Molarcropolis: A Mobile Persuasive Game to Raise Oral Health and Dental Hygiene Awareness

Carmen Soler
School of Design
Universidad Tecnológica
Metropolitana – UTEM
Dieciocho 390, Santiago, Chile

carmenluz.soler@gmail.com

Alejandra Zacarías
School of Design
Universidad Tecnológica
Metropolitana – UTEM
Dieciocho 390, Santiago, Chile

alezacariasv@gmail.com

Andrés Lucero
User Experience and Design
Nokia Research Center
NRC Tampere
FI-33721 Tampere, Finland

andres.lucero@nokia.com

Figure 1. Strico and Philusa, the male and female characters that users can choose from at the start of *Molarcropolis.*

ABSTRACT

In this paper we present the design and exploratory evaluation of *Molarcropolis,* a mobile persuasive game to raise adolescents' oral health and dental hygiene awareness. The game uses strategies of persuasion to reach the aforementioned target behavior. During the game, players receive information on oral illnesses and their causes, habits and activities that put adolescents in a special risk situation, and tips on improving oral health. In an exploratory evaluation, adolescents indicated that the game is both entertaining and informative, they learn new aspects of their oral health, and it has potential to change oral health habits.

Categories and Subject Descriptors

H.5.m **[Information Interfaces & Presentation]**: Miscellaneous.

General Terms

Design, Human Factors.

Keywords

Mobile Gaming, Persuasion, Adolescence, Oral Health.

1. INTRODUCTION

Oral health care begins at home when parents teach their toddlers how to brush their teeth. After they have turned 7 or 8 and start going to school, children then have the dexterity to brush and floss on their own [2]. Instilling oral health habits in children at home

such as proper and thorough brushing and flossing, eating healthy foods and scheduling regular visits to the dentist help prevent dental caries and prepare them for more challenging times later on in their lives. The adolescent population has special needs when it comes to oral health care [1]. Some of the most common problems that affect these youths include a high caries rate, increased risk for traumatic injury, poor nutritional habits, tobacco, pregnancy, eating disorders and unique social and psychological needs. By late adolescence nearly 70% of them are affected by dental decay (cavities) [4]. Some of these problems are later carried on to adulthood leading to more severe problems such as tooth loss.

Several systems and applications have been developed to create an oral health habit or to support tooth brushing. A notable example is The Playful Toothbrush [5], a system to motivate kindergarten children (3-4 year-olds) to improve their tooth brushing skills. The system enhances the effectiveness of brushing by interfacing the physical activity with a computer game that guides children in learning proper brushing techniques. Other products such as Tooth Tunes [9] from Hasbro are designed to encourage tooth brushing in children. Sensors in the toothbrush recognize brushing activity triggering a two-minute song that encourages children to brush for the amount of time recommended by dentists. Although we also propose a playful approach to motivate the target audience to reach a certain target behavior by means of a game, our application was specifically designed for adolescents and their special health care needs.

In this paper we present the design and exploratory evaluation of *Molarcropolis,* a mobile persuasive game to raise oral health and dental hygiene awareness for adolescents (and young adults). The game uses strategies of persuasion to reach the aforementioned target behavior. Players take the role of one of two bacteria that create dental caries hence playing the antagonist role of "destroying" the environment. During the game, players receive information on oral illnesses and their causes, habits and activities that put adolescents in a special risk situation, as well as tips on ways to improve oral health.

2. CONCEPTUAL DESIGN

We use the steps of the design process for persuasive technologies to describe our game [8].

2.1 Simple Target Behavior: Dental Hygiene

The target behavior is to raise dental and oral hygiene awareness. We considered that raising awareness was a smaller but more realistic first step towards achieving our final objective, which is for people to brush, floss and visit the dentist regularly. The smaller goal of raising awareness on dental hygiene serves as an approximation towards the final objective.

2.2 Receptive Audience: Adolescents

Our target audience consists of adolescents between the ages of 13 and 24. There is no consensus on the definition of adolescent [3] or the exact end and start ages of adolescence. According to Papalia [11], adolescence marks the transition between child and adulthood and thus roughly includes the ages between 11 and 20. We use the term adolescent to include both teenagers and young adults who live with their parents. Adolescents have an increased aesthetic desire and awareness [1]. Adolescents become self-conscious about their appearance and there may be dissatisfaction with what they see in the mirror. This target audience has a desire to improve their appearance and their dental health plays a big part in it.

2.3 What Prevents the Target Behavior: Lack of Motivation

Adolescents lack the motivation to perform the target behavior. They are unaware of the many illnesses that result from poor dental hygiene habits (e.g. periodontitis, gingivitis, plaque, caries, etc.) [2]. Moreover, adolescents also need to be informed on some particular activities or trends that increase the risk of having dental problems (e.g. piercings, eating disorders, smoking, contact sports, etc.) [2]. Therefore, the game will facilitate the target behavior of raising awareness on these issues.

2.4 Familiar Technology Channel: Mobile Phones and Games

Mobile phones are a natural part of the adolescents' life to communicate, create an identity, and also to play games [10]. Adolescents carry their mobile phones nearly everywhere (e.g. to school, on the bus, outdoors, etc.). This aspect provides different convenient moments to play the game, occupying time while standing in line or waiting for the bus. Therefore, we have selected mobile gaming as the main technology and communication channel to persuade.

3. DESIGN

The game uses three persuasion strategies to reach the target behavior of raising oral health awareness: 1) cause-and-effect simulations, 2) suggestion, and 3) attractiveness [7]. First, the game allows users to see how their actions inside the game deteriorate the mouth over time without having to wait for a long time. Second, we wanted to create an environment that is both entertaining and informative. The game presents information on various aspects of oral health at opportune moments depending on the current stage. Third, we created visually attractive characters and environments that use the aesthetics of the target audience.

3.1 Story

The game is set in *Molarcropolis* (from *molar + acropolis* or "city on the edge"). The inhabitants of Molarcropolis are different types of bacteria that cause caries (i.e. *Streptococcus Sanguis, Lactobacillus Acidophilus, Actinomyces Naeslundii,* etc.). These bacteria over exploited the available resources and therefore the oral world (i.e. the mouth) began showing its discontent through several natural disasters: salival tsunamis, tooth brushing, flossing and other strange objects fell from the skies. A larger catastrophe, the *fluorogenesis,* was about to happen: large storms destroyed small-inhabited areas and the remaining ones were destroyed by giant drills and other unknown tools. The *fluorogenesis* left only a few survivors who had to hide in order to survive.

Five years have passed since and the oral world has repopulated once again. The *fluorogenesis* survivors have created an even more comfortable environment than before. However, they are not measuring the consequences of their actions as a new similar catastrophe is upon them.
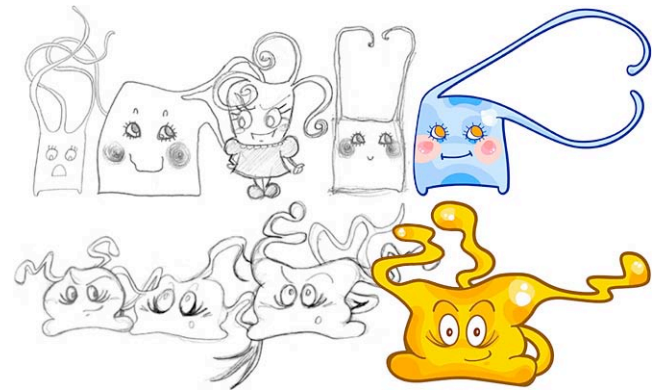
3.2 Characters

Figure 2. The two characters in *Molarcropolis* represent two types of bacteria that create caries. Philusa (top) is a *Lactobacilus Acidophilus* and Strico (bottom) is a *Streptococcus Sanguis.*

The two main characters in the game are Strico and Philusa (figure 2). Each character represents a different type of caries-creating bacteria. Strico is short for *Streptococcus Sanguis* and Philusa is short for *Lactobacilus Acidophilus.* Players take an antagonist role in the game. Their goal is to deteriorate the environment to ensure their survival. Along the process, players receive information on oral health. Playing an antagonist role where the bad guys are presented as the "good guys" has proved to be extremely popular (e.g. Wario) [12].

Both characters can be chosen to play the game from different perspectives. Philusa and Strico are the female and male characters in the game respectively. Philusa thinks the "wisdom man", the oldest bacteria alive, is the key to their survival. Strico on the other hand relies on his own instincts and thinks Philusa could be in danger looking for the "wisdom man" on her own. Strico believes that together they can save their oral world.

During the game, both characters will learn new tricks and techniques that will be useful to complete their mission. Philusa uses her two antennas to defend herself. She is smaller in size compared to Strico and can access areas in the game that have a high pH (i.e. saliva). Strico on the other hand is stronger and larger than Philusa. He uses his three large antennas to move

around and to defend himself. Strico can throw acid in order to destroy parts of the environment, creating caves where he can hide or accessing areas that Philusa is unable to reach.

3.3 Gameplay

Users choose at the start of the game which of the two characters (or bacteria) they would like to play with. The player must protect the new oral world from external elements that try to cure the mouth. As the game progresses, the user's actions determine how the oral world is affected. At the end of each stage, users are presented with the current state of the oral world, explaining how a sustained "damage" similar to the one they have just created to the environment affects oral health in the long run.

3.4 Game Interface

Molarcropolis is a scrolling puzzle-platform game [6]. It consists of several non-linear stages where users have to solve mini-games in the form of puzzles. Users must run, jump over obstacles and climb to advance through each stage. As the character moves, the screen scrolls sideways as well as up and down. In each stage, users learn new tricks and collect different items that can be used later in the game.
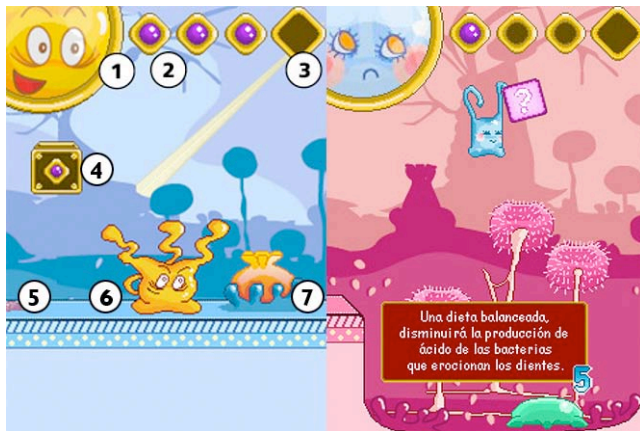
Figure 3. The *Molarcropolis* interface. The interface elements (left): the character's 1) mood, 2) health, and 3) items, 4) a chest, 5) platforms, 6) the character, and 7) interactive elements. Informative panels (right): activated when the character touches the "?" sign at the top.

Figure 3 (left) presents the different interface elements. In the top part of the screen, participants can find the general status of the character: 1) the mood, 2) health or hit points (HP), and 3) items collected. In the middle section, participants encounter chests (4) that can contain a carrot, which reduces HP as it is a healthy food, or a candy that does the opposite. The lower part of the screen, consists of 5) platforms, 6) the character, and 7) interactive elements such as other bacterial flora.

The screen space is also used for different purposes. First, there are informative panels (Figure 3, right) that are activated when the characters touch the "?" sign at the top. The informative panels provide facts regarding different types of oral diseases as well as tips on how to improve oral health. Second, narrative transitions (Figure 4, left) present dialogues that the main character has with other bacteria in the game and that guide the main story. Finally, status panels (Figure 4, right) present information on the character (i.e. detailed information on how this bacteria helps produce caries) and an overview of the different collected skills.

Figure 4. Narrative transitions (left): elements of the story are displayed as the game progresses. Status panel (right): contains information about the character (or type of bacteria) as well as an overview of the collected skills.

4. EVALUATION

This section describes the results of an exploratory evaluation, which was guided by the following inquiries:

• How effective is *Molarcropolis* in raising awareness on dental and oral hygiene?

• How likely is it that users would change their dental hygiene habits in the long run because of the game?

4.1 Procedure

Seventeen adolescents within the age range between 13 and 24 years of age participated in the study. The evaluations took place in the participants' homes. The *Molarcropolis* demo was implemented using Flash CS3 and was written in ActionScript 3. Participants played the demo from their own computer or laptop using a Flash-enabled browser that simulated the mobile phone screen resolution of 240x320 pixels by blacking out the rest of the screen (Figure 5).
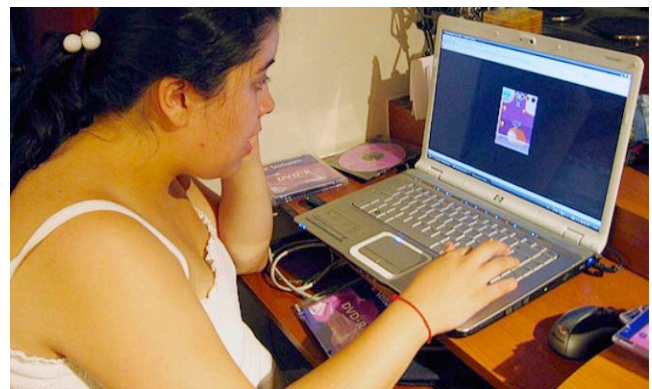
Figure 5. Evaluation setup: a participant playing the game on her laptop. The rest of the screen is blacked out to simulate the screen resolution of a mobile phone (240x320).

The evaluation consisted of three parts. First, participants were involved in an interview prior to using the game. We asked them different questions regarding their current habits and knowledge on oral health, as well as how familiar they were with playing games on their mobile phones. This part lasted 10-20 minutes.

Second, we asked them to play *Molarcropolis.* We first explained the basics that would allow them to play the demo. We then let them freely explore the demo and we would answer their questions if they had any. This part lasted 10-20 minutes. Finally, we had a post-game interview where we asked them questions in relation to whether they had liked the game or not, if they had learned anything new regarding oral health, and if they thought the game might change their hygiene habits in the long run. This part lasted between 15-25 minutes. In total, the evaluations lasted on average 45 minutes.

4.2 Initial Findings

4.2.1 Pre-game interview

Most participants felt that their current knowledge on oral health was insufficient (n=15), and that most of them would only worry about the topic if they developed some oral illness (n=11). More than half of the participants (n=9) regularly played games on their mobile phones or on a similar portable platform (e.g. Nintendo DS). The rest said that they had played the basic games that come with the phones but only scarcely.

4.2.2 Playing Molarcropolis

More than half of the participants had problems while playing the game (n=8). The main reasons observed for this were that the initial difficulty level of the game was set too high for starters, and that participants had a hard time discerning enemies from background objects in the game. Otherwise, participants were able to finish one stage of the game.

4.2.3 Post-game interview

Most of the participants found the game to be both entertaining and informative (n=13). Out of the remaining 4, 2 said that while it was entertaining, they were a bit frustrated with how difficult the game was, one thought it was mildly entertaining and informative, and one said it was only informative. One participant was worried about playing an antagonist role that implies "destroying" the mouth instead of trying to save it. The rest actually liked the approach of playing the antagonist in the game. Only one participant was initially confused by this approach but ended up liking it as well.

The majority of the participants said they had learned something new regarding their oral hygiene (n=13). They said that they had mostly gained knowledge on the origin of caries and the bacteria that cause them, which is directly related to the main characters of the game. This is a positive result considering our goal of raising awareness of dental and oral health.

Regarding whether participants thought that they would change their oral hygiene habits after playing the game, less than half said they would (n=6) and the majority said that they would not (n=11). Among the latter, three participants expressed their own reasons for not changing. One participant said he already was taking good care of his dental hygiene before playing the game, another said the game might be able to motivate when it is fully developed, and the last one said dental hygiene was not among his priorities. The aspect of behavior change was the most difficult to assess. Only after measuring continued use of the complete game with all its levels and over a longer period of time we would be able to provide a more conclusive answer in this respect.

5. CONCLUSIONS

Molarcropolis is a mobile game that uses strategies of persuasion to reach the target behavior of raising adolescents' oral health and dental hygiene awareness. As adolescents are playing the game, they receive information on oral illnesses and their causes, habits and activities that put adolescents in a special risk situation, and tips on improving oral health. In an exploratory evaluation, adolescents indicated that the game is both entertaining and informative, that they learn new aspects of their oral health, and that it could potentially change oral health habits. Future work includes performing an evaluation where adolescents would play *Molarcropolis* on their mobile phones over a longer period of time. Only then we would be able to assess the game's real impact on the oral health habits of adolescents.

6. REFERENCES

[1] American Academy of Pediatric Dentistry. 2005. Guideline on Adolescent Health Care, Vol.30(7), 94-101. http://www.aapd.org/media/policies_guidelines/g_adolesheal th.pdf (accessed 22.6.2009).

[2] American Dental Hygienists' Association. 2006. Ask Your Dental Hygienist About Proper Health Care for Children. http://www.adha.org/downloads/children.pdf (accessed 22.6.2009).

[3] American Psychological Association. 2002. Developing Adolescents: A Reference for Professionals. Washington, DC: American Psychological Association, 1-42. http://www.apa.org/pi/cyf/develop.pdf (accessed 22.6.2009).

[4] Centers for Disease Control and Prevention. 2005. Fact Sheet: Key Findings from NHANES 1999-2002. http://www.cdc.gov/OralHealth/publications/factsheets/nhan es_findings.htm (accessed 22.6.2009).

[5] Chang, Y., Lo, J., Huang, C., Hsu, N., Chu, H., Wang, H., Chi, P., and Hsieh, Y. 2008. Playful toothbrush: ubicomp technology for teaching tooth brushing to kindergarten children. In *Proc. of CHI '08.* ACM, 363-372.

[6] Crawford, C. 2003. Chris Crawford on Game Design. New Riders Publishing.

[7] Fogg, B.J. 2003. Persuasive Technology: Using Computers to Change What We Think and Do. Morgan Kaufmann.

[8] Fogg, B. 2009. Creating persuasive technologies: an eight-step design process. In *Proc. of Persuasive '09,* ACM, 1-6.

[9] Hasbro. TOOTH TUNES. http://www.hasbro.com/toothtunes/ (accessed 22.6.2009).

[10] Kasesniemi, E. and Rautiainen, P. 2002. Mobile culture of children and teenagers in Finland. In Perpetual Contact: Mobile Communication, Private Talk, Public Performance. Cambridge University Press, 170-192.

[11] Papalia, D.E., Olds, S.W., and Feldman, R.D. 2001. Human Development. McGraw-Hill.

[12] Wikipedia: Wario. http://en.wikipedia.org/wiki/Wario (accessed 22.6.2009).