Let's Play! Mobile Health Games for Adults

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ABSTRACT
Researchers have designed a variety of systems that promote wellness. However, little work has been done to examine how casual mobile games can help adults learn how to live healthfully. To explore this design space, we created *OrderUP!*, a game in which players learn how to make healthier meal choices. Through our field study, we found that playing OrderUP! helped participants engage in four *processes of change* identified by a well-established health behavior theory, the Transtheoretical Model: they improved their understanding of how to eat healthfully and engaged in nutrition-related analytical thinking, reevaluated the healthiness of their real life habits, formed helping relationships by discussing nutrition with others and started replacing unhealthy meals with more nutritious foods. Our research shows the promise of using casual mobile games to encourage adults to live healthier lifestyles.

Author Keywords
Mobile games, casual games, health, food, nutrition, behavior change, Transtheoretical Model.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Design, Human Factors.

INTRODUCTION
Ubiquitous computing (Ubicomp) research has shown that pervasive technology can encourage people to engage in healthy living. For example, researchers have designed mobile, sensor-based applications that monitor behaviors to provide people with a greater awareness of how healthfully they are living [5,6]. Other researchers have designed and evaluated *exergames*, which encourage exercise by requiring the player to be physically active for play [12,13].

In our research, we have examined how mobile devices can encourage adults to live healthfully through a different game genre: casual (quick and easy to play) educational games. We were motivated to explore this design space because while previous research has shown the benefit of educational games for children [2,3], little is known about their impact for adults. Furthermore, many educational health games have been developed for non-mobile platforms: desktop computers and video game consoles. In contrast, we explore the mobile phone as a pervasive platform for play, and the implications of using this platform together with the casual game genre to encourage healthy living.

Specifically, we designed a casual nutrition game for mobile phones called *OrderUP!* and conducted a real-world evaluation of the game with 12 participants over a three week period. Through pre- and post-intervention surveys, interviews and a diary activity we studied how participants reacted to the game and how they were affected by playing. We use the Transtheoretical Model (TTM), a well-established health behavior theory, to frame our results. While numerous health behavior theories exist, the TTM is one of the most widely used, and is particularly useful for characterizing the *processes of change* that help people transition towards healthier lifestyles. Our results point to the ways in which playing OrderUP! helped our participants engage in four such processes: *consciousness raising*, *self-reevaluation*, engaging in *helping relationships*, and *counter-conditioning.*

In the following sections we describe related work, the design of OrderUP!, our study methodology and our results. Through the design and evaluation of OrderUP!, we expand Ubicomp's understanding of how casual mobile games can be used to encourage healthy thinking and actions in adults. We conclude this paper by providing recommendations for future research on casual mobile health games, specifically discussing how they can be uniquely useful in encouraging processes of change.

RELATED WORK
In the following sections we discuss related research on health games and introduce the genre of casual gaming. We conclude by providing a brief overview of the Transtheoretical Model.

Games for Health
In Ubicomp-related fields, the majority of health-oriented games have been *exergames*, applications that encourage

UbiComp 2010, Sep 26 – Sep 29, 2010, Copenhagen, Denmark.

exercise because players must engage in physical activity to play. For example, Mueller *et al.* [13] developed a variety of fitness games that allow people to compete in structured physical activity sessions (such as playing a ball game) with remote third parties. Höysniemi *et al.* [9] designed *Shadow Boxer*, a boxing game in which the player controls their characters by physically moving their arms to punch a virtual target. Other exergames are more ubiquitous, in that they extend outside of the confines of the living room or gym, and into individuals' everyday lives. As they go through their days, such games record players' physical activity and physiological data (*e.g.,* heart rate) and it is this data that controls their progress in the game [5,8,13]. Exergames have proved quite effective (*e.g.,* by helping people increase caloric expenditure [17]), however much less research within Ubicomp has focused on educational games for health.

Such games have been given greater attention within the medical domain, where researchers have designed a number of electronic games that promote wellness by teaching players about healthy living. Typically these games have been designed for children. Our work is most similar to previous research on health-related role-playing and simulation games in which users play the role of someone who is trying to engage in healthy behaviors. These games allow players to explore behavioral alternatives and their outcomes and consequences in a safe environment [14,19]. For example, researchers have designed games in which the child's character has to manage their diabetes (*e.g.,* by taking insulin injections) [3] and negotiate sexual decisions with fictional partners (*e.g.,* deciding to use contraceptives) [19]. These games tend to be relatively time-intensive, requiring anywhere from 20 minutes to many hours to complete [2,3,19].

Previous research has shown that educational health games effectively help children develop healthier eating habits, better manage chronic diseases, and increase their health-related knowledge [2,3,19]. While these benefits have been documented for children, a recent study found that little work has been done to design such games for the adult population [2]. Yet, as the average game player in the U.S. is 35 years old[1], games may be a promising medium for improving the health of adults. In addition, educational health games have primarily been developed for stationary gaming environments (*e.g.,* desktop computers). We contribute to previous work by exploring how an off-the-desktop platform – the mobile phone – can be leveraged in the design of educational health games for adults.

Casual Games

One area of gaming that is growing in popularity is that of *casual games*. Casual games differ from traditional video games in that they have simple rules, are easy to learn and play, and require very little video game expertise [1]. They are typically played in short bursts, and can be easily stopped and restarted. For example, traditional video games usually require 20 minutes to 2 hours to complete a level, whereas casual games typically take 1-10 minutes to complete a level or an entire game. Solitaire and Tetris are two canonical examples of this game genre. While some casual health games have been developed, particularly for children (*e.g.,* www.playnormous.com), researchers have rarely studied the impact that such games have on players' health attitudes and behaviors.

Casual games tend to reach a broader audience than traditional video games, for example, one report indicated that approximately 50% of all casual game players are women [1]. Also, unlike traditional video games which are typically played at home, mobile casual games are appealing because they act as an easy way for people to fill time, for example, as they are waiting for friends or while riding public transportation [11]. While some Ubicomp researchers have designed casual games outside of the health domain (*e.g.,* [11]), the effectiveness of mobile casual games for wellness has been virtually unexplored. And yet, we argue that because casual games tend to have broad demographic appeal and a low barrier to entry, it is important to examine the ways in which they might help people become healthier.

The Transtheoretical Model

We now describe the Transtheoretical Model (TTM), a theory that we use to frame our results in this paper. The TTM helps characterize how ready and willing a person is to make changes to their health-related behaviors. This theory identifies stages of change through which an individual can progress as they begin to modify their habits. These stages are temporal constructs that describe the trajectory of behavior modification over time. They range from *precontemplation* (the state of not thinking about a change) to *preparation* (getting ready to make changes) and *maintenance* (changes have been successfully adhered to over time) [16]. Some shortcomings of the model include a lack of consensus on how to best classify individuals into stages [18]. Even with these limitations, the TTM has been successfully used in a variety of health interventions, and remains one of the most widely used health behavior models. Previous Ubicomp researchers have used the TTM to identify target users and examine how health systems affect people who are in different stages of change [6,12].

Prochaska *et al.* [16] identified 10 *processes of change* that help people move between stages. These processes are things that people do to begin modifying problematic behaviors, for example, *consciousness raising* (receiving feedback and education about how to live healthfully), *self-reevaluation* (assessing the healthiness of one's current behaviors), developing *helping relationships* (in which health issues are discussed with others) and *counter-conditioning* (substituting new activities for old). In this paper, we show how our casual mobile health game helped adults begin to engage in these processes of change.

[1]Entertainment Software Association, www.theesa.com/facts

Figure 1. OrderUP! screen shots. (Far left) Players receive opening screens that explain the premise of the game. (Middle and far right) Players must choose the healthiest options for their customers from among the three dishes displayed at the bottom of the screen. At the top right of the screen, 3 colored circles are displayed (red, yellow and green), providing "stoplight" feedback on the players' choices. At the top left of the screen, the total health points are shown and below that, the health points for this particular customer are displayed next to the customer's name. Beneath the customer's total health points, the timer shows how much time has elapsed in the game.

ORDERUP!: GAME DESIGN

We introduced OrderUP! as an unimplemented design concept in our previous work [8]. We then iterated extensively upon that concept to arrive at the final design, which we modified through brainstorming meetings with the research team and feedback sessions with HCI researchers, game design experts and a dietitian. The work we describe in this paper is distinct from our previous research in that we present our revised and implemented design and the results of our field trial of the game.

We implemented OrderUP! for the Nokia N95 cell phone platform using Adobe ActionScript 2.0 and the Adobe Flash Lite framework (see Figure 1). The customer characters were created using Yahoo! Avatars. Players interact with the game using buttons on the phone's keypad.

In OrderUP!, the player assumes the role of a server in a restaurant and her goal is to make meal recommendations to customers as quickly and healthfully as possible. Doing so allows the player's character to keep her job in this fictional setting. We chose this scenario because various health organizations (such as the American Diabetes Association) have indicated that learning how to make the healthiest possible choices when eating at fast food and other restaurant establishments is an important skill to develop[2].

Our target audience in this work was African American adults in the Southeastern United States (U.S.), as this population disproportionately faces most diet-related health problems (*e.g.,* diabetes and obesity) [4]. Medical researchers have consistently called for interventions specifically designed to address these health disparities. Furthermore, they have shown that by accounting for the cultural uniqueness of eating patterns, these interventions can be made more effective [4]. As such, our goal was to tailor our game design to incorporate distinctive African American cuisine. Accordingly, in addition to general American foods, *soul food* (traditional African American cuisine) dishes also appear in OrderUP!.

There are 10 customer characters that appear repeatedly in the game. Each customer starts with a health score of 100 points (which totals to 1000 health points for all 10 customers). For each customer, the player is presented with three randomly chosen meal options (desserts, entrees or side dishes). The player must decide which among these options is the healthiest, and make that meal recommendation to the customer. After the player makes a selection, they receive *stoplight feedback*, that is, a green light flashes if they have chosen the healthiest food, a red light if they select the unhealthiest food, and a yellow light if they have chosen something in between. We decided to give feedback in this way because of the familiarity, simplicity and ease of understanding that comes with the stoplight metaphor: something that was critical to making OrderUP! a casual game.

We derived a *health value* for each dish by gathering nutrition data for a number of fast food items from popular restaurant chains in the U.S. and by searching an online recipe website[3] for the nutrition values of soul food dishes. Examples of fast food included sandwiches, onion rings, salads, mashed potatoes and yogurt parfaits while soul food dishes included items such as collard greens, candied yams, peach cobbler and black-eyed peas. The health value for each food item was based upon the calorie, fat, saturated fat, fiber, cholesterol, sodium and sugar content. Our goal was to include foods that our participants might commonly have access to when wanting to quickly eat out or when

[2] http://www.diabetes.org/food-nutrition-lifestyle/nutrition/meal-planning/eating-out.jsp

[3] http://allrecipes.com

wanting to eat traditional soul food dishes. While we could have included many other types of foods as well, we chose to narrow the data set to focus our study. In particular, including cultural dishes allowed us to see if there is any benefit in tailoring the game to our participants' cultural background in this way.

With every dish that the player chooses for a customer, that customer's health score decreases: the healthier the selection made, the smaller the score decrement, and the longer the player stays in the game. With this design decision, our goal was to subtly point to the fact that making the healthiest choices is important (hence healthier choices mean a smaller decrement to the customer's health score), but continuously eating out may be detrimental to one's health over time (hence the fact that the customer's health score always decreases, no matter how healthy the choice).

Each customer must be served within six seconds or they will become aggravated and leave. In this case, the player loses all the points associated with that customer. When the health points of any customer goes below 40 points or the total health points for all guests goes below 400 points, the game ends. The job of the player is to make the healthiest choices as often as possible, and therefore "keep her job" longer. This duration also functions as the final score in the game (measured in minutes and seconds). Thus, the higher the final score (i.e. the duration of the game), the better the player's game performance. Forty seconds is an example of a low final score in the game, whereas a much better final score would be three or four minutes. In summary, the player's goal is to choose the healthiest foods possible, so that she can keep the game running as long as possible.

METHOD

We conducted a real-world deployment of OrderUP! with African Americans in the Atlanta, GA metropolitan area to assess in what ways a casual mobile game can encourage healthy eating. We gave 12 participants a Nokia N95 cell phone with OrderUP! installed on it to use for three weeks. During our first meeting with participants, we explained the study, how to play the game and how to use the phone. At this time, we placed each person's existing SIM card in the phone and they used it as their primary phone for the 3-week study period. Participants were asked to play the game at least once each week, but beyond that, we encouraged them to play only as much as they were interested in doing so.

We used surveys, diaries and interviews to triangulate how OrderUP! impacted our participants nutrition-related attitudes, thinking and actions. During our initial meetings, participants completed baseline surveys in which they provided basic demographic information, their thoughts on nutrition and information about their eating habits. We also asked them to describe their cell phone usage and their experience and interest in playing electronic games. Participants also filled out an exit survey at the end of the study. In this survey, we repeated the questions on nutrition and eating habits from the baseline survey to see if their answers changed after playing the game. In addition, we asked them questions about OrderUP!, for example, how often they played it, how relevant the foods were to them as an African American and how entertaining the game was.

Participants also completed short diary entries during the study. These entries provided a snapshot of how well they were playing and their reactions to the game. Once a week, participants were asked to play OrderUP! and write down: 1) the date and time that they played the game, 2) where they played, 3) their final score, 4) how entertaining the game was and 5) if the game caused them to think about their eating habits, and if so how. We collected these diaries during our final meetings with the participants.

Finally, we conducted semi-structured interviews with each participant after one week and after three weeks. (Due to work commitments, one person was only able to complete one interview at the end of the study.) We asked them questions on topics including their overall experience playing the game, its cultural relevance and how playing affected their eating habits and healthy eating knowledge.

Analysis

We recorded all survey responses and diary entries and computed descriptive statistics, looking for trends in the data and examining how participants' answers changed between the baseline and exit surveys and across diary entries. These descriptive statistics serve as a supplement to our rich qualitative data. Finally, we conducted a thematic, inductive analysis of the interview transcripts. We began by applying descriptive codes to phenomena that we saw arising in each transcript. We then iteratively clustered these codes into higher-level category groupings until we arrived at the themes that we will describe in this paper.

Participants

We had 10 female and two male participants. Four were married and 10 had children. Seven participants were in the 38-54 age range, two in the 55 or older range, two in the 18-30 range and one in the 31-37 range. Most participants reported their highest level of education as being a high school diploma (or equivalent) or some college. Two had college degrees and one had a graduate degree. The majority of participants had a household income of $45,000 or below, and three had an annual income of $60k or higher. Our participants had a range of occupations including security guard (three were coworkers), childcare provider and HVAC technician. All participants owned a cell phone that they use two or more times daily. When asked if they like playing electronic games, 10 agreed and two somewhat disagreed. Six participants play cell phone games multiple times each week, two play a few times each month, and four basically never play.

RESULTS

Overall, most people said OrderUP! was fun and that they would play it in the future. Table 1 shows participants' high

Participant ID	Gender	Low Score	High Score	Play Frequency
P1	F	2:36	2:50	Multiple times/day
P2	F	1:10	2:53	Few times/wk
P3	M	1:17	1:51	Once/wk
P4	F	2:30	2:41	Multiple times/day
P5	F	1:06	2:37	Few times/wk
P6	F	2:10	3:15	Multiple times/day
P7	M	1:21	3:20	Multiple times/day
P8	F	2:59	3:32	Few times/wk
P9	F	1:52	2:10	Multiple times/day
P10	F	1:26	2:49	Once/wk
P11	F	3:30	3:50	Multiple times/day
P12	F	1:01	2:38	Few times/wk

Table 1. Participant overview including gender, the lowest and highest reported score in their diaries (the amount of time that they game lasted, in minutes and seconds), and how frequently they played OrderUP! (as reported in their exit surveys).

and low scores, as well as the frequency with which they played OrderUP, with all but two people playing at least a few times each week.

The remainder of our results show how OrderUP! helped our participants engage in four processes of change identified by the TTM: consciousness raising, self reevaluation, helping relationships and counter-conditioning. Through these findings, we show how a ubiquitous application (a game that pervades users' lives through its mobility) can help people take the initial steps towards increased wellness.

Learning How to Eat More Healthfully

In our exit surveys and interviews 10 people said that playing OrderUP! helped them to learn more about eating healthfully. These results provide a preliminary indication of the *consciousness raising* that happened for our participants. Consciousness raising is a process of change that occurs when people learn more about a health topic, and it can be identified by assessing to what extent individuals recall information from educational health materials [16]. The following sections provide more insight into how our participants began to engage in this learning process.

Correcting One's Previous Understanding

In OrderUP!, players must continuously choose the dish that they think is healthiest. By receiving the stoplight feedback that we mentioned previously, participants began to see which foods were healthier. They were often very surprised at what they saw. Specifically, eight participants described how playing the game corrected their previous understanding about which dishes were the healthiest individually and as compared to other foods. They said that playing OrderUP! helped them realize that they did not know as much about eating healthfully as they thought. For example, P4 said,

> "Some of the foods we thought were healthy weren't healthy. (laughs) Like gravy & liver, that was one of them… The main thing that I learned was some of the foods I thought were healthy just weren't healthy at all."

Similarly, P11 mentioned learning that sherbet was a healthier dessert than ice cream. P6 described thinking that certain dishes were healthy because they contained ingredients that seemed nutritious and then realizing that they were not:

> "They have…fried oysters on there and I thought that would be healthy because it was seafood but apparently it was not."

OrderUP! also helped participants to learn about the relative healthiness of foods. Indeed, since players were presented with a randomly generated list of three meal options for each customer, the healthiest option in one list might turn out to be the least healthy option in another list. For example, P8 noted that when she served one customer, the glazed donut was the healthiest option. Then, when she saw the glazed donut appear again she assumed it would be the healthiest even though the other two options in the list were different. She then chose the donut and was surprised to see that it was the worst choice. Thus, OrderUP! helped participants to think not simply about the healthiness of individual dishes, but how foods compare to others.

Learning How One Can Personally Eat Healthier

The previous examples show that people corrected their understanding about dishes that are commonly available at many fast food and soul food restaurants. Seven participants went a step further and described not simply what they learned, but how what they learned applied to their lives. For example, P9 said she realized that peanut brittle was a healthier option *for her to choose* than other desserts. P8 described how OrderUP! expanded her understanding of which foods she can eat if she wants to make healthier choices when eating out:

> "What I liked about [OrderUP!] is... it gives you an ideal - or your worst and best choices of food to eat when you're out there.... You know, like when you're out buying different things you wanna make sure you stay health-conscious, and [OrderUP!] gives you a choice."

P6 said that while playing the game she tried to remember the healthier items so that when she goes out to eat she can choose them:

> "I will know that I [should] choose the small yogurt and fruit over [the] butter pecan ice cream."

P1 mentioned that the game caused her and her family to be interested in trying foods that they had never tried before:

> "We didn't even know what sorbet was. I mean, we've seen it, but really never fooled with sorbet. 'Cause I know sherbet, I know ice cream. So the game kind of let us know – ooh, we gotta find out what sorbet is anyway 'cause we know sherbet and we like sherbet."

Thus, there were a variety of ways in which playing OrderUP! helped participants gain ideas for how they can eat more nutritiously in their everyday lives.

Analyzing & Trying to Understand

Another aspect of the consciousness raising process is actually contemplating information that is obtained. We found that OrderUP! facilitated this thinking because participants did not just passively receive the information shown in OrderUP!: they also engaged in analysis and reasoning as they tried to understand why different foods were healthier than others. They did this in a number of ways, including thinking about the effects of preparation and portions on healthiness and expressing a desire for more feedback on the choices that they made in the game.

Portions & Preparation: Heuristics for Decision-Making

Half of our participants described how through playing the game, they were led to consider how portions and preparation methods affect the healthiness of foods. Indeed, engaging in this type of reflection was an important part of being able to play the game: participants used their understanding of the distinguishing characteristics of each dish to decide which ones would be the healthiest. For example, P1 described having to think about the relative healthiness of a medium sorbet and a large sherbet. The game included a variety of other portion sizes as well, for example players might be met with decision of choosing between six chicken nuggets and a small hamburger. Some people also mentioned using their understanding of preparation methods when playing OrderUP!. P5 made decisions based upon whether foods were fried or baked. When trying to decide which dessert to choose, P6 reasoned that the dish that contained fruit must be the healthiest, but then realized that it actually wasn't as nutritious as the other options.

A Desire for More Feedback

Though we did find that participants used their previous understanding of portions and preparation methods to make their decisions, once they made these decisions most people were not satisfied with the amount of information they were given about why foods were healthier than others. The stoplight feedback in the game simply tells people that their choices were wrong, but it does not say which item would have been a better choice or why. We consciously made the design decision to have very lightweight feedback to ensure that players felt that they were playing a game instead of being lectured. Still most of our participants wanted more feedback.

For example, P9 said that in the cases where she chose an item that was not the healthiest, she would have wanted to know which one was best:

> "One time I chose the fish sandwich and it [turned out to not be the best choice]. And when you think of a fish sandwich… a plain regular fish sandwich like you go to McDonald's or whatever. You thinking that's, you know, OK I'm doing good [by choosing that]. Whereas that was not the case all the time…So you know, I would like to know [what I should have picked]."

Other participants also wanted to know more detailed information about each food item. P2, P3 and P10 mentioned wanting to know which choices would have been better to choose as well as nutritional information (*e.g.,* the calorie or fat content) about the menu items. Players not only wanted more detailed feedback so that they could make better choices in the game; some wanted to get feedback for reasons separate from game play. For example, P7 said having more detailed feedback would give him useful information to take away from the game. Similarly, P10 was disappointed that the game did not give more feedback because she wanted to use that information to improve her own eating habits. She said that if she had this additional information she would modify her choices in the following way,

> "Like after every game I really wanted to know the calorie count and the fat count in what I chose. 'Cause I really wanted to be able to change that in my own [life]."

Assessing the Healthiness of One's Eating Habits

In the previous section, we described how some participants wanted more feedback on their game choices so that they could learn how to make better choices in their own lives. Following on from this, in our exit surveys, all participants indicated that at some point during the study, playing OrderUP! led them to think about their own nutrition-related behaviors. In doing so, they were engaging in the *self-reevaluation* process of change in which people assess themselves in light of their health-related behaviors. From our participants' diaries, we saw that there was a slight change in the number of people who reported this effect during their first, second and third week of game play: 10 people said that the game caused them to think about their eating habits in the first week of game play, 11 in the second week and eight in the third week.

Our interview results shed more light on this process of reflection. P7 said that the game helped him to think about nutrition, something he had not paid much attention to previously:

> "I was trying to lose weight but I wasn't thinking about [nutrition]. I was just thinking about the exercise…This made me think… is that the right thing to be eating?"

P3 also reassessed his habits, as he said playing the game caused him to think more about what he eats at restaurants. P6 had this to say about eating out after playing,

> "When I'm going out to get something to eat [I think to myself] I should choose this sugar cookie over this brownie. So actually it's had me thinking a whole lot more than I did [previously]."

For many participants, playing OrderUP! helped them to realize how poorly they were eating. For example, P4 saw one of her favorite dishes in OrderUP! and realized how unhealthy it is:

> "I love shrimp and grits... But you know, I'm like OK, I can eat a little healthier. And plus I wanna lose some weight, so [OrderUP!] kind of like put me on the right track."

By playing OrderUP! P9 also realized that one of her favorite dishes was not very healthy and this helped her to see that it is important for her to try to change her habits,

> "It made me think, it really did. I was just thinking about how I need to stop eating a lot of that stuff. You know because it's not healthy. You be thinking it is. You know like the collard greens [and] the ham hocks…that's one of my favorite dishes."

P1 reflected upon her choices in the context of her family,

> "When I struggled with picking the best food choices on the game I thought about how I was making the wrong choices for my husband and children when grocery shopping."

Further analysis helped to uncover what aspects of the game may have helped participants reflect upon their eating habits. We found that overall, they felt that the content in OrderUP! was culturally relevant. In particular, most felt that the dishes in OrderUP! were relevant to them given their African American cultural background and that they are foods they normally eat. Thus, as participants felt that they could identify with the foods in OrderUP!, this may have helped them reflect upon the game in the context of their own lives.

Discussing Nutrition with Others

Previous research has shown that social support is a critical part of how individuals engage in healthy behaviors and cope with health problems. In particular, the *helping relationships* process of change is characterized by people having others with whom they can discuss health topics and who will listen to their challenges. Playing OrderUP! led nine participants to have discussions about nutrition and eating with people in their social network. These discussions were on a variety of topics, including assessing the healthiness of foods in the game and talking about health more broadly. For example, for P3, playing the game led him to talk about choosing healthy meals with his family and friends. While at work, P8 and her coworkers, who were also in the study, discussed their surprise over which foods in the game were healthier. P9 was compelled to encourage her friend to lose weight.

In addition, we found that the mobility of the game was an important factor in stimulating discussions. The fact that the game was on participants' cell phones meant that they had it with them in a variety of settings. This in turn made OrderUP! available for social play, that is, as participants let others play the game, and played the game themselves in front of others. Such social play was a catalyst for health-related discussions. For example, seven participants mentioned letting their friends, family and coworkers try out OrderUP!, which in turn sometimes led to health-related discussions. For example, P11 allowed her adult daughter to play the game and said that this led to conversations about how to make healthy choices in their lives. In addition, P1 allowed her children to play the game, and that facilitated family discussions about eating healthfully. After P6 shared OrderUP! with her friend, the two women discussed positive ways of actually increasing one's body weight to a healthy level.

Half of our participants said that playing OrderUP! in front of others triggered people to ask them about the game. This dialogue then sometimes led to health discussions. For example, P7 said that as he played the game at work, his coworkers would ask him about it. This then led to a discussion about the extent of their nutrition knowledge. As P7 told us this story, he seemed to feel that he knew more about healthy eating than his coworkers and so for him, having this discussion was a way of challenging them to think about how much they know about nutrition.

When examining our survey data, we found that for seven of our participants, their answer to the question, "I know enough about healthy eating to give advice to my friends and family" was more positive after playing OrderUP. Thus, one of the reasons that participants engaged in discussions about healthy eating with those in their social network may be that they felt more confident in having such discussions after playing the game. Given that we discussed earlier how participants said playing OrderUP! helped them learn about healthy eating, we believe that this is a plausible conclusion.

Modifying Eating Habits

Finally, *counter-conditioning* is another process of change in the TTM. This process happens as people begin to substitute healthier actions for detrimental ones. In analyzing our baseline survey data, we saw that prior to playing OrderUP!, four participants said that the healthiness of foods influences what they decide to eat. Our exit surveys show that after playing OrderUP!, this number increased from four to nine. Thus, we saw that five people went from not considering the healthiness of foods, to having that be one of the factors that affects their choice of what to eat. This is one early indication that participants began the process of counter-conditioning.

Furthermore, most (eight) participants described the specific ways in which playing OrderUP! actually led them to eat differently. When interviewing participants, we were

careful to clarify instances when they felt that it was the game play itself (and not other outside factors) that led them to eat differently. P3 described how before the game, he and his coworkers were trying to eat better while at work, and that playing the game helped to reinforce for him the need to engage in these healthier behaviors. P12 discussed how playing the game led her to eat more healthy foods, for example, salads and fruits. Various participants described replacing ice cream with sherbet, which is shown as a healthier dessert option in OrderUP!.

Participants also described seeing foods that they ate appear in OrderUP! as unhealthy options, and how this led them to make changes to their eating habits. For example, P6 said:

> "I love chicken and dumplings and I saw on the game that it was like one of the worst [dishes]… So I've been trying my best to stay away from a lot of bread and fried stuff."

Playing the game also encouraged participants to try foods that they had never tried before. For example, P4 discussed purchasing a healthier version of ice cream,

> "For the first time in my life, I bought sugar free ice cream. Low fat, sugar free. I did!...And that came from the game."

P8 also mentioned trying something that she had previously refused to try:

> "For years people have always told me, "here try this broccoli, try this broccoli!" I'm like no I'm not trying this broccoli! But last week was the first time in my 40 something years, I ate broccoli. I ate it…And it was good! It was good. (laughs)… So [the game] really helped."

By playing OrderUP!, people were encouraged to change their eating habits in general, to try the foods that they saw were healthier in the game and to replace the unhealthy foods that they were accustomed to eating. As we discussed, our participants related to the foods in OrderUP! both personally (because they are dishes that they eat) and culturally (because many are common dishes in African American cuisine). Because OrderUP! included foods that players are familiar with, it helped them see which are less healthy, and subsequently which foods they should eat less of or in moderation. Furthermore, the game showed healthier alternatives, specifically in the context of foods that they typically eat. Thus, players not only received ideas for foods to eat, but more importantly how to make healthier choices relative to how they had been eating. In addition, by seeing foods that they had never eaten in the game, participants were encouraged to try new things.

DISCUSSION: CASUAL GAMES FOR HEALTHY LIVING

While our results came during a short-term study, they show the initial ways in which playing OrderUP! helped our participants engage in processes of change. And, as we mentioned previously, the TTM indicates that these processes can, over time, help people to make long-term, lasting changes to their behaviors. Future longitudinal studies can determine to what extent such long-term changes may be facilitated by games such as OrderUP!.

Within Ubicomp and related disciplines, the processes of change construct has not been as heavily examined as the stages of change construct – a trend that has been seen within medical literature as well [18]. Yet, studying the impact of casual games on processes of change can help address the challenge of conducting longitudinal studies of cutting-edge technologies within Ubicomp. By focusing on processes of change – which can be studied in a shorter period of time – researchers can get an initial sense of how well new applications impact the cognitive and behavioral processes that are crucial for more sustained lifestyle changes over time. Gaining this type of clarity, and pinpointing which processes are best addressed by the technology can provide the justification for conducting larger, longer studies. Furthermore, researchers can better understand what types of users a technology may best be suited for, because different processes of change become more relevant and critical depending on the stage of change an individual is in.

In the remainder of this section, we articulate specific directions for future Ubicomp research on designing casual mobile games to help adults live healthier lives. In particular, we describe how the casual and mobile characteristics of such games may be uniquely useful in addressing nine processes of change.

Consciousness Raising & Dramatic Relief: *Consciousness raising* and *dramatic relief* are two related processes within the TTM. While, as mentioned previously, consciousness raising refers to people increasing their knowledge about health-related behaviors, dramatic relief refers to a deeper internalization of and emotional reactions to this knowledge. In our study, the stoplight feedback mechanism in OrderUP! gave participants a basic indication of how healthy their selections were. This coarse level of feedback led them to question and think about why different food options were the healthiest. While some participants saw this as a drawback of the game, it provides us with insight into how feedback mechanisms in casual health games can facilitate questioning and reflection. In a casual game, the content should be easily digestible. We offer, then, that a benefit of the casual game genre for health is this: while other gaming genres may facilitate more extensive and detailed information dissemination, casual games can be used to spur questioning and analytical thinking outside of game play. Such analytical thinking can facilitate the consciousness raising process.

Furthermore, analytical questioning outside of game play can encourage adults to think for themselves rather than simply have information fed to them. Such questioning can compel players to engage in more conscious, careful processing of the game content versus a passive reception of it. This is important because conscious processing of information has been shown to be more effective at helping people engage in sustained attitude change [15]. By engaging in this analytical thinking, adults may have the opportunity to engage in the dramatic relief process as they

reflect upon the meaning of the information presented in the game in the context of their own lives. We suggest that future work further examine the usefulness of lightweight feedback mechanisms as a feature of casual games.

Helping Relationships: While previous work has shown how health games can stimulate social interaction for kids [3], our work shows that casual mobile games are useful for encouraging health-related interaction between adults as well. Because OrderUP! was installed on participants' mobile phones, they were able to access it in a variety of settings, and this in turn helped spur discussion. Future work should further examine how to design mobile health games that take advantage of the fact that they may be played in settings where people from the player's social network are physically present and available for discussion. For example, designing games that bring up thought-provoking topics could spur the player to engage in dialogue with others. As we saw in our study, health-related dialogue may help facilitate the *helping relationships* process, in which people solicit encouragement, support and understanding from individuals in their social network.

Counter-conditioning: The simplicity of the casual games genre requires that straightforward information be delivered. Complex recommendations for healthy living would not fit in casual games, as the information presented must be easy to absorb such that the game is quick and easy to play. Thus, casual games are uniquely positioned to provide useful ideas for healthy living that players can easily understand and implement. This in turn makes them useful for encouraging the *counterconditioning* process, in which individuals begin replacing problematic behaviors with healthier ones. For example OrderUP! helped our participants to quickly see the relative healthiness of different foods and have a better understanding of how to make healthier choices when they visit restaurants. They were then able to implement the basic strategies learned in the game in their real lives. Of course, the ability to actually make changes to one's behaviors are mediated by a myriad of factors (*e.g.,* personal motivation, economic constraints, etc.), however our point here is that the simplicity of casual games can help people to get useful, actionable information that can make it relatively easier to make changes.

Self-Reevaluation: *Self-reevaluation* is the process by which people reflect on themselves, including what it means for them to engage in healthy and unhealthy behaviors. We suggest that future work examine the extent to which the mobility of casual cell phone games facilitates this process differently than stationary video games (*e.g.,* those played on the computer or on a game console). As people play mobile health games in different settings of their everyday life, it may become easier for them to apply the material to their own life and reflect upon their health-related behaviors. For example, playing a game related to asthma management while sitting outside on a day with high smog levels (which is detrimental to an asthmatic person's breathing) may cause the content in the game to come to life in a way that it would not have when playing at one's desktop computer.

Self-Liberation: Casual games are often played repeatedly over time [10]. This may be due in part to the fact that the barrier to playing these games is low (since they are easy to play and typically take only a few minutes to complete). For example, we found that half of our participants played OrderUP! multiple times per day. This repetitive play leads to repeated exposure to the game material over time. We suggest that future work examine to what extent repeated exposure facilitates the *self-liberation* process (in which people accept personal responsibility for their behaviors and commit to change) by helping people build up the readiness to take responsibility for their actions and make a change.

Stimulus Control & Social Liberation: As others have found [11], we saw that the mobility of OrderUP! meant that our participants played it in a variety of environments and at various points during their day. The fact that game play is interspersed throughout a person's day means that mobile health games may have a good chance of reinforcing the importance of avoiding negative behaviors. For example, some of our participants played OrderUP! at work. Playing for a few minutes prior to taking a lunch break may mean that the information gained in the game is on their mind around the time that they have to decide what to eat. Thus, future work should further examine to what extent mobile games – because game play is interweaved into an individual's daily routines – can facilitate the process of *stimulus control*, in which people begin avoiding things that lead to negative behavior.

Future work should also examine how mobile games can help facilitate the process of *social liberation* in which people notice aspects of their environment that can help them to be healthy. That is, does having the ability to play mobile games out in the world in which one is actually trying to engage in healthier behaviors make the game material even more salient? For example, Fujiki *et al.* [7] designed mobile physical fitness games and found that through playing, some people began to walk up stairs more to increase their physical activity. Future work should further compare the impact of mobile versus stationary games at helping people to notice environmental supports for healthy living.

Reinforcement Management: Casual games are typically easily rewarding, such that the game is fun even after only a few minutes of play [10]. We offer that there is opportunity to explore how rewarding players for positive health behaviors in casual games translates into real-life rewards. In particular, further research should examine how casual games can encourage the process of *reinforcement management* in which people reward and praise themselves for healthy behaviors. Previous research has shown how rewards in mobile health applications can effectively encourage physical activity [6]. We believe that there is

benefit in going one step further to examine how in-game rewards can encourage reinforcement management in the players' real life. In particular, we suggest that since casual games are inherently easily rewarding, they have the opportunity to show players how to begin rewarding themselves for small health-related victories in their own lives.

CONCLUSION

We contribute to ubiquitous computing research by presenting the results of our evaluation of OrderUP!, which showed the impact that casual mobile health games can have on adults. In particular, we have shown how playing helped participants begin to engage in processes of change. We hope that our results, together with the implications for future research that we have provided will spur further work in this area.

ACKNOWLEDGEMENTS

We thank REACH for Wellness, Ian Bogost, Cristina Caro and Celia Pearce.

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