people get to actively participate? If not, then how might we engage observers? Another limitation in these ideas is that most of them are one-time, short experiences. How might we design systems that participants can interact with over longer time periods and still find them pleasurable? We also realize that this domain of food and storytelling, and the ability to 'play with one's food' comes from a lens of food abundance and privilege. How can we ensure that food is not wasted in these experiences? Broadly in HFI, it is also worth exploring how food can be kept fresh in such experiences, and how to take care of dietary restrictions and allergies.

8 CONCLUSION

We encourage interactive storytellers to consider food as an interaction mechanism, and we encourage HFI researchers to include narrative experiences, such that people can be active participants. This can elicit new ways of experiencing and appreciating food, encourage people to know more about gastronomy and degustation, discover the pleasure of being a part of a narrative world,

and turn attention to one's own body and physical well-being. We advocate for exploring food-based interactions in HFI and interactive storytelling beyond nutrition and health tracking, as food not only provides energy to the body but also nourishes the soul [31]. We explored this intersection of interactive narratives and food through brainstorming design ideas based on design concepts from interactive storytelling and food and play. Through these design ideas and common design themes, we encourage positioning food, the body, experiences with food (nostalgia, emotions, etc.), and actions with food (eating, mixing, making) as diegetic and interactive components in the experience which allow participants to impact and participate in the narrative. We hope this work provides design directions for multi-sensorial food based interactive storytelling for design in HFI, amusement parks, mixed reality spaces, interactive theater, museums, educational environments, and thematic restaurants exploring new ways of dining.

ACKNOWLEDGMENTS

Oğuz 'Oz' Buruk has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No 833731, WEARTUAL.

REFERENCES

[1] Kazi Masudul Alam, Abu Saleh Md Mahfujur Rahman, and Abdulmotaleb El Saddik. 2013. Mobile Haptic e-Book System to Support 3D Immersive Reading in Ubiquitous Environments. ACM Trans. Multimedia Comput. Commun. Appl. 9, 4: 27:1-27:20. https://doi.org/10.1145/2501643.2501649

[2] Ferran Altarriba Bertran, Jared Duval, Katherine Isbister, Danielle Wilde, Elena Márquez Segura, Oscar Garcia Pañella, and Laia Badal León. 2019. Chasing Play Potentials in Food Culture to Inspire Technology Design. In Extended Abstracts of the Annual Symposium on Computer-Human Interaction in Play Companion Extended Abstracts (CHI PLAY '19 Extended Abstracts), 829–834. https://doi.org/10.1145/3341215.3349586

[3] Ferran Altarriba Bertran, Danielle Wilde, Ernő Berezvay, and Katherine Isbister. 2019. Playful Human-Food Interaction Research: State of the Art and Future Directions. In Proceedings of the Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '19), 225–237. https://doi.org/10.1145/3311350.3347155

[4] Ferran Altarriba Bertran, Rosa Lutz, and Katherine Isbister. 2020. Where interaction design meets gastronomy: Crafting increasingly playful and interactive eating experiences. In Experiencing Food, Designing Sustainable and Social Practices (1st ed.), Ricardo Bonacho, Maria José Pires and Elsa Cristina Carona de Sousa Lamy (eds.). CRC Press, 38–46. https://doi.org/10.1201/9781003046097-6

[5] Jim Bizzocchi, M.A. Ben Lin, and Joshua Tanenbaum. 2011. Games, narrative and the design of interface. International Journal of Arts and Technology 4, 4: 460. https://doi.org/10.1504/IJART.2011.043445

[6] Jim Bizzocchi and Theresa Jean Tanenbaum. 2012. Mass Effect 2: A Case Study in the Design of Game Narrative. Bulletin of Science Technology Society 32, 5: 393–404.

[7] David Bordwell and Kristin Thompson. 1997. Film Art: An Introduction. The McGraw Hill Companies, Inc., New York.

[8] Jean Ho Chu, Paul Clifton, Hank Blumenthal, Abhishek Nandakumar, Balasubramanium Ganapathi, Janet Murray, and Ali Mazalek. 2015. Universal Threshold Object: Designing Haptic Interaction for Televised Interactive Narratives. In Proceedings of the Ninth International Conference on Tangible, Embedded, and Embodied Interaction (TEI '15), 285–292. https://doi.org/10.1145/2677199.2680563

[9] John W Creswell. 2003. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. Sage Publications, Thousand Oaks.

[10] Daniel Echeverri and Huaxin Wei. 2021. Designing Physical Artifacts for Tangible Narratives: Lessons Learned from Letters to José In Proceedings of the Fifteenth International Conference on Tangible, Embedded, and Embodied Interaction (TEI '21), 1–12. https://doi.org/10.1145/3430524.3446070

[11] Anne Galloway and Catherine Caudwell. 2018. Speculative design as research method: From answers to questions and "staying with the trouble." In Undesign: Critical "Practices at the Intersection of Art and Design, Gretchen Coombs, Andrew McNamara and Gavin Sade (eds.). Routledge. https://doi.org/10.4324/9781315526379-8

[12] Bill Gaver and Heather Martin. 2000. Alternatives: exploring information appliances through conceptual design proposals. In Proceedings of the SIGCHI conference on Human Factors in Computing Systems (CHI '00), 209–216. https://doi.org/10.1145/332040.332433

[13] Gheorghita Ghinea and Oluwakemi A. Ademoye. 2011. Olfaction-enhanced multimedia: perspectives and challenges. Multimedia Tools and Applications 55, 3: 601–626. https://doi.org/10.1007/s11042-010-0581-4

[14] Melanie C. Green and Keenan M. Jenkins. 2014. Interactive Narratives: Processes and Outcomes in User-Directed Stories. Journal of Communication 64, 3: 479–500. https://doi.org/10.1111/jcom.12093

[15] Saumya Gupta and Theresa Jean Tanenbaum. 2019. Evaluating the Pleasures of Agency in Shiva's Rangoli, a Tangible Storytelling Installation. In Proceedings of the 2019 on Designing Interactive Systems Conference (DIS '19), 49–60. https://doi.org/10.1145/3322276.3322380

[16] Saumya Gupta, Theresa Jean Tanenbaum, and Karen Tanenbaum. 2019. Shiva's Rangoli: Tangible Storytelling Through Diegetic Interfaces in Ambient Environments. In Proceedings of the Thirteenth International Conference on Tangible, Embedded, and Embodied Interaction (TEI '19), 65–75. https://doi.org/10.1145/3294109.3295635

[17] Daniel Harley, Jean Ho Chu, Jamie Kwan, and Ali Mazalek. 2016. Towards a Framework for Tangible Narratives. In Proceedings of the TEI '16: Tenth International Conference on Tangible, Embedded, and Embodied Interaction (TEI '16), 62–69. https://doi.org/10.1145/2839462.2839471

[18] Daniel Harley, Aneesh P. Tarun, Daniel Germinario, and Ali Mazalek. 2017. Tangible VR: Diegetic Tangible Objects for Virtual Reality Narratives. In Proceedings of the 2017 Conference on Designing Interactive Systems (DIS '17), 1253–1263. https://doi.org/10.1145/3064663.3064680

[19] Adafruit Industries. 2021. FLORA - Wearable electronic platform: Arduino-compatible. Retrieved May 12, 2020 from https://www.adafruit.com/product/659

[20] Azusa Kadomura, Koji Tsukada, and Itiro Siio. 2013. EducaTableware: computer-augmented tableware to enhance the eating experiences. In CHI '13 Extended Abstracts on Human Factors in Computing Systems (CHI EA '13), 3071–3074. https://doi.org/10.1145/2468356.2479613

[21] Rohit Ashok Khot, Jeewon Lee, Larissa Hjorth, and Florian "Floyd" Mueller. 2015. TastyBeats: Celebrating Heart Rate Data with a Drinkable Spectacle. In Proceedings of the Ninth International Conference on Tangible, Embedded, and Embodied Interaction (TEI '15), 229–232. https://doi.org/10.1145/2677199.2680545

[22] Rohit Ashok Khot and Jung-Ying (Lois) Yi. 2020. GustaCine: Towards Designing a Gustatory Cinematic Experience. In Proceedings of the Fourteenth International Conference on Tangible, Embedded, and Embodied Interaction (TEI '20), 757–770. https://doi.org/10.1145/3374920.3375010

[23] Naoya Koizumi, Hidekazu Tanaka, Yuji Uema, and Masahiko Inami. 2011. Chewing jockey: augmented food texture by using sound based on the cross-modal effect. In Proceedings of the 8th International Conference on Advances in Computer Entertainment Technology (ACE '11), 1–4. https://doi.org/10.1145/2071423.2071449

[24] Martijn J.L. Kors, Gabriele Ferri, Erik D. van der Spek, Cas Ketel, and Ben A.M. Schouten. 2016. A Breathtaking Journey. On the Design of an Empathy-Arousing Mixed-Reality Game. In Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '16), 91–104. https://doi.org/10.1145/2967934.2968110

[25] Zhuying Li, Rakesh Patibanda, Felix Brandmueller, Wei Wang, Kyle Berean, Stefan Greuter, and Florian "Floyd" Mueller. 2018. The Guts Game: Towards Designing Ingestible Games. In Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '18), 271–283. https://doi.org/10.1145/3242671.3242681

[26] Diana Löffler, Robert Tscharn, and Jörn Hurtienne. 2018. Multimodal Effects of Color and Haptics on Intuitive Interaction with Tangible User Interfaces. In Proceedings of the Twelfth International Conference on Tangible, Embedded, and Embodied Interaction (TEI '18), 647–655. https://doi.org/10.1145/3173225.3173257

[27] Ali Mazalek, Glorianna Davenport, and Hiroshi Ishii. 2002. Tangible Viewpoints: A Physical Approach to Multimedia Stories. In ACM Conference on Multimedia. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.6.4303&rep=rep1&type=pdf

[28] Ali Mazalek, Ali Wood, and Hiroshi Ishii. 2001. genieBottles: An Interactive Narrative in Bottles. In SIGGRAPH. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.16.3093&rep=rep1&type=pdf

[29] Ine Mols, Elise van den Hoven, and Berry Eggen. 2016. Technologies for Everyday Life Reflection: Illustrating a Design Space. In Proceedings of the TEI '16: Tenth International Conference on Tangible, Embedded, and Embodied Interaction (TEI '16), 53–61. https://doi.org/10.1145/2839462.2839466

[30] Florian "Floyd" Mueller, Richard Byrne, Josh Andres, and Rakesh Patibanda. 2018. Experiencing the Body As Play. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18), 210:1-210:13. https://doi.org/10.1145/3173574.3173784

[31] Florian "Floyd" Mueller, Tuomas Kari, Rohit Khot, Zhuying Li, Yan Wang, Yash Mehta, and Peter Arnold. 2018. Towards Experiencing Eating As a Form of Play. In Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play Companion Extended Abstracts (CHI PLAY '18 Extended Abstracts), 559–567. https://doi.org/10.1145/3270316.3271528

[32] Janet H. Murray. 2016. Hamlet on the Holodeck. Simon and Schuster.
[33] Takuji Narumi. 2016. Multi-sensorial Virtual Reality and Augmented Human Food Interaction. In Proceedings of the 1st Workshop on Multi-sensorial Approaches to Human-Food Interaction (MHFI '16), 1:1-1:6. https://doi.org/10.1145/3007577.3007587
[34] Takuji Narumi. 2016. Multi-sensorial Virtual Reality and Augmented Human Food Interaction. In Proceedings of the 1st Workshop on Multi-sensorial Approaches to Human-Food Interaction (MHFI '16), 1:1-1:6. https://doi.org/10.1145/3007577.3007587
[35] Marianna Obrist, Rob Comber, Sriram Subramanian, Betina Piqueras-Fiszman, Carlos Velasco, and Charles Spence. 2014. Temporal, Affective, and Embodied Characteristics of Taste Experiences: A Framework for Design. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '14), 2853–2862. https://doi.org/10.1145/2556288.2557007
[36] M. S. Premila. 2006. Ayurvedic Herbs: A Clinical Guide to the Healing Plants of Traditional Indian Medicine. Psychology Press.
[37] Özge Samanci, Yanfeng Chen, and Ali Mazalek. 2007. Tangible Comics: A Performance Space with Full-body Interaction. In Proceedings of the International Conference on Advances in Computer Entertainment Technology (ACE '07), 171–178. https://doi.org/10.1145/1255047.1255082
[38] Jay Silver and Eric Rosenbaum. 2012. MaKey MaKey. MaKey MaKey. Retrieved February 14, 2015 from http://makeymakey.com/
[39] C. Spence. 2019. Gastrophysics: a new scientific approach to eating. CRC Press. Retrieved February 10, 2021 from https://ora.ox.ac.uk/objects/uuid:969f804d-79c3-45a1-870d-6ca91acb1852
[40] Charles Spence, Marianna Obrist, Carlos Velasco, and Nimesha Ranasinghe. 2017. Digitizing the chemical senses: Possibilities & pitfalls. International Journal of Human-Computer Studies 107: 62–74. https://doi.org/10.1016/j.ijhcs.2017.06.003
[41] Karen Tanenbaum and Theresa Jean Tanenbaum. 2010. Agency as commitment to meaning: communicative competence in games. Digital Creativity 21, 1: 11–17. https://doi.org/10.1080/14626261003654509
[42] Karen Tanenbaum, Theresa Jean Tanenbaum, Alissa N. Antle, Jim Bizzocchi, Magy Seif el-Nasr, and Marek Hatala. 2011. Experiencing the Reading Glove. In Proceedings of the Fifth International Conference on Tangible, Embedded, and Embodied Interaction (TEI '11), 137–144. https://doi.org/10.1145/1935701.1935728
[43] Theresa Jean Tanenbaum. 2015. Identity Transformation and Agency in Digital Narratives and Story Based Games. Simon Fraser University, Surrey, British Columbia, Canada. Retrieved from http://summit.sfu.ca/item/15285
[44] Theresa Jean Tanenbaum and Jim Bizzocchi. 2009. Rock Band: A Case Study in the Design of Embodied Interface Experience. In Proceedings of the 2009 ACM SIGGRAPH Symposium on Video Games (Sandbox '09), 127–134. https://doi.org/10.1145/1581073.1581093
[45] Victoria Turk. 2017. This London restaurant is using 3D projection to bring food to life. Wired UK. Retrieved February 3, 2020 from https://www.wired.co.uk/article/le-petit-chef-dinner-theatre-projection-london-restaurant
[46] Carlos Velasco, Yunwen Tu, and Marianna Obrist. 2018. Towards Multisensory Storytelling with Taste and Flavor. In Proceedings of the 3rd International Workshop on Multisensory Approaches to Human-Food Interaction (MHFI'18), 2:1-2:7. https://doi.org/10.1145/3279954.3279956
[47] Yan Wang, Zhuying Li, Robert S. Jarvis, Angelina Russo, Rohit Ashok Khot, and Florian "Floyd" Mueller. 2019. Towards Understanding the Design of Playful Gustosonic Experiences with Ice Cream. In Proceedings of the Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '19), 239–251. https://doi.org/10.1145/3311350.3347194
[48] Danielle Wilde and Ferran Altarriba Bertran. 2019. Participatory Research through Gastronomy Design: A designerly move towards more playful gastronomy. https://doi.org/info:doi/10.1386/ijfd.4.1.3_1
[49] Sarah Wiseman, Janet van der Linden, Ad Spiers, and Maria Oshodi. 2017. Control and Being Controlled: Exploring the Use of Technology in an Immersive Theatre Performance. In Proceedings of the 2017 Conference on Designing Interactive Systems (DIS '17), 3–14. https://doi.org/10.1145/3064663.3064694
[50] 2016. Batman in 4DX with fake rain and added smells? Bring it on | Film | The Guardian. Retrieved February 3, 2020 from https://www.theguardian.com/film/2016/mar/10/4dx-cinema-new-york-batman-v-superman-fake-rain-smells
[51] 2020. Chorizo. Wikipedia. Retrieved May 12, 2020 from https://en.wikipedia.org/w/index.php?title=Chorizo&oldid=954987388
[52] 2021. Edible Cinema at the Science Museum: Eat along to Charlie and The Chocolate Factory | London Evening Standard. Retrieved February 3, 2020 from https://www.standard.co.uk/go/london/edible-cinema-at-the-science-museum-eat-along-to-charlie-and-the-chocolate-factory-a2921716.html
[53] 2021. Homepage | Gingerline Group. Retrieved May 12, 2020 from https://www.gingerline.co.uk/
[54] 2021. Mad Mixologist – IndieCade. Retrieved February 22, 2020 from https://www.indiecade.com/mad-mixologist/
[55] 2021. Drink Up Fountain. YesYesNo Interactive projects. Retrieved May 12, 2020 from http://www.yesyesno.com/drink-up-fountain
[56] 2021. LICKESTRA – Emilie Baltz. Retrieved May 12, 2020 from http://emiliebaltz.com/experiments/lickestra/
[57] Meow Wolf - An Immersive Experiences Company. Retrieved January 6, 2020 from https://meowwolf.com/
[58] "Untitled" (Portrait of Ross in L.A.). The Art Institute of Chicago. Retrieved February 2, 2021 from https://www.artic.edu/artworks/152961/untitled-portrait-of-ross-in-l-a
[59] Alison Knowles | Make A Salad, 1962. Art Basel. Retrieved February 2, 2021 from https://www.artbasel.com/catalog/artwork/39164/Alison-Knowles-Make-A-Salad
[60] Annotated portfolios and other forms of intermediate-level knowledge | ACM Interactions. Retrieved February 10, 2021 from https://interactions.acm.org/archive/view/january-february-2013/annotated-portfolios-and-other-forms-of-intermediate-level-knowledge
[61] Shrek | Official Site | DreamWorks. Retrieved February 10, 2021 from https://www.dreamworks.com/movies/shrek
[62] 12 Powerful Ayurvedic Herbs and Spices with Health Benefits. Healthline. Retrieved May 12, 2020 from https://www.healthline.com/nutrition/ayurvedic-herbs
[63] Opaque - Dining in the Dark, LA - Santa Monica, CA on OpenTable. www.opentable.com. Retrieved May 12, 2020 from https://www.opentable.com/opaque-dining-in-the-dark-la