Gravitamine Spice: A System that Changes the Perception of Eating through Virtual Weight Sensation

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ABSTRACT

The flavor of food is not just limited to the sense of taste, but also it changes according to the perceived information from other perception such as the auditory, visual, tactile senses, or through individual experiences or cultural background, etc. We proposed "Gravitamine Spice", a system that focuses on the cross-modal interaction between our perception; mainly the weight of food we perceived when we carry the utensils. This system consists of a fork and a seasoning called the "OMOMI". User can change the weight of the food by sprinkling seasoning onto it. Through this sequence of actions, users can enjoy different dining experiences, which may change the taste of their food or the feeling towards the food when they are chewing it.

Author Keywords

Cross-modal; Interactive System; Virtual Reality; Augmented Reality, Entertainment System.

ACM Classification Keywords

H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

INTRODUCTION

Nutrition is an essential part of our lives. We acquire our nutrients mainly through our intake of food. However, food is not just limited to help our body system. We also place importance to enjoy the flavour and texture of the food. Our perception of food are highly influenced by our five senses. For example, the table settings, the outlook of the food, the smell from the food and etc. One interesting properties we would like to focus on, is how the different characteristics of tableware can influence our perception of food. Researchers such as Vanessa Harrar and Charles Spence, have conducted studies to learn more about the influences of different sizes, colours and shapes of tablewares on our perception of food [1]. Interestingly, they found a strong relationship between these study matters. Our proposed system utilise this cross-modal interaction between tableware and our perception of food to observe how the characteristic of food can be changed.

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Numerous researches have detailed reports about utilising cross-modal interactions [2][3][4]; aiming to observe the changes in sensation while one is dining, by controlling the tactile, visual, and auditory sensations. Among the difference sensations, we decided to focus on changing one's perception of the weight of food through the tableware. Psychologically, we tend to presume that heavier objects has a higher value due to its weight [5]. A common action while shopping for groceries is to check the weight or density of the goods before purchasing. Interestingly, in the Japanese language, there are numerous onomatopoeia which express the sense of weight as well. These few examples show that there is a connection between the perception of weight and flavour of food which influences one's eating experience.

Here, we propose "Gravitamin Spice", a system to illude the weight of food. The concept utilizes a common eating gesture to control the weight interactively, by sprinkling seasoning onto the food. Through this illusion, we will like to observe how can one's taste sensation be augmented by changing the weight of food. In this paper, we will discuss in more details about the mechanism of the system and an experiment conducted to observe the relationship between the different weight and perception of flavour. In addition, we will also present feedbacks from users who have tested our system..

RELATED WORKS

Relationship between Food and Cross-modal

Gravitamine spice is designed using the cross-modal interaction between two or more distinct sensory modalities. For example, one can hardly taste anything during a nasal congestion, as the sense of smell has been restricted. This shows a cross-modal interaction between the sense of taste and smell [8]. In addition, reports have mentioned that

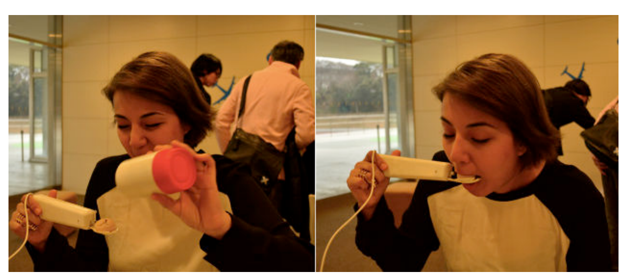

Figure 1. Gravitamine Spice

80[%] of the sense of taste presumed by people is caused by the sense of smell. This has been commonly applied in numerous situations to augment the taste of food. For example, caramel essence are added to sweeten caramel flavoured tea [7].

In addition, the surrounding environment, such as the colours or the shapes of tableware [1][9], also have strong influences on flavours. Many previous interactive systems are built upon this cross-modal relationship. For example, Narumi et al. proposed a system, composed of a Head Mounted Display to display different smell and colours to the users, without changing the chemical composition of the food. They conducted an experiment to observe how users perceived the taste and obtain relatively positive results [3]. In another research, Narumi et al. also introduced a method to change the perception of satiety and to control the nutritional intake, by altering the apparent size of food with augmented reality [4]. In addition, Narumi et al. also verified that visual feedback can help reduce exhaustion [10]. Koizumi et al. have also conducted a survey to assess the influence on flavours by adding different textures using haptic or auditory information [2]. Their system feedbacks the chewing sound from the mouth to the hearing sense. By utilising these cross modal interactions, it is possible to change one's perception of tiredness or satisfaction etc. Similarly, our system also focuses on changing one's taste perception or to influence one's eating posture by altering one's perception of the weight of food.

Relationship between Food and Interactive Technology

Various reports related to applications in entertainment systems or augmenting eating experiences have already been presented. Yamaoka implemented an interactive system, known as "Tag Candy", to provide variable textures to the mouth through tactile sensation [11]. Hashimoto et al. proposed an entertainment system, known as the Straw-like User Interface, which produces tactile sensations to the lips and mouth by using vibration and sound production [12]. Nakamura et al. proposed an entertainment system designed to implement electronic taste, a sense your tongue feels when it gets electrically stimulated [13]. Their method utilises actuators to stimulate the touch senses in the mouth. On the other hand, we proposed an interactive tableware system to change what users perceived of their food.

Various innovative entertainment systems control the sound and visual information when one is eating. Komura et al. proposed "EducaTableware", a design for interactive tableware devices to enhance the enjoyment of eating and to improve one's eating behaviour through auditory feedback, by encouraging specific mealtime behaviour [14]. Mori at el. proposed a system that enriches visual appearances of dishes at a dining table by using projection [15]. Our interactive system also aims to enhance a new eating experience by augmenting the weight of food using spice, for people to be more aware of their food texture.

Methods to Create Virtual Weight

SPIDAR [16] and PHANTOM [17] are a few of the prior systems to create virtual weight or force. However, the large scale of their devices may have an effect on the user visually and also may limit the range of user's movements when placed on top of the dining table. Due to these influences, user may be challenged when trying to perceive the change of flavour.

Our system creates the virtual weight by changing the balance of moment. Yamaoka et al. verified that by controlling the mass distribution, it is possible to change one's perception on length [18]. Okazaki et al. also showed a method to control the perception of a striking position in a bar-shaped object [19]. These works show that it is possible to change the weight by controlling the centre of gravity.

Omosaka et al. also focused on the centre of gravity, by verifying the influence of mixed reality visual stimulations on the centre of gravity, in mixed reality environments [20]. However, their methods required a head mounted display which may also influence one's perception. Here, we proposed a method to control the centre of gravity by changing the balance of moment of the interface.

GRAVITAMINE SPICE

Influence by the Changing Perception of Food Weight

The system aims to change the flavours by perceiving the weight of food before eating. The trial was based on the hypothesis that people commonly predict the flavours from their perception of weight through the tableware, before they eat. For example, when users hold a heavier cream puff, they may assume that the contents in the food is richer.

Users may predict a cracker to be harder, or marshmallow to be stickier, or an illusion that there are more cotton candy than what it is in reality. The system aims to change the flavours of food by changing the perception of weight. The psychological model of the relationship between the weight of food and the predicted food texture is based on the skills that users learned from their eating experiences. Therefore, it is anticipated that there will be variable results from different users. Therefore, it is expected that there will be variable results from each user.

Foods Used to Create an Experience

We decided to choose a common mass-produced sweets as users are familiar with the taste. Figure 2 illustrates the food appearance. We used chocolate choux sold by LAWSON, INC, a snack which contains chocolate in the choux, quite similar to a cream choux. We also prepared crackers sold by KAMEDA SEIKA CO., LTD., marshmallow sold by EIWA Co., Ltd., and cotton candy sold by SAITO Co., Ltd..

However, these snacks are not commonly used with fork, which may cause some influences on the flavour during the experience. To reduce these influences, we designed the experiment whereby the user will compare consuming the same snack twice; with and without adding the virtual weight.

System Configuration

Figure 3 illustrates a diagram of the system configuration. The system consists of a fork and a seasoning called "OMOMI". In order to control the virtual weight interactively, an accelerometer is used to detect the number of times the seasoning device was shaken, and a photo reflector sensor attached to the fork device is used to detect whether a food is placed on the fork or not. Based on the data from both the accelerometer and the sensor, the system will control the centre of gravity by using a motor slider inserted in the fork interface.

Figure 4 shows the appearance of the interfaces. The system is composed of common daily tools, a fork and a seasoning, as they are intended to create a different daily life experience. Disposable fork can be attached to the fork interface, allowing the change of disposable fork for each experience. This is mainly for sanitary purposes.

Method to Create the Virtual Weight

Our system alters the virtual weight of the food by changing the centre of gravity in the fork interface. Figure 5 shows the inner appearance displaying the virtual weight, or not. When the holding point is a fulcrum and the weight point is a power point, it is possible to display the virtual weight by moving the weight to the top of the fork interface.

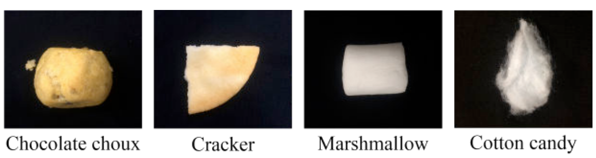

Figure 2. Food used in experience

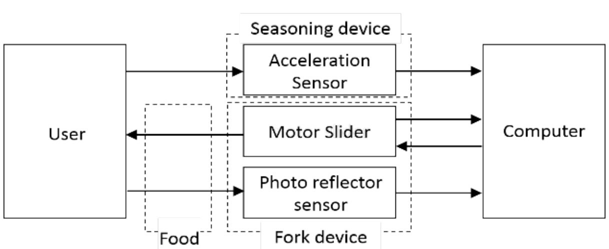

Figure 3. System configuration

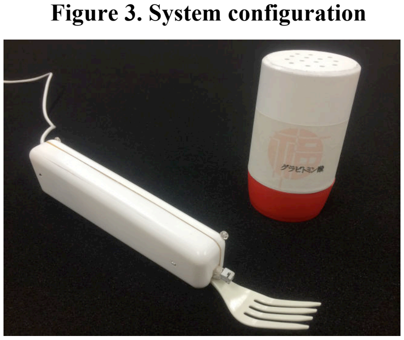

Figure 4. System Overview

Unlike previous systems [16][17], our system can display the virtual weight regardless of the physical properties of the participants, or on the holding style of the participants. In addition, there will not be any changes to the composition or looks of the food. This prevents outer influences to the user, allowing user to concentrate when consuming the food. However, holding the device with a strong grip may interfere with the perception of the virtual weight. Therefore, we instructed a unified method to hold the device.

The mechanism of the device is implemented by using a slider to move the weight within the fork interface. This fork interface weighs about 140g and has a length of 23[cm]. The slide in the fork interface can shift about 52[g] of weight by 10cm using a motor.

Interactive System Using a Seasoning Interface

Users can control the weight of food by sprinkling the seasoning interface onto the food. The more the user sprinkles on the food, the heavier the weight of the food will be. This interactive system does not only limits to increasing the food weight, but also user can enjoy sprinkling the seasoning, creating an entertainment experience to augment daily dinner.

The interactivity of the system is mainly by connecting the virtual weight with the amount of sprinkles of the special seasoning. This seasoning is composed of a triaxial acceleration sensor to detect the sprinkles, where the maximum amount of sprinkles to reach the maximum weight is approximately 10 times. The speed of this action is adjusted according to the users' feedbacks.

VERIFICATION OF THE VIRTUAL WEIGHT PERCEPTION

Aim of the Experiment

The purpose of the experiment is to examine the indication of virtual weight mechanism in conversion mass. Figure 6

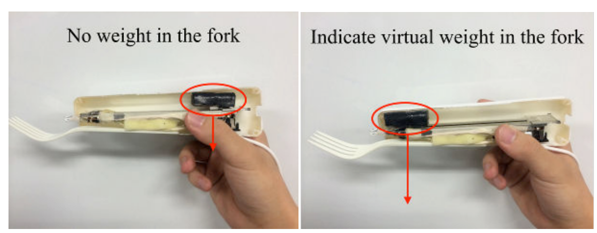

Figure 5. Internal appearance of the device

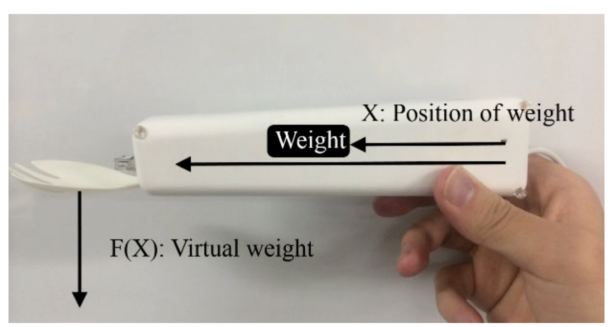

Figure 6. Mechanism of virtual weight change

depicts the virtual weight mechanism. When the weight is on top of the fork interface, the virtual weight is at its heaviest weight. And when it moves to other side, the virtual weight will reduced. As shown in Figure 6, the virtual weight is determined by a function of the position (F(X)). It is possible to calculate the weight by measuring with a weighing machine and comparing the measured weight with the real weight. However, as each user have different habits, such as different ways or position to hold a fork, the data is rather scattered. In order to prevent this, we carried out this experiment as a method of adjustment. Additionally, it is also possible to examine how accurately the users can perceive the value.

Method of Experiment

We designed the experiment based on the method of adjustment. Figure 7 (A) shows an empirical research with a participant. During the experiment, each participant will first compare the virtual weight with the real weight. Then, participant will adjust the real weight until both values are equal. The situation indicates that the real weight is constructed by pulling the thread.

Figure 7 (B, C) shows the device used in the experiment to measure the virtual weight and the real weight. Figure 7 (right side) is taken from the users' point of view, and Figure 7 (left side) is taken from the experimenter's point of view. In order to prevent bias when user is perceiving the weight, we adjusted the real weight in the experiment in a hidden manner.

Users were also instructed to hold the tip of the interface when holding the device. During the experiment, two interfaces will be shifted alternatively and rapidly. 10 male and female participants aged from 22 to 25 years old participated in our experiment.

10 samples of each experiment are statistically sampled. The conversion mass in the experiment caused by each virtual weight will be changing at the centre of gravity at 20[%], 40[%], 60[%], 80[%], and 100[%] of the slider in the fork interface.

Result and Observations

Figure 8 shows the results of the experiment. The system indicates 21g (maximum) as a virtual weight. The error bar in Figure 8 shows the standard deviation of the statistics. Chocolate choux is used as a subject of this psychological experiment in order to measure the changes in perception. However, 4 different kinds of snacks as indicated in Figure 2 were used in a public showcase of this experiment. Each snacks weight about 4g. The result shows that the system can increase the weight of a snack up to about 5 times.
By using a prototype, in order to maximize the accuracy of measuring the virtual weight of the sweets, users were required to feedback the change in their perception of weight when the weight is increased by 10 times. During the experiment, it was found that participants cannot perceive the increased weight when it was increased by 2 times. However, they started to perceive the change when the weight is increased more than 3 times. When the weight was increased by 10 times, they find their eating experience a little unnatural. As a result, increasing the weight for about 1~5 times is adequate for this system.

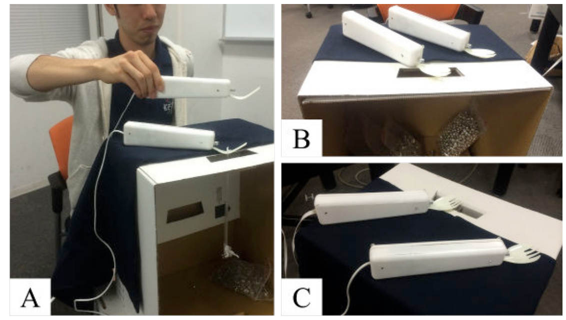

Figure 7. Apparatus used in the experiment

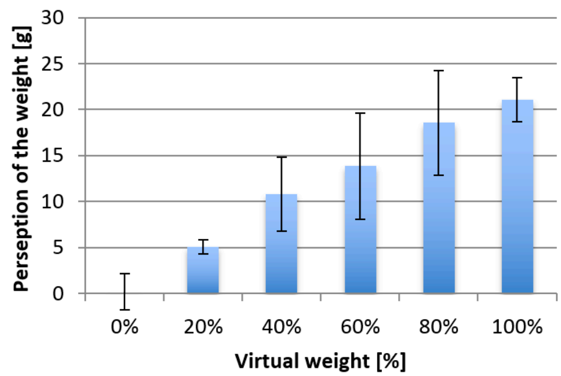

Figure 8. Experimental sresults

VERIFICATION OF THE CHANGE OF THE FLAVORS BY PSYCHOPHYSICAL EXPERIMENT

Aim of the Experiment

In this experiment, the change of perception on the amount of chocolate choux is measured when the virtual weight is added on the choux. The hypothesis states that flavours will be affected by the change in the perception of the weight of food. Especially for food where the inside is invisible, where user will have to presume the inner contents. If the weight is heavier, they may assume that there are more contents in it. This causes an illusion where the contents of food is perceived greater than the actual amount.

Method of Experiment

The participants evaluate the amount of chocolate in the chocolate choux when various virtual weight was added to the fork interface. The participants will then feedback their level of perception of the weighted food. We will then analyse the significant differences from their feedbacks by using the analysis of variance method. This experiment method is according to the research of Vanessa Harrar and Charles Spence [1] and Koizumi at el.[2].

Measurement of the Point of Subjective Equality with Food

The evaluation of change in the perception becomes possible as participants can experience that change. In the experiment, chocolate choux were used (Figure 2). The weight of each choux is approximately 3.3g, while the weight of the chocolate included in choux is around 2.0g. We prepared two types of chocolate choux (increase or decrease 0.25g of chocolate inside choux) to measure the point of subjective equality. The amount of chocolate we used for adjustment is based on the preliminary experiment: the increased or decreased chocolate choux actually eaten. This amount is within the range where participants can feel the difference in the amount of chocolate.

Before the experiment, examinees ate the processed chocolate choux to get the maximum and minimum point of subjective equality. In more details, the perception of eating 0.25g increased chocolate choux is the max level (= the chocolate is fully filled), and perception of eating 0.25[g] decreased chocolate choux is the min level (= the chocolate is slightly filled). These max / min level becomes the base for evaluation of the change of perception by our system.

Bias to be Regarded and Solution for Bias

In the original system, virtual weight is added by sprinkling the seasoning device. However, this action may cause bias when participants suspect that the weight is added to the system through that interaction. Therefore, this gesture is omitted, and we adjusted the weight in the fork in a hidden manner, unknown to the participants.

Some contrivances are also applied to prevent the participants from realising the increase in weight. During the preliminary experiment, the participants was not able to identify the weight differences when comparing only both increase in 30[%] and 70[%] weight. However, the experiment increased to compare the difference between 0[%], 30[%], 70[%] and 100[%] weight, there is a significant difference between the 30[%] and 70[%] weight. As the participants can easily identify the difference between both 0[%] and 100[%], these two cases are ignored in the evaluation. Instead, they are just dummy cases to obtain the proper data of the difference in perception.

In addition, suspicious prejudice on the effect of the system can also affect the perception. In order to solve this problem, we explained to the participants that the amount of chocolate in the choux will be changed and inquire on their opinion on the amount of chocolate they presume is inside the choux. However, all the choux were the same. By using this method, the participants may not recognise whether there are more chocolate in the choux or the weight is just an effect from the system. With this, we can get a better unbiased results.

For the point of subjective equality in this experiment, the first step is for the participants to eat a chocolate choux. In case they forget the initial perception of the choux, they are allowed to eat the choux again at any time. This change in condition of the participants is one of the cause for the bias as well. For the same reason, we explained to the participants about the weight change mechanism of the system before starting the experiment.

The Flow of Experiment

1. Participants will eat 2 chocolate choux (one increased and one decreased in amount of chocolate), and remember these perceptions as the maximum and minimum level of subjective equality.
2. We will then explain the flow of the experiment; whereby we will choose an enhanced choux randomly where the amount of chocolate inside was changed, and let participants eat the choux with the device. In reality, we will use a non-processed choux which have an average amount of chocolate.
3. Examinees will eat the choux, and feedback how much chocolate they feel is inside depending on the point of subjective equality.

Result

Figure 9 shows the results of the experiment. In the graph, the level of perception is divided into 100. We get 2 samples from each 10 examinees in above condition. By statistical processing (N=20), we find a significant difference between comparing 30[%] with 70[%] and 70[%] with 100[%] ($t <= 5$[%]). The error bar in the graph shows the standard deviation. From the result, it is shown that the presentation of virtual weight in this system, influence people to feel as if the chocolate in the choux had increased.

Discussion of the Experiment

We verified that the virtual weight of our system has influenced the perception on the amount of chocolate in the choux through a psychophysical experiment. These results support our hypothesis; if people feels that the food with invisible contents is heavier, they may perceive that the contents are greater than actual amount. The results also show that people can perceive the virtual weight accurately to a certain extent, and it can induce the change of perception about flavour (referenced in Figure 8, the result in chapter 4). However, some participants may not feel that the chocolate in the 100[%] weight has increased. The reason may be because they have noticed the concept of the weight change.

Similarly, in the mental model, the influences on the perception of flavour depends on the feature of the food: hard food (like cracker) may seems to be harder, elastic food (like marshmallow) may seems to be more elastic, or undefined form food may seems to have more amount. However, the proof of these hypothesis will be left for future research. In this experiment, the interaction of sprinkling the jar of seasoning was omitted. Though, we obtained qualitative evaluation through a demonstration and an exhibition which will be discussed in the next chapter.

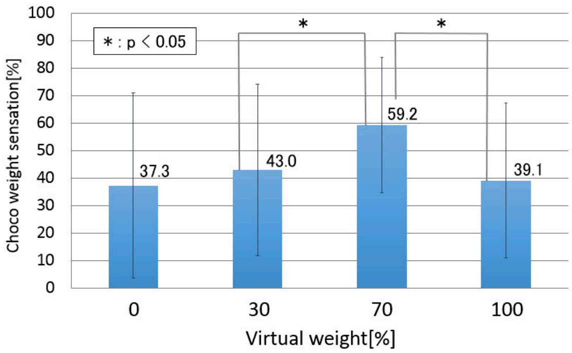

Figure 9. Experimental result

Figure 10. Users experiencing the system during IVRC2013

DEMONSTRATION

Overview of the Exhibition

We took part in the International collegiate Virtual Reality Contest 2013 (IVRC2013), and conducted an exhibition and a demonstration [21]. In this event, about 600 visitors came and experienced our system. There, we obtained a qualitative evaluation on whether the change of perception of weight can have influence on the texture of the food. Visitors will first chose a snack from either marshmallow, chocolate choux, rice cracker or cotton candy. They will eat the snack without the addition of any virtual weight. Then, they will eat the same snack with the addition of a virtual weight interactively through sprinkling onto the fork interface.

After this experience, we received many positive comments through the questionnaires. In the questionnaire, we listed a list of the possible change in feelings that we predicted beforehand; "Feels Harder". "Feels Softer", "Have Stronger Taste", "Feels More High-Grade", "Feels Denser", "Feels like Amount Had Increased", "Feels Bigger" and "No Change". Visitors will chose one proper word from the list. If no proper word was on the list to describe their feelings, they can write their own words on a small label. We also set a video camera at the booth, to record the entire process of this experience and distributed questionnaires.

In addition to IVRC2013, we also conducted an exhibition and demonstration in the Japanese Society for Sensory Evaluation [22], an event held at the National Museum of Emerging Science and Innovation [23], a study group about cross-modal Design [24] and during the open campus event at Keio University [25]. Through these events, over 800 people have experienced our system. Figure 10 illustrated the exhibition at IVRC2013.

Feedback through Exhibition

Around 60[%] of the visitors felt the change in flavour which occurs when the type of food is different. Some of the most common feedbacks for marshmallows were "Feels Harder" and "Feels More Elastic", for chocolate choux, "Feels like Amount Had Increased" and "Feels Harder", for rice cracker, "Feels Harder" and for cotton candy, "Feels like Amount Had Increased" and "Taste Sweeter". "Feels Denser" and "Satisfied" appeared to be common feedbacks for all types of food. Other answers, such as "Feels More High-Grade", "Feels Softer", "Feels Smaller", "Feels Strange", "Feels More Viscous", "Feels Cooler", "Taste Crunchier", "Taste Sour", "Taste like Strawberry" and "Something has changed, but hard to express what has" were rarely chosen in all types of the food. From the video, we also found that the changes of posture also influences one's perception. For example, some visitors opened their mouse wider, leaned forward to eat or use another hand for support, to avoid the food from dropping when the weight of the food was increased.

On the other hand, the remained 40[%] of the visitors replied that they could not feel any changes in the flavour, and could not understand the connection between the weight and the flavour of the food. Some mentioned that "as I noticed the mechanism inside the fork, I could only feel as if the fork becomes heavier" and "Sometimes during the system tryout, the mechanism becomes obvious and that the effect of the fork has disappeared". Especially, engineers and researchers noticed the mechanism itself in an early phase. Therefore, the device will strongly influence people below the age of high school. Many positive comments about this interactive device were also received, such as "the motion of the sprinkling device is interesting" and "I just think that this really adds weight to the food!".

The standard deviation in Figure 10 is large due to various reasons. The main reason is that a majority of the participants were adults and more than half of them have engineering knowledge. This causes many to understand the mechanism itself at an early phase, preventing participants to enjoy the experience.

Re-verification of the Questionnaire

In IVRC, due to high percentage of visitors (approximately 600), we could not get the questionnaire from all the visitors. Therefore, in the open campus event at Keio University (named KMD Forum) [25], we made another demonstration for 118 visitors to obtain more feedbacks from questionnaires. In the demo at KMD, we used the same method used at IVRC - to show a list of choices, and allow visitors to choose one. We were able to reveal thaarshmallow. However, there are not enough samples to determine the results for rice cracker and cotton candy. Figure 11 and

12 show the rate of change of perception for both chocolate choux and marshmallow; 81[%] and 74[%] of visitors simultaneously, averaging to about 73[%] of the visitors. "Feels Denser" was the most frequent answer for chocolate choux, while "Feels Harder" was the most frequent answer for marshmallow.

Discussion of the Exhibition and Demonstration

Feedbacks were obtained from visitors in the form of questionnaire. Various unexpected changes in the perception of taste and posture were observed as well. In terms of the change in taste, some visitors felt that the inner portion is denser. Similarly, Vanessa Harrar and Charles Spence [1] suggested that the size or colour of the spoon do influences the change in taste and the density of the food.

From another point of view, the sprinkling of the jar of spice, a common gesture for changing a food taste by spice, may have effects on the food unconsciously as well. On the other hand, the change in posture may be likely be influenced by the perception of the food's weight. For example, heavier food placed on a fork has higher chance of dropping due to imbalance, causing the change in posture.

Our mental model worked well for some of the visitors. However, it did not work as well with others as they were more focused on the mechanism of the system, rather than perceiving that the weight of food increases. According Barbara J. Rolls's report [26], the influence of the environment on the perception of food texture does not work well if the eating experience is poor. Therefore, initially we anticipated that young age users may not feel the change in perception as much, due to the lack of experience with food. However, unexpectedly, children were more excited about the change. This may be because they are unaware or less focused on the mechanism of the system and was able to enjoy the change in perception itself.

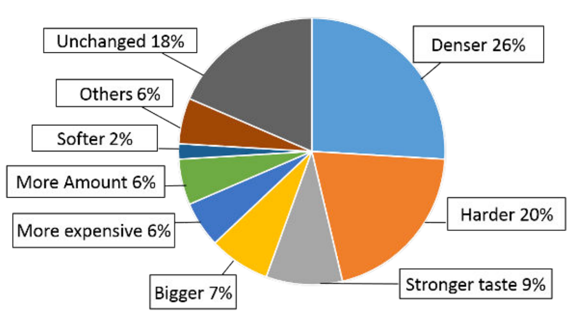

Figure 11. Survey results of eating chocolate choux

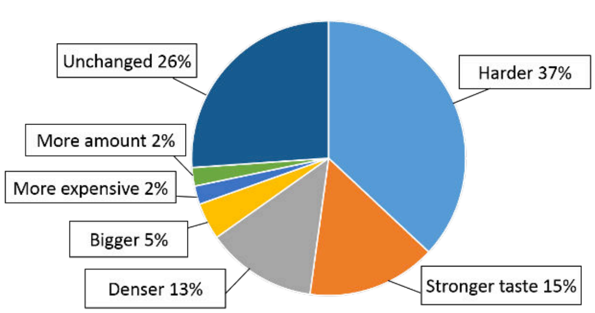

Figure 12. Survey results of eating marshmallows

LIMITATION OF THE APPLICATION

Through the demonstration, this system find challenges to work in many situations. As mentioned in the observation of the demonstration, people who are engineers or researchers tend to know the theories behind this experiment and thus did not work well on them. According to the questionnaire, they could not concentrate on the experience because they were more interested in learning the concept of the interface and how it could be influenced by the artifact. The experiment also did not work well on people with incredulous attitude. We observe that they were affected by strong artifact interruption and perception. Additionally, some people could not relate weight with the change in flavours. For example, people who are strong or have unusual eating style cannot feel the virtual weight. Therefore, we have to improve the mechanism to be compatible for strong people.

In terms of durability, the more the users used the system, the less the system tends to work well on them. The reason is because they have realised the mechanism, preventing them from concentrating on the test. Therefore, in order to survey the changing perception from a psychological point of view, we carried out a test where we will initially explain the mechanism to the participants. We explained that the system can indicate 21g as virtual weight and augmented the weight up to 5 times of the 4g snack. Another limitation is that users cannot perceive the virtual weight when using excessive heavy food. Therefore, we have to implement other adequate mechanisms in order to use excessive heavy food.

CONCLUTION AND FUTURE WORK

In this paper, we proposed "Gravitamin Spice", a system aims to focus on the weight of food perceived through tableware and cross-modal interactions. Users can add virtual weight to the food and perceive the changing flavour caused by the virtual weight. In the evaluation of the system, we measured the virtual weight using the method of adjustment. Additionally, we also experimented with the psychophysical method in order to measure the increase in chocolate in the chocolate choux using this system. We exhibited the system at the International collegiate Virtual Reality Contest, and received numerous user feedbacks. For example, users felt that the food became bigger or heavier than in reality. Some of them felt that the inner chocolate of the chocolate choux has also increased.

In this paper, we evaluated the system through demonstrations and experiments. For the next step, we will examine the perceptions in more details. For example, how accurate the users perceived the change in flavours or what are the ranges and scales when they could feel the virtual weights. These detailed data can be a good piece of knowledge for the advancement of the interface as well as the paper. We also obtained feedbacks about the interaction through the demonstrations. Some users seemed to enjoy the interactive system, and some considered the system as a real seasoning. For future work, we aim to research the influence of the interaction in changing flavours. It is important for the system to brush up to be a better entertainment system. We received many feedbacks with adequate satisfactions from the users. Some mentioned that it can be brushed up for diet applications. Narumi al. confirmed that visual sensation can enhance the satisfaction of food [4]. Our system also apply to heighten satisfaction on eating.

One of the main limitation is that 40[%] of the users cannot perceive the change in flavours as mentioned earlier. They realised the virtual weight mechanism, and cannot perceive the change in flavours due to lack of realistic sensation of the system. Some of them also cannot associate weight with flavour. For these users, it is important to implement the system sophisticatedly, as it is essential in order to rigorously test the limitation of the application.

Through the demonstration at IVRC2014, we got various feedbacks such as change in hardness, expensiveness, viscosity and many more. If the system can control these perceptions, it may be able to approach health problem to a better extent. Additionally, not just limiting to changing the perception of food, it also can be developed into an entertainment system which augment perception or enjoyment of the eating experience. Therefore, we aim to continue to improve the system as a food entertainment system to encourage users to be more aware of the food textures which many users are not conscious about in their daily lives.

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