SpiceWare: Simulating Spice Using Thermally Adjustable Dinnerware to Bridge Cultural Gaps

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Figure 1: Prototyping process of SpiceWare, where 1) we first modeled the spoon to be able to fit a thermal peltier at the head position easily, 2) testing, from left to right, stainless steel, pure aluminium, and alloy of aluminium and tin for their thermal conductivity, and 3) the final prototype that allows the user to control the temperature while eating

ABSTRACT

Preference and tolerance towards spicy food may vary depending on culture, location, upbringing, personality and even gender. Due to this, spicy food can often effect the social interaction on the dining table, especially if it is presented as a cultural dish. We propose SpiceWare, a thermally adjustable spoon that alters the perception of spice to improve cross-cultural communication. SpiceWare is a 3D-printed aluminium spoon that houses a thermal peltier that provides thermal feedback up to 45°C which can alter the taste perception of the user. As an initial evaluation, we conducted a workshop among participants of varying cultural backgrounds and observe their interaction when dining on spicy food. We found that the overall interaction was perceived to be more harmonious, and we discuss potential future works on improving the system.

CCS CONCEPTS

• **Hardware** → **Temperature control**; • **Social and professional topics** → *Cultural characteristics.*

KEYWORDS

gustatory, spice augmentation, dinnerware, cross-cultural gap

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1 INTRODUCTION

The factors that influence our preference and tolerance towards spicy food greatly varies [2–4]. Yet cultural background remains a significant factor especially in social scenarios. Ludy and Mattes [8] found that the average daily chili pepper consumption from Asian nations are 16 times more that the United States. Additionally, it was found that the taste threshold of people from Thailand are significantly higher than from Japan, leading to higher spicy food consumption [16]. This is potentially attributed to the climate, where spicy food contain more antibacterial properties that are necessary to rid food of pathogen that arise from hot climates [6]. To overcome this, we explore gustation augmentation methods so that those with varying spice tolerances may potentially enjoy the same dish together.

From previous works, electrical stimulation is a popular method to simulate taste, specifically sour, bitter and salty flavours [10–12]. MetaCookie [9] proposed a method to change taste using augmented reality (AR) and scent. Tag Candy [14] also proposed a way to change the perceived taste of candy based on cross-modal effects evoked by vibration and sound. Hasimoto et al. [7] proposed the SUI (Straw User Interface) that allows users to virtually experience drinking water using an ordinary straw attached to the system.

One of the closest related work is by Yoshida et al. [1] that used the thermal grill illusion to simulate spiciness. Yet, these works did not explore the cultural effects, nor were they practical for an actual eating scenario.

To that end, SpiceWare's contributions are threefold: 1) We propose a thermally adjustable dinnerware where users can adjust the perceived spiciness of their dish using an embedded thermal peltier in a spoon, 2) we evaluated the prototype for its effect on cross-cultural interaction and how regulating perceived spiciness of dishes is able to improve their experience, and 3) we found that cross-cultural communication was enhanced and individuals participated in the workshop had a satisfying dining experience.

2 SPICEWARE PROTOTYPE

2.1 Form Factor

We selected the spoon-based form factor for several reasons. Firstly, there was overall a lack of related works regarding this form factor as researchers have explored chopsticks [13], soup bowl [13], and cups [15]. Yet, a spoon makes a lot of sense for eating specifically spicy food like curry. Additionally, we aim to explore the cross-cultural effects of dining together. The use of chopsticks are still not as ubiquitous as that of using a spoon due to a higher learning curve. Lastly, we were interested to explore dinnerware with a large contact area to not just the tongue, but to also the surrounding lips which are more sensitive to temperature change [5]. The design of SpiceWare can be seen on Figure 1(1), where the spoon is hollowed out to fit a thermal peltier[1]. At the middle of the spoon where it is least thick, a concave notch of $2x2$cm is designed for the placement of the peltier for better heat transfer. A conjunction is designed for ease of assembly and disassembly without any kind of fasteners.

2.2 Material Selection

For the material, we considered two aspects: weight and thermal conduction. From these considerations, we narrowed down to three 3d-printed materials, which are stainless steel, aluminium and aluminium alloy as shown in Figure 1(2). These materials are light, low cost to produce, and have high thermal conductivity at room temperature. We ran a short pilot test with 13 participants and asked them to compare the spoons and vote on their preferred material in terms of their weight and thermal conductivity when a thermal peltier was heated up to certain level. We found that aluminium overall received the highest vote, followed by stainless steel and aluminium alloy due to the thermal conductivity being significantly higher and weighting only 90 grams. Additionally, a maximum temperature of 50°C was preferable before the spoon was deemed too hot to be held.

3 INITIAL STUDY AND FEEDBACK

The goal of the study is to determine if SpiceWare can potentially enhance cross-cultural communication during meals involving spicy food. Six participants (4 females, mean:25, SD:2.0) were recruited for the study. They were each required to state their nationality (2 Japanese, 2 Chinese, 1 United Kingdom, and 1 biracial Japanese and Chinese), preference, and tolerance towards spicy food on a 10-point Likert scale. Each participant was seated around a round table to encourage eye contact and face-to-face interaction. Shown in Figure 2, they were provided with a bowl of commercially-available instant curry with a spice level determined on the packaging (level 5 which is the most spicy). Starting with a spoon of level 5 spicyness as shown in Figure 2, they are then divided into three groups depending on their rated spicy level. Group 1 thought the curry was too spicy, group 2 thought it was satisfactory, and group 3 thought it was not spicy enough. Next, they used SpiceWare to augment the perceived spice level for a second spoon of curry. Group 1 used it at 20°C, group 2 at their preferred levels, and group 3 at 40°C. Throughout the process, their interaction and conversation were continuously monitored. After 10 minutes, they were then interviewed to provide feedback regarding the overall experience.

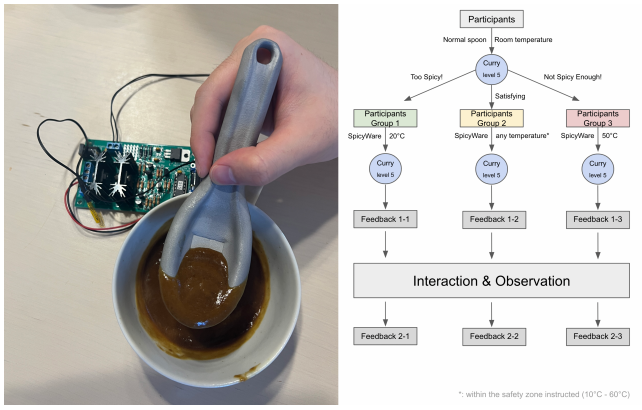

Figure 2: Eating curry with SpiceWare and the study design

From our observation, group 3 had the most favourable response. One of the participants stated that the "taste of the curry magically changed" to taste more spicy. It also created a smoky smell from the heating which contributed to the sensation. On the other hand, group 1's results were neutral. A participant thought that the "change of spice did not change significantly", and the curry was still too spicy. We believe that people are more susceptible to the perception of spice when the temperature increases compared to when it decreases. Additionally, the participants from group 2 adjusted the SpiceWare to about 30°C, yet did not find any significant change to the curry's spicyness as they were already satisfied with it. The overall flow of the conversation was regarding the perceived spiciness, and all participants mentioned that they were satisfied with the experience and that the interaction felt harmonious. 5 out of 6 participants also mentioned that they would like to use the system for future dining occasions.

4 CONCLUSION AND FUTURE WORKS

We propose SpiceWare, a thermally adjustable dinnerware meant to aid in cross-cultural communication. From our preliminary findings, we will further improve the prototype design for better thermal conductivity to reduce any delay in heating the spoon and perform a controlled experiment with a larger sample size.

[1]https://www.mycomkits.com/SHOP/MK-515-BUILT.html

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