EducaTableware: Computer-Augmented Tableware to Enhance the Eating Experiences

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ABSTRACT
We propose "EducaTableware (Educate/Tableware)", a design for interactive tableware devices that makes eating more fun and improves daily eating habits through auditory feedback to encourage specific mealtime behaviors. We have developed two kinds of device: "EaTheremin" is a fork-type device used for eating, and "TeaTheremin" is a cup-type device used for drinking. These devices emit sounds when a user is consuming a food item. In this paper, we discuss the EducaTableware concept, describe the implementation of EaTheremin and TeaTheremin, and show the usages.

Author Keywords
Children; Dietary Education; Gamification; Tableware; Ubiquitous Computing

ACM Classification Keywords
H.5.m [Information Interfaces and Presentation (e.g. HCI)]: Miscellaneous.

INTRODUCTION
Dietary education has become an important public issue. In 2005, the Japanese government passed the Basic Law on SHOKUIKU[1] to promote dietary education

[1] "SHOKUIKU" means "dietary education" in Japanese.

for citizens including children to enjoy an active life and live healthy. The policy notes that unbalanced nutritional intake and unhealthy dietary habits such as lack of vegetable intake have increased, and mandates dietary education in kindergartens from 2009 onwards. Although most kindergartens have conducted dietary education sessions, such education appears to have limited effect. When we asked about the matter, four kindergarten teachers stated, "Even if teachers tell children about nutrition, it is difficult for parents to maintain standards at home". Then, we think that a gamification approach using computer technology to make everyday activities fun can be applied to helping children improve their eating habits. In the past, such research has typically focused on food environments, such as dining tables and dishes [1] [2]. Against this background, we focus on the eating/drinking activity itself, and propose a new approach named "EducaTableware (Educate/Tableware)". EducaTableware is computer-augmented tableware that

Figure 1. Conceptual Figure of EducaTableware

emits sounds when a user eats or drinks (Figure 1). EducaTableware aims to enhance human-food interaction using computer technology, encourage children to eat through gamification, and help in dietary education during mealtimes at home.

DESIGN CONCEPTS

According to our survey with 112 parents that was carried out on a paper-based questionnaire, "dislikes[2]" and "unfocused[3]" were two of important concern in the dietary education. We have designed our system focusing on these results of the survey.

—Interaction Design

We considered the actions associated with the eating process: spearing food with a fork, moving the food to the mouth, and biting (eating) into the food. In this paper, we focused on the biting/drinking action since we thought it was most suited for dietary education of children: augmenting the spearing or moving actions may encourage a child to merely play with food without eating it. Our devices change sounds depends on several input values: the resistance value of the food item that differs by food type, the number of biting times after start eating and the interval of biting.

—Feedback Design

To encourage children to eat through gamification, we decided to generate feedback when a user eats (bites into) a food. There are several possible types of feedback, such as visual (e.g., picture/animation), auditory (e.g., sound/music), and tactile (e.g., vibration). Visual feedback has high expressiveness but may reduce a child's focus on eating; in fact, eating in front of visual displays such as a laptop or a TV is a well-known social problem [3]. Tactile feedback has

[2] The child dislikes certain foods.

[3] The child cannot concentrate on his/her eating.

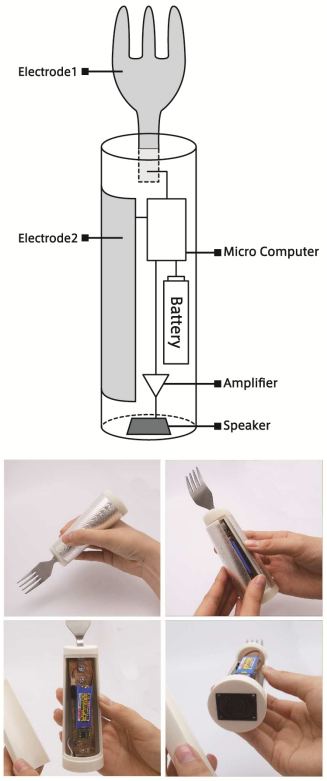

Figure 3. EaTheremin Device

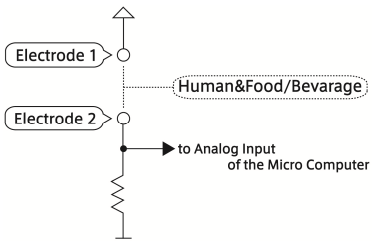

Figure 4. Sensing Circuit

limited expressiveness and is unlikely to please children.

We thus selected auditory feedback, which is expressive without being distracting. We pre-recorded two types of sounds: (1) onomatopoeic sounds related to eating (e.g., Paku) that are familiar to most people in Japan and (2) the sounds/voices of popular cartoon characters. We can change the sounds easily depending on a child's preferences.

We prepared about 10 sounds per device in view of the limited memory size. The system selects a sound to play on the basis of several parameters (e.g., food type) and a random factor to solve the "dislikes" problem, i.e., to motivate children to eat new foods. Moreover, we believed that the system might solve the "unfocused" problem by attracting children's attention to the meal. In addition, we believe that auditory feedback is a natural accompaniment to dinnertime conversation.

—System Design

To allow the system to be used conveniently at dinnertime, we integrated it into familiar tableware. We embedded all the electronic components (e.g., a microcomputer, a speaker, and a battery) into a device for standalone use in the daily environment. We believe that people can easily use our augmented tableware, since they can treat it as normal tableware.

IMPLEMENTATION AND USAGES

We have developed two prototypes: the fork-type prototype EaTheremin, which focuses on the eating act, and the cup-type prototype TeaTheremin, which focuses on the drinking act. Both prototypes use the same sensing mechanism to detect the moment when a user eats or drinks something (Figure 2). Each device has a pair of electrodes: EaTheremin uses the fork tines and grip as electrodes and the TeaTheremin uses the cup bottom and grip. These devices detect weak electric current through the human body, foods, and two electrodes. The current varies based on the resistance values of foods or beverage. The sounds change in response to input values (e.g., these resistance values, number of eating times, or eating interval).

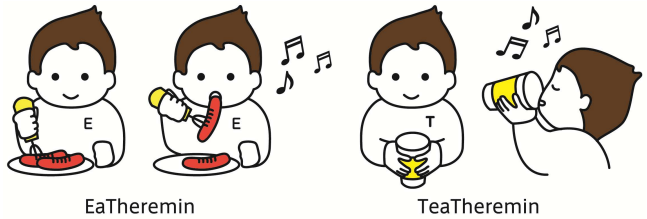

Figure 2. Sound Generating Timing

—EaTheremin

EaTheremin emits pre-recorded sounds when a user touches foods to his/her mouth; that is, the system generates a single sound with each bite.

Our previous prototypes of EaTheremin [4] required external boards and speakers that were connected by wires. After conducting a pilot user study with the previous prototypes with five children for one day at their homes, we found that most children and parents were concerned about the wires. Therefore, we have developed a "standalone" prototype that contains all the electrical components (a microcomputer, an amplifier, a speaker, and a battery) within its casing. As shown in Figure 3, the metallic tines of the fork and the metal grip act as electrodes. The grip conceals a speaker to generate sounds, an amplifier to amplify the audio signal, a microcontroller (Arduino Pro Mini) to control these devices, and a rechargeable battery. The

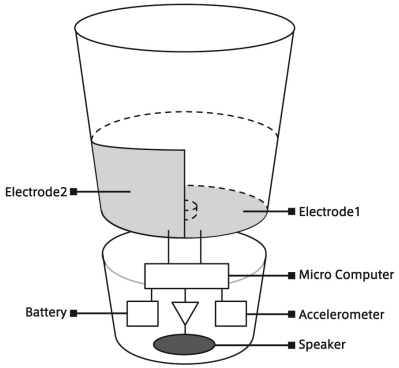

Figure 5. TeaTheremin Device

Figure 6. Multi-user Interaction

speaker is connected to the pulse-width modulation (PWM) pin of the Arduino through the amplifier. The system loads binary-encoded audio clips from the external memory (EEPROM). The tine electrode is connected to the supply voltage, while the grip electrode is connected to the analog input of the Arduino. When a user eats using this fork, the system detects electric current through the tine electrode, the human body (hand and mouth), the food, and the grip electrode (Fig. 4).

—TeaTheremin

TeaTheremin consists of a cup part to hold the beverage and a device part to contain electrical components (Figure 5). The basic mechanism is similar to EaTheremin. The cup part has two electrodes: one is attached around the cup and the other is attached at the bottom. The device part consists of an accelerometer (KXM52-1050) to detect the tilt of the device for future use, a speaker to generate sounds, a microcontroller (Arduino Pro Mini) to control the above devices, and a rechargeable battery. The bottom electrode is connected to the supply voltage, while the side electrode is connected to the analog input of the Arduino Pro Mini. When a user drinks from this cup, the system detects electric current through the side electrode, the human body (hand and mouth), the beverage, and the bottom electrode (Figure 4).

Our devices can also emit sounds with two users: that is, one user holds the EaTheremin and feeds another user by holding his/her hand (Figure 6). For example, parents often feed their young children because the children cannot eat unassisted.

DEMONSTRATION and USER STUDY

We have demonstrated our previous wired-fork devices three times in Asia. The total participants were around 600. The current wireless devices have been used by actual three families for one week each, to evaluate the usability and effects on eating habits. We found that our devices were enough robust for continuous use and had positive effects on children's eating habits.

CONCLUSION

We proposed the EducaTableware approach that generates sounds when a user eats or drinks in order to encourage good eating habits. We implemented two devices: EaTheremin, which generates sounds when a user is eating, and TeaTheremin, which generates sounds when a user is drinking. Our most important motivation is to make the family smile at dinner and encourage children to eat healthily and happily. We believe that providing novel stimuli along with food, we can encourage children to develop greater interest in food.

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