A Persuasive Game to Encourage Healthy Dietary Behaviors of Kindergarten Children

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ABSTRACT

We have explored the design of an interactive, persuasive game to assist adults to improve dietary behaviors of kindergarten children. The persuasive game is played over a smart lunch tray. The smart lunch tray incorporates both context-awareness and interactive media persuasion, enabling the creation of a persuasive smart object.

INTRODUCTION

Studies have shown that our dietary habits are developed during the first few years of our childhood experiences with foods. Our preferences for specific foods come about mainly through the following three factors: (1) the sensory flavor of the food, (2) the post-ingestional effects of the food, and (3) the frequency of the food eaten. Among them, the frequency of the food eaten can be controlled by proper parenting. That is, a child may obtain a dislike of a certain food because he/she has never tried to taste the food or tried frequently enough to become accustomed to its taste, shape, color, texture, etc. Over time, this dislike grows into a permanent dietary habit. Proper and smart parenting can help reverse such specific food aversions. However, most parental experiences can reflect that verbal persuasions can be ineffective and overly time consuming for many young children.

To address this problem, we have designed and implemented an interactive game to assist parents (or educators) in encouraging healthy dietary behaviors of their young children (3-6Y). The interactive game is played over a sensor-augmented lunch tray that can detect a child's dietary behaviors. In addition, a small LCD display, embedded as a tile on the lunch tray, is used to show the state of the interactive game on the lunch tray. Our design combines the *context-awareness* and the *interactive media technique* in persuasive computing into a *persuasive smart object*.

There are been several work on applying computing to human persuasion and behavior modification. Fogg [2] listed basic principles for designing persuasive technology. These principles are adapted in our design described later. Out [3] designed a high-tech doll that looks like a human baby to simulate how hard it is to care for a baby.

DESIGN CONCIDERATIONS

Since our target users are young children, we have identified the following three design considerations. The first design consideration is that most young children are not capable of operating digital devices. Therefore, our game design relies on using the child's *natural eating actions* as inputs. The second design consideration is to minimize the change on the lunch-ware (objects) accustomed to young children during their normal eating routines. This prevents our installed sensors from adversely affecting the young children's normal eating. The third design consideration takes into account the limited cogitative level of young children. The design of our interactive game must be simple enough for them to understand and attractive enough to draw and maintain their attention. More importantly, the game must have a persuasive ingredient in encouraging the desirable behavior - eating and finishing all the food items placed on the lunch tray. The game design adapts a common strategy used in behavior modifications: applying a positive reinforcer to the desired behavior - if the young child finishes all the food items, the cartoon characters will be fully colored and look gorgeous; on the other hand, if the young child avoids eating a specific food item, the color corresponding to that food item will be missing and the cartoon character will look incomplete and unattractive.

Figure 1. A child eats on an awareness-enhanced smart lunch tray with a media-feedbacks monitor.

DESIGN AND IMPLEMENTATION

The design of our system is shown in **Figure 1**. A child eats on an awareness-enhanced lunch tray with a media-feedback display. The smart lunch tray is made up of an array of weighing sensors embedded underneath the bottom of the tray, shown in **Figure 2**, which recognizes tabletop dietary behaviors of a child. The recognized behaviors are then fed as inputs to the interactive game to provide persuasive feedbacks.

Smart Lunch Tray

Our current smart lunch tray prototype has a dining surface of 30x45 cm^2, which is about the size of a small lunch tray for children. The tray is divided into a matrix of 2x3 cells, each with the size of 15x15 cm^2. Except the middle top cell which is a small LCD display, each of the rest five cells

contains a weighing sensor, and the weight sensor detects how much weight a child eats from the food container placed on the cell. To simplify our design, each food container is fixed on one and only one cell. This is done by simply gluing the food container to a corresponding cell. The mapping between the food content and each container is entered manually into our system by the child's parents. We also assume that a child can use a fork/spoon or hands to pick up food from a food container and puts into mouth directly.

A child's eating activity is recognized by the *Weight Change Detector* shown in **Figure 2**. It performs two tasks: (1) it aggregates weight samples collected from each of the 6 weighing sensors; and (2) it reports *Weight-Change* events of food containers by filtering out noises in the stream of weight samples. These weight change events are interpreted into the amount (weight) of food consumed by a child from these food cups on the tray. These weight change events are then fed as inputs to the *Persuasive Game* component described next.

Persuasive Game
To persuade children to eat all food items on the lunch tray, we take the strategy of positive, just-in-time feedbacks. The positive feedback isn't just about giving praises, but it also means rewards and incentives for trying to eat food items which they dislike. Experts say that the positive feedback is the most powerful tool parents have to improve their children's behaviors [1]. By sensing a desirable behavior and then providing just-in-time feedback, a computer system can help a child easily learn the causal relationship between a desirable behavior, e.g. finishing all food items on the lunch tray, and a positive feedback. In addition, as the targets of our work are children, we have added the ingredient of fun in the persuasion, by making it an interactive game.

Based on the idea of positive feedbacks, we have designed a game to let a child play while they are eating as shown in **Figure 2**. The game is to color the picture of a child's favorite cartoon character. The positive feedback of our persuasive game is turning their favorite character into a pretty and colorful one. Specifically, each food item corresponds to a particular crayon color, and the color will be drawn on the character when the corresponding food item is eaten. To make his/her favorite cartoon character colorful, a child is then motivated to eat and finish all food items on the table, including food items that he/she dislikes.

EVALUATION
We tested our prototype implementation on a child (Alicia) who was 3 years and 8 months old. We placed 5 cups of fruits shown in **Figure 2**, containing small bites of apples, bananas, papayas, wax apples (tropical fruit), and dragon fruits (tropical fruit). Alicia's parents told us that (1) she did not like dragon fruit and banana, (2) she enjoyed coloring cartoon character very much, and (3) her favorite cartoon character was a tiger-like character shown in the upper

middle block of **Figure 2**. The result showed that Alicia comprehended the game and was actively trying different fruits to color her favorite character.

Figure 2. The smart lunch tray and the persuasive game.

Based on the previous result, we extended our study to 10 NTU kindergarten students of age 4 to 5, who have been identified by their teachers as having unbalanced dietary habits. We first interviewed these 10 children to understand (1) why they disliked eating certain food, and (2) under what situations they would try the disliked food. After the interview, we let the children play our game. We observed and recorded their behavior during their play, and then asked questions on what they think about the game.

Our first finding is that the game is easy and simple to understand for the young children – one bite of food leads to some coloring of the cartoon character. The children found two fun aspects of the game. The first fun aspect is the novel linkage between eating food and drawing cartoon character – they have never thought that it is possible to mix the playing and eating activities together. The second fun aspect is to explore and learn the mappings between the food items and the drawn colors. This exploratory aspect creates incentive for children to try food items, which they may previously disliked, just to see what color appears where on the cartoon character. Our second finding is the important social aspect of game play. While some children were playing with the game, some of their friends were spectators watching from the side. The enthusiasm from some spectators was noticeably passed into the at-play children who initially seemed half-hearted but were later changed to become absorbed into the game.

FUTURE WORK
We will apply the social factor among young children (according to our user study) and explore more factors that may influence children's dietary behavior. We will compare the effectiveness of a persuasive game with traditional verbal persuasion. Furthermore, we will incorporate persuasive games to shape other behaviors, such as brushing teeth, cleaning a room, etc.

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