Rhythm Satellite: design of a game to change morning wake-up behavior

Title: Rhythm Satellite: design of a game to change morning wake-up behavior
Author: Tsang, Kiron, Okude, Naohito
Publisher: Keio University Graduate School of Media Design
Publication year: 2014

The copyrights of content available on the Keio Associated Repository of Academic resources (KOARA) belong to the respective authors, academic societies, or publishers/issuers, and these rights are protected by the Japanese Copyright Act. When quoting the content, please follow the Japanese copyright act.
Master’s Thesis
Academic Year 2014

Rhythm Satellite:
Design of a Game to Change Morning Wake-up Behavior

Graduate School of Media Design,
Keio University

Kiron Tsang
A Master’s Thesis
submitted to Graduate School of Media Design, Keio University
in partial fulfillment of the requirements for the degree of
MASTER of Media Design

Kiron Tsang

Thesis Committee:
Professor Naohito Okude (Supervisor)
Professor Masahiko Inami (Co-supervisor)
Associate Professor Kazunori Sugiura (Co-supervisor)
Abstract of Master’s Thesis of Academic Year 2014

**Rhythm Satellite:**
Design of a Game to Change Morning Wake-up Behavior

Category: Design

Summary

Today, smartphone has replaced traditional alarm clock for waking up in the morning, especially among young adult users with 80% of smartphone ownership[^1]. Smartphone alarm provides multiple alarms and snooze functions which seem to be helpful in waking up the users. Such functions, on the contrary, are encouraging a behavior of re-sleeping until the last minute. Consequently, many young adults often run late for work or school. *Rhythm Satellite* is a game with morning-exclusive gameplay to engage young adults to wake up on time in the morning. It features an alarm which leads the players to get out of bed and a rhythmic exercise gameplay which has effects in waking up the player physically and mentally.

*Rhythm Satellite* aims to change the wake-up behavior of young adults with joyful experience so that they can wake up as planned and be able to maintain a regular wake-up timing. This thesis describes the concepts of *Rhythm Satellite* and a design process to bind behavior changing goals into game design. This thesis also suggests an approach for designing games, but not gamification, for behavior change.

Keywords:

Game Design, Behavior Change, Pervasive Computing, Alarm, Wake-up Experience

Graduate School of Media Design, Keio University

Kiron Tsang

# Contents

1 Introduction ........................................... 1
   1.1. Background ........................................ 1
   1.2. Causes of “Snoozing” ......................... 4
   1.3. The Power of Game ............................. 6
   1.4. Concept ........................................... 8

2 Related Works ........................................ 10
   2.1. Approaches for Improving Awakening Experience .... 10
   2.2. Game Design Elements for Behavior Change .......... 13
       2.2.1 Guidelines Derived from Behavioral Science .... 13
       2.2.2 Game Mechanics Tailored for Different Gamer Type . 14
       2.2.3 Serious vs Fun? Real vs Virtual? ............ 15
   2.3. Pervasive Gameplay .............................. 17
       2.3.1 Pervasive Game Possibilities ............... 18
       2.3.2 Pervasive Game for Health ................... 19
       2.3.3 Casual Pervasive Game Guidelines ........... 19
   2.4. Contribution of This Research ................. 20

3 Design ................................................. 21
   3.1. Concept .......................................... 21
   3.2. Ethnography ..................................... 24
       3.2.1 Fieldwork ................................... 24
       3.2.2 Mental Model ................................ 30
       3.2.3 Target Persona ............................... 31
   3.3. Ideation ......................................... 33
3.3.1 Brainstorming ................................. 33
3.3.2 Concept Making ................................. 34

3.4. Game World Design .............................. 37
3.4.1 Game World .................................. 37
3.4.2 Game Character ................................. 42

3.5. Gameplay Design ................................. 44
3.5.1 Inspirations .................................. 44
3.5.2 Game System .................................. 46
3.5.3 NoriNori Battle ................................. 49
3.5.4 Morning Exclusive Mode (Wake-up Intervention) ... 52
3.5.5 Key Path Scenario .............................. 57
3.5.6 Game Elements For Sustainability .......... 60

3.6. Implementation ................................. 61
3.6.1 Program Structure .............................. 62

3.7. Design Summary ................................. 68

4 Evaluation ........................................ 70
4.1. Methodology .................................... 71
4.2. Observations .................................... 74
4.3. User Test Studies ............................... 75
4.3.1 Interview 1 .................................... 75
4.3.2 Interview 2 .................................... 77
4.3.3 Interview 3 .................................... 78
4.4. Proof of Concept ............................... 80

5 Conclusion ......................................... 82
5.1. *Rhythm Satellite* Lifestyle ...................... 82
5.2. Discussion ....................................... 84
5.3. Future Discussion ............................... 86

Acknowledgements .................................. 88
List of Figures

3.1 Concept Diagram ............................................... 22
3.2 Extended Gameplay Model ...................................... 23
3.3 Elderlies Practising Rajio Taiso .............................. 25
3.4 Families Practising Rajio Taiso .............................. 26
3.5 Fieldwork Master ............................................... 26
3.6 Sequence Model ............................................... 27
3.7 Flow Model ..................................................... 27
3.8 Physical Model .................................................. 28
3.9 Artifact Model ................................................... 29
3.10 Cultural Model .................................................. 29
3.11 Target Persona .................................................. 32
3.12 Brainstorming with Graphics ................................. 34
3.13 Concept Sketch 1 .............................................. 35
3.14 Concept Sketch 2 .............................................. 35
3.15 Concept Sketch 3 .............................................. 36
3.16 Concept Sketch 4 .............................................. 36
3.17 Mindmap of “Morning” ........................................ 38
3.18 Mindmap of “Farm” ............................................. 39
3.19 Mindmap of “Sun” ............................................. 40
3.20 Mindmap of “Music” ........................................... 41
3.21 Character Idea Sketch 1 ...................................... 43
3.22 Character Idea Sketch 2 ...................................... 43
3.23 Rhythm Satellite Logo .......................................... 44
3.24 Rhythm Satellite Devices ...................................... 47
3.25 Game Modes ................................................... 48
List of Tables

3.1 Fieldwork Master Mental Model ......................... 30
3.2 Abstract Mental Model .................................... 31
3.3 Person’s Mental Model .................................... 33
Chapter 1

Introduction

1.1. Background

It is Monday morning. A typical daytime working young adult is sound asleep in bed. The clock reads 7:00 A.M. and the alarm sounds. The young adult stretches out his arm and grabs his smartphone next to his bed. He can barely open his eyes but he knows he has to tap the screen to snooze the annoying alarm. Once the alarm has stopped, he puts his smartphone back and falls back asleep. After 10 minutes, the alarm goes off again. He takes the smartphone in his hand, looks at the “7:10 A.M.” shown on the screen and stops the alarm without any thought. As he knows he will not be late for work as long as he is out of the house by 7:45 A.M, he goes back to sleep. At 7:30 A.M., an alarm that he sets for when he sleeps through 7:00 A.M. sounds. He still feels very sleepy and so he hits the snooze button yet again. At 7:40 A.M., the alarm sounds. At this time, he realizes that if he does not get up now, he will be late. He jumps out of bed, washes his face, brushes his teeth, changes his clothes, skips breakfast and is out the door at 7:47 A.M.. He runs to the train station but misses the express train. At 9:10 A.M., he finally arrives at the office, but is late for the regular meeting. After the meeting, his boss takes him aside and talks to him about his poor punctuality and low work performance during the day. Feeling stressed and anxious, he hopes he can make a change in his morning.

Today, many young adults have been struggling in bed every morning similar to the situation mentioned above. They have been relying on the snooze button
or multiple alarms to allow themselves to sleep for extra minutes or even hours. Many of them planned to wake up a bit earlier but end up waking up in the last minutes. They then put themselves in a hurried situation and they usually end up being late for work or school.

This research aims to create a game with morning-exclusive gameplay to engage young adults to wake up as planned. The success of this will provide more time to their morning routines and reduce the risk of being late for work or school.

As it was portrayed above, many young adults cannot get out of bed and abuse the snooze button of the alarm clock in their smartphones. Originally, the snooze button lets us sleep extra minutes while avoiding over-sleep with another short-period alarm. It is a very considerable function for the users. However, the more we snooze, the more we want to get back to sleep. In particular, todays smartphones’ alarm clock provides user interface which actually encourages you to snooze, rather than getting out of bed. We are all getting used to the behavior of going back to sleep after the first alarm as we know that the alarm will wake us up again very soon. We did not behave the same 10 to 20 years ago as most of us did not have an alarm that goes off again and again. It might be interesting to trace back how did we start to turn ourselves into “snoozers”.

The first snooze alarm clock called Snooz-Alarm was introduced by General Electric-Telechron in 1956. It is an alarm clock that allows an user to tap the snooze button on top of it and sleep for a few minutes more before it sounds again. In 1956, Westclox also created a snooze alarm clock, called Drowse with which a user can choose to snooze five or ten minutes with a rocking button on top. Such design was patented and we could hardly find snooze function in most of the analog alarm clocks.

However, as the digital technology advanced, the implementation of snooze function became much easier than it was in an analog alarm clock. It had become one of the common features in radio alarm clocks. With the popularization of mobile phones and smartphones, almost everyone now owns an alarm clock with snooze function. As smartphones have already become our personal central

---

1Pappy. 7H241 The Snooz-Alarm. Telechron.net. [http://www.telechron.net/eod/7h241.htm](http://www.telechron.net/eod/7h241.htm).

devices of our lives, most of the people, especially young people who has 83% of smartphone users, nowadays simply use their phones as an alarm clock to wake up in the morning. According to the Jacobs Media Tech Survey[^3] conducted in 2014, 67% of the people who were born in between 1980 and 2000 use their smartphones to wake up in America.

This might have associated with the fact that many young adults are being “snoozers” in the morning, as everyone has a snooze alarm in their phones now. Life At Home Report[^4] conducted in April 2014 by IKEA in eight cities around the world, found out that 46% of the people, aged between 18-60, snooze their alarms at least once during their wake-ups in average. More than half of them snooze twice or more. If the scope is narrowed down to the group of age 18-29, 60% of this age group snooze at least once compared to the 38% found in the group of age 30-60. This shows that young adults, in particular, have a great tendency to snooze.

However, it might not be so ideal to ask people to give up the “smart-device-lifestyle” and adopt to an “early to bed, early to rise” lifestyle. Recently, scientific approaches emerge in alarm clocks. The latest sensing technology is applied to ease waking up through improving sleep qualities. There are a number of activity tracking products and applications that can track a user’s sleep behavior in the market. Fitbit[^5] and Jawbone Up[^6] are the most popular ones. Motion sensors are utilized to track the sleep activities of a user. The data collected is analyzed and determines whether a user is in deep or shallow sleep in different sleep cycles. One of the most favorable feature is the smart alarm function. The smart alarm goes off during the shallowest possible sleep before the target wake-up time so that the users can wake up more easily on time.

Despite of the accuracy and the effectiveness of these sleep tracking devices, poor sleep is not the only factor leading to snoozing. Whether or not we are willing to get up is the most decisive factor. However, we have to overcome the impaired decision-making abilities and poor self-control during the first few

[^6]: UP by Jawbone [https://jawbone.com/up](https://jawbone.com/up)
minutes of waking up. If we fail to do so, we would probably hit the snooze button. Instead of sleep tracking data, which aims to raise our awareness about our sleep, a more direct way to change our behavior of waking up might be more effective in changing the wake-up behaviour specifically.

Therefore, it is believed that the experience of waking up may play an important role in avoiding people turning into a “snoozer”. If the experience of waking up is fun, everyone should be excited and willing to wake up every day. A well designed experience can also act as a motivator and guidance for us to wake up without a high demand for decision making and self-control.

This research attempts to provide joyful wake-up experience through a game to change the wake-up behavior. The game designed for this research is called *Rhythm Satellite*. It provides an experience that motivates and guides a player to get up to enjoy the start of a day. *Rhythm Satellite* is a rhythmic exercise video game which has a morning-exclusive game mode. Such game mode offers an extended gameplay to provide a step by step routine for waking up in the morning. The routine involves fun and simple exercises that can wake up a player both physically and mentally. Motivation and routine for waking up will be created not only by the interaction and rewards in the game, but also by the good feeling through maintaining a sleep-wake rhythm after consistent participation in the game every morning.

### 1.2. Causes of “Snoozing”

It is true that daytime sleepiness is caused by deprived sleep but it is not the only cause. Many people have the idea of compensating the sleeping debt built up in weekdays by sleeping more in weekend. However, the situation never seem to improve by that. It is because quality is more important than quantity. In order to increase the quality, we need to sleep and wake in a way that favours our body clock.

We all have our preference for natural sleep and wake time. Such preference is known as chronotype. It is regulated by the circadian clock in our body. Clock genes and environmental influences contribute to the variation of the chronotypes, from extreme early types to extreme late types. On the other hand, the schedules
determined by the society, such as school and work, do not necessarily align to our circadian clock. Late chronotypes will have a late natural wake-up time later than the social time. The difference between the biological and the social time is described as social jetlag.\footnote{Wittmann, Marc, Jenny Dinich, Martha Merrow, and Till Roenneberg. 2006. “Social Jetlag: Misalignment of Biological and Social Time.” Chronobiology International 23 (1-2): 497509, 1-10. (Wittmann, Dinich, Merrow, and Roenneberg 2006)}

Such social jetlag is the reason why we need an alarm clock for workdays in the first place. Our body is in fact not ready for a natural wake up at the alarm time. Body temperature and hormone levels changes throughout the sleep/wake cycles to facilitate sleep and wake. The timing of the changes are associated with the circadian clock. Our body will start to adjust and prepare for wake-up prior to our biological wake-up time. However, when the alarm clock of the social time sounds, we are forced to wake up suddenly during a deep sleep and at a time that our body is not prepared yet. This leads to prolonged drowsiness and groggy feeling which may last for hours. Such phenomenon is called sleep inertia.\footnote{Tassi, Patricia, and Alain Muzet. 2000. “Sleep Inertia.” Sleep Medicine Reviews 4 (4): 34153, 1-3. (Tassi and Muzet 2000)}

Sleep inertia refers to the period between waking up and being fully awake when we feel groggy. Such transition is very gradual. In the first few minutes of waking up, some parts of our brain, expecially prefrontal cortex, which involved in cognitive behavior, personality expression and decision making, are not fully functioning. With the impaired cognitive and behavioral performance, what we usually do unconsciously is going back to sleep as we feel drowsy. This may explain why it is so difficult for us to control ourselves not to push the snooze button and get out of bed in the morning.

However, if we try to snooze to compensate that, the situation will only get worse. If we hit the snooze button, we are actually putting ourselves into a new sleep cycle. When the snooze alarm sounds again, we are woken up in the middle of a cycle. The new sleep cycle is not finished and the sleep quality is poor due to sleep fragmentation\footnote{Stepanski, Edward J. 2002. “The Effect of Sleep Fragmentation on Daytime Function.” Sleep 25 (3): 26876, 7-8 (Stepanski 2002)}. We may then end up with a more serious groggy feeling and looking for another extra minutes of sleep. In other words, snoozing is a
vicious cycle that makes us even more tired and more reluctant to wake up. This explains why most of the people who snooze will tend to snooze more than once, as shown in the IKEA Life at Home Report mentioned before. Research has also found that regular wake-up timing is associated with better sleep quality. Avoiding any snoozing is, therefore, the key to wake up feeling less groggy and the first step towards better sleep quality. However, changing such behavior is not easy especially we have poor decision making ability when we just wake up. This research, therefore, attempts to use game as a tool to achieve it.

1.3. The Power of Game

Jane McGonigal said that playing a game is the voluntary attempt to overcome unnecessary obstacles. No matter it is a video game, card game or board game, we are actually challenging ourselves with some unnecessary obstacles. When we are intensely engaged playing a game, all of our neurological and physiological systems that make us happy are fully activated. This means that we gain positive emotion through gameplay. Such emotion can motivate us to voluntarily overcome obstacles, even if they are unnecessary. In other words, we are happy to overcome unnecessary obstacles through games. If waking up immediately is well translated into obstacles of a game, we should then be positive in overcoming it.

Wii Fit and Wii Sports are some of the successful examples of applying games in the context of exercise. However, sports originally are games. They transformed sports games into games that have lower requirements for the respective skills. Music games, such as Rock Band also provide similar experience.

12Wii Fit, Nintendo http://wiifit.com
13Wii Sports, Nintendo http://www.nintendo.com/games/detail/10Tt006SP7MS2gi5m8pD6CnabhW8CzxE
by decreasing the skills required for playing in a band through a game. However, sports and music are originally fun activities. How we can make normal or even unenjoyable daily activities more engaging through gameplay maybe the next challenge of game design.

A popular and important area that has been being explored is healthcare or wellness. There have been a lot of researches about applying video games for healthy behaviors. Such kinds of video games are known as “serious video games”. Serious games has been agreed to be an innovative approach for effective behavior change.

However, the recent trend of approaching it has changed due to the advancement of sensing and ubiquitous computing technologies. Gamification became the hot topic for such area of research. Cameron Lister said that gamification is an effective means only for increasing the motivations for target behaviors but it cannot effectively serve the purpose of triggering them. According to the behavior model for persuasive design suggested by BJ Fogg, There are three key components to change a behavior. They are motivation, ability and triggers. Lacking any of the three will fail to persuade a person to perform a target behavior. Cameron suggests that game should be brought back to play the trigger role in behavior changing. He thinks that integrating gamification, game and behavioral theory with mobile technologies will have a great impact to health intervention.

This research attempts bring game design back to the context of behavior changing even though gamification is overwhelming in the market for healthcare application. This research also attempts to explore a new game design which involves multiple gameplays on multiple devices because pervasive or ubiquitous technologies are emerging and we are no longer having just one computing device in this Post-PC era to work and to get entertained.

---


16Lister, Cameron, Joshua H West, Ben Cannon, Tyler Sax, and David Brodegard. 2014. “Just a Fad? Gamification in Health and Fitness Apps.” JMIR Serious Games 2 (2): e9, 10. (Lister, West, Cannon, Sax, and Brodegard 2014)

1.4. Concept

The game proposed in this project is called *Rhythm Satellite*. It provides a joyful experience for waking up. The contents of the game is designed to fit into the context of waking up to provide reasons and attachments to play the game. A rhythmic exercise gameplay is featured and it is extended to a wake-up routine to engage a player in the morning. Through playing the game, a player will start to anticipate waking up in the morning. In the long run, a player can not only stay away from the snooze button, but also experience the benefits of keeping a sleep-wake rhythm.

*Rhythm Satellite* is not a gamification of a wake up process. Gamification is defined as an application of game thinking and game elements such as points, goals and awards to non-game context\(^{18}\). It is an only a design pattern in experience design. Gameplay, which defines a game, is absent in gamification. The approach taken in this project, is, on the other hand, to provide new experience for waking up through gameplay. As it is discussed before, gameplay creates positive emotion. Through the joyful experience, players will be engaged to wake up. Since this research is trying to address health-related problems, it can be categorized as a “serious game”.

Ethnography of Rajio Taiso, a popular morning rhythmic warm-up exercise in Japan, was conducted. The design of the game is based on the experience of Rajio Taiso. Similar experience was brought to every player’s home during the preferred wake-up time instead of 6:30 A.M. at a park. Just like Rajio Taiso, the game aims to increase the energy level of a player in the morning, but in a simple and interactive way right out of the bed. The hurdle to start a morning routine is lowered and more motivation are provided through the game design.

In order to create a reasonable gameplay in the morning and an attachment between a player and the game, a game world and a character design concept was created.

The game is taken place on *Rhythm Satellite*. It is a satellite responsible for generating energy for its planet. The citizens living on this satellite, known as

\(^{18}\)Lister, Cameron, Joshua H West, Ben Cannon, Tyler Sax, and David Brodegard. 2014. “Just a Fad? Gamification in Health and Fitness Apps.” JMIR Serious Games 2 (2): e9, 2. (Lister, West, Cannon, Sax, and Brodegard 2014)
Nori, have an ability to generate energy through rhythmic body motions. They also have to defend the energy towers to avoid energy being stolen by the intruders from the other planet.

The gameplay was designed based on the ethnography findings and game world settings. *Rhythm Satellite* is an online multi-player rhythmic exercise game. It was developed on the Mac OS X and iOS platform. The main gameplay is on Mac OS X while the iOS will act as a game controller and an alarm application. It can be played anytime but the exclusive morning game mode, called Norinori Assembly, can earn extra rewards.

The morning exclusive gameplay, Norinori Assembly, plays the role of waking up a player. At a player’s preferred wake-up time, music from his/her mobile phone will be played as an alarm to wake up the player. The player then, in turn, has to perform some simple gestures with the phone in accordance to the beats of the music to wake up his/her sleeping character. Ideally, the player will be more awake after waking up the character. The player then has to bring his/her character on an iOS machine to a Mac OS machine with game screen located away from the bed. The player has to send the character to the main screen on Mac OS machine and wait for other players before game starts. Through the gameplay which involves physical exercise, the energy level should be raised after the game. The player should be more awake both physically and mentally. He/she may not be fully recovered from sleep inertia, but the possibility of returning back to sleep is greatly reduced.

As a player continues to participate in Norinori Assembly every morning at the same time, he/she will then adopt to a constant wake-up timing. In order to provide motivation to a player to wake up at the same time even during weekends, extra rewards will be awarded for regular participants.

Through Rhythm Satellite, waking up will become an enjoyable experience. Such experience will lead a player to take the first step to start changing the snoozing behavior in the morning. When a player participate in the Norinori Assembly every morning, he/she will experience practising a morning routine like Rajio Taiso which involves simple rhythmic stretching. Once a player sticks to the routine, wake-up behavior changes unnoticeably.
Chapter 2

Related Works

This research tries to explore the potential of using game as an alarm clock to change the wake-up behavior of young adults. Based on the concept discussed in the previous chapter, HCI of alarm clock, serious games and pervasive games are the three areas closely related to this research. Recent works in these three areas done by other scholars will be discussed here.

2.1. Approaches for Improving Awakening Experience

Many people want to wake up feeling refreshed and mentally positive every morning. Activity or sleep tracking devices and applications have gained some popularities in the past 2 years. Jessica M Kelly\(^1\) reviewed various kinds of sleep-monitoring products in the market in 2012. Wearable products, such as Jawbone UP and Fitbit, and smartphone applications, such as Sleep Cycle were reviewed. They aim to increase motivation for healthier sleep-wake behavior change through informing the users about their sleep-wake data. Motion sensors are utilized to track a user’s motion in bed and keep track of which sleep cycle a user is in. “Smart alarm” functions are available in these products and applications. With

such feature, they are able to wake up the user at his/her lightest possible sleep. These products claim that using the smart alarm allows easier wake-up and feeling more refreshed with less sleep inertia. However, Kelly pointed out that the accuracy of sleep tracking via movement detection lacks scientific trial and data for validation. The validity of the claimed experience of using smart alarm is still open for discussion.

On the other hand, Jack Stevens proposed using behavioral economic strategies for promoting adherence to sleep interventions. Although Cognitive-behavioral treatment (CBT) for insomnia is a very effective sleep intervention, its adherence levels are very low. Therefore, behavioral economic strategies, with its application expanded from marketing to health care recently, are applied to sleep-wake behaviors to directly help patients make immediate, yet correct decisions, and hence behave as desired. Maintaining a fixed wake time is an important part in the treatment. Nonetheless, snooze button and standard alarm clock mechanisms can easily override the desired behavior. He suggested “changing defaults” as a strategy to prevent that. He raised Clocky, an alarm that runs around in the room once it sounds, as a creative example to change the easy defaults of pushing the stop or snooze button on a phone. A user of Clocky has to get out of his/her bed to catch and switch off the alarm. The possibility of adhering to the fixed wake time can be increased.

There are other researches that focus on providing new experience of alarm clocks through Human-computer Interaction (HCI) designs which can also be new “defaults” for waking up. Rung-Huei Liang published a journal in 2012 about incorporating serendipity, or random mechanisms, in digital products to enrich their user experience. He asserts that serendipitous is an aesthetic moment that can be created by designers working with daily activities. As one of the prototypes to prove the concept, Social Clock was created. It allows members of a social group to upload their sound clips and they are shared randomly within the group as the sounds of the alarm for awakening. The sound clips can vary from normal alarm sounds, to music, and to voice recordings. The unexpectedness for the alarm


sounds becomes a rich experience in the process of awakening every morning. The trivial and boring awakening is turned into an anticipated moment.

Tsujita Hitomi\(^4\) explored smile encouraging interaction design for daily digital appliances since 2011. They argue that by encouraging people to make a smiling facial expression, positive mood can be promoted. Previous researches have developed theories suggesting that our emotion occur because of physiological changes. Therefore, they developed a HappinessCounter a system that detects smile and provides feedback to promote positive mood. The system was applied to alarm clock as an example. Such alarm clock requires the user to smile to turn off the alarm. The user experience of HappinessCounter was tested to be positive. The users became more and more natural in smiling through interacting with the system for a few days. Hence, a positive mood can be induced every morning with the alarm clock. They also proposed that designed inconvenience can be a new principle for interaction design that promotes better self-awareness and mental states.

Yanmei Wang\(^5\) designed an alarm clock that avoids young student re-sleeping in the morning through physical exercises and English learning. Wang noticed that many young students have poor efficiency in wake up with smartphone alarms or traditional mechanical alarm clock alarms. He also doubts whether young students really need a smartphone as most students easily get addicted to web surfing, games or movies offered on smartphones. In order to lower the chance of students getting the chance to use a smartphone, he came up with an alarm that forces the students to speak out some English words and to perform some simple physical movements before they can turn off the alarm. Students will be not only be more likely to wake up through exercises once the alarm sounds, English learning or practice is also encouraged. Unfortunately, the evaluation is missing to understand the experience of using such an alarm clock in the paper.

In this research, enhancing wake-up experience through a game is proposed.


Such experience differs from other alarm experience that it provides an enjoyable game routine which actually changes the snoozing or re-sleeping behavior in the morning. There has been a great amount of researches about games designed for behavior change. In the next section, a few recent serious or pervasive game reviews are picked up to discuss the elements and design principles for a game that aims to change player’s behavior.

2.2. Game Design Elements for Behavior Change

2.2.1 Guidelines Derived from Behavioral Science

Debbe Thompson published a journal to identify some of the behavioral principles that will guide the future development of serious video games for changing health related behaviors. The journal summarizes some of the knowledge she gained from the previous researches she participated in, such as a clinical trial and the design of a serious video games that attempted to change children’s diet and physical activities to lower the risk of obesity and type 2 diabeses. She presented five behavioral science concepts for guiding game design decisions:

(1) Knowledge and skill are the foundations for behavior change. Knowledge and skill allow players to know how to execute and to maintain a certain behavior. (2) Mastering the skill and use avatar to reflect it. To learn a new skill or behavior, we need to perform it successfully. Game mechanics such as goals and levels

---


should be used to enhance feeling of mastery. Using an avatar to represent a player to mirror the achievement in both real and virtual world is important. (3) Observational learning facilitates behavior change. Guiding or modeling is an effective way to learn new behavior. (4) Tailoring is important, as it can enhance personal relevance of a player and facilitate the change. (5) The game has to be fun as players would have expected a game to be entertaining. “Fun-ness” plays an important role in motivating a player to continue to play and ultimately change the behavior.

Thompson also identified a number of areas that should be further researched for video games for health to unleash its full potential. Within her list, behavior focus, avatars, fun, motivation, virtual to real world learning transfer, and behavioral maintenance were explored in this research.

2.2.2 Game Mechanics Tailored for Different Gamer Type

Concerning the tailoring issue raised by Debbe Thompson, Rita Orji\(^9\) wrote a paper about tailoring persuasive health games to gamer type. She realized two main problems in the field of persuasive game, serious game research. First, most of the persuasive games are not designed based on the theories of what motivates behavior change. This makes researchers difficult to evaluate whether an approach works or not. Current researches on persuasive games also unable to articulate how theoretical factors were translated into game mechanics. Persuasive game designers are then difficult to apply research findings from successful examples which might be targeting a different behavior. Second, most of the persuasive games are unable to provide tailor-made or comprehensive gameplay to motivate different gameplay preferences.

Therefore, she conducted a quantitative study of different gamer types in relation to their healthy eating determinants. She employed the BrainHex model\(^{10}\) for

---


identifying gamer types and Health Belief Model (HBM) for health determinants. Based on the results, she proposed two theory and data-driven approaches for designing persuasive games to motivate behavior change for gamers. One is an all-purpose approach which can appeal to the majority of gamer types. The other one is a play style specific, targeting a specific group of users. Since the current research is for mass public, only the all-purpose approach will be discussed. In order to allow game designers to design a persuasive game that motivates the target users, theoretical motivators are mapped to a list of common game mechanics such that game design decisions can be made based on theories of behavior change.

The “self-efficacy” determinant has either positive or no impact across all gamer types. Therefore, she suggested that persuasive should include game elements and mechanics that address self-efficacy. Ownership, loyalty, pride, repeating simple actions and urgent optimism are some of the game elements that build up self-efficacy for playing a persuasive game. Determinants “cues to action” and “perceived benefits” overall has positive relationship with the general gamer types. Mechanics that provide cue to action and demonstrate benefits of playing the game will be appealing to the majority of the gamer population. Reward-based mechanics such as point and levels, and blissful productivity can act as the “perceived benefits” while structure play such as quests, appointments and cascading information theory can be effective cues leading to action. Interestingly, results showed that no gamer type was motivated by perceived barrier. She suggested that mechanics such as disincentives and extinction of rewards should be avoided for persuasive games.

2.2.3 Serious vs Fun? Real vs Virtual?

There are a number of comprehensive reviews on persuasive or serious games which attempted to promote health behavior change in a qualitative way. A recent analysis\textsuperscript{[11]} shows that serious games in general have positive effects on

healthy lifestyle, but only to a small extend. Although they provide positive knowledge which is a long term effect to the players, there seems to be a know-do gap. Persuasive games for behavior change should be more directly persuading players to modify their behavior, instead of educating them or increasing exercise activities\textsuperscript{12}. While commercial games have a great potential to be addictive\textsuperscript{13}, theoretically, serious or persuasive games should also be able to attain certain high retention. A lot of pervasive game reviews mentioned that fun factor should not be neglected. After all, a game has to be fun no matter what message or behavior are intended to deliver to the players. Furthermore, as peer support is also important for changing behavior, multiplayer health games should also be explored.

Ellen Brox\textsuperscript{14} mentioned about persuasive games tend to be more persuasive with extrinsic contents, meaning that getting the player involved in doing something outside the game which may not be directly related to the the game goal. For instance, Fish’n Steps\textsuperscript{15} in which players are encouraged to walk more to keep the fish in a virtual aquarium alive. Another example is Didget, a game in which a player will earn game points when testing blood glucose level. However, there is a big disconnection between the players’ activities and the contents of the game. The flow of the game may not be as natural as intrinsic gameplay, and hence desired behaviors are not carried out seamlessly. Therefore, combining intrinsic and extrinsic contents as one may be the future of persuasive games. Pervasive or ubiquitous technology seems to be the enabling technology, which involves sensors, non-personal computers, mobile network and etc. The games that utilize such technology is called pervasive games\textsuperscript{16}. In fact, the games mentioned above

\textsuperscript{14}Ellen Brox 2011
\textsuperscript{16}Hinske, Steve, Matthias Lampe, Carsten Magerkurth, and Carsten Reker. 2007. Classifying
are also pervasive games to some extend. More examples of pervasive games will be discussed in the next section.

This research aims to learn from the previous serious games, and try to propose a potential future direction for serious game design. The essential fun experience of a gameplay is explored. It seems that the focus has been shifted to the human-computer interaction and gamification in recent years. However, it is believed that the design of the game contents itself is also important as interaction is only part of a gameplay. With the latest technology, game design for behavior change might be another breakthrough time from now on.

2.3. Pervasive Gameplay

Games that made use of pervasive technology can be found in early 2000s. Smart toys\textsuperscript{17} augmented tabletop games\textsuperscript{18} location-aware games\textsuperscript{19} and augmented reality games\textsuperscript{20} started to gain attention since then. Pervasive gaming are emerging and attracting more and more interests recently due to the experience of involving both physical and social elements in the virtual game world as well as development.


in sensor and mobile technology\textsuperscript{21}. Sensor and mobile technology enabled context-aware computing, which is one of the enabling features of pervasive computing. By understanding the context, such as spatial information, temporal information, environmental information, social information, and physiological information\textsuperscript{22}, adding a layer of virtual world to the physical world is then possible.

\subsection*{2.3.1 Pervasive Game Possibilities}

Vlasios Kasapakis and Damianos Gavalas\textsuperscript{23} developed Barbarossa, an outdoor, location-aware pervasive role-playing game. It tried to address some of the issues that existing pervasive games has, such as relocation of game space, unattractive scenario design, poor usability, game duration and intensity. They argue that these are important aspects to substantiate game design decisions which will raise user acceptance and result in more immersive game experience. The game scenario is based on the medieval story of the pirate brothers Barbarossa. There are three player roles in the game and each has an individual game scenario. Their common goal, though, is to trace and open a chest, locked with a four digit combination lock and hidden somewhere in the city. The scenario can be unfolded anywhere, anytime, as long as the players are within the same area. Such game provides a totally different experience to explore an area and the behavior in the street is totally changed based on the player roles in the game.


2.3.2 Pervasive Game for Health

Azusa Kadomura\textsuperscript{24} created a fork-type sensing device called the Sensing Fork that detects the eating behavior of children. The Sensing Fork is connected to a smartphone game called Hungry Panda 2 which interacts with the user based on the eating behavior. It aims to motivated children to eat all kinds of food on their table as a well-balanced diet is essential in maintaining good health. The Sensing Fork can detect food types and the eating status such as biting and poking. The information is then sent to a smartphone with Hungry Panda 2 running on it. The hungry panda, acting as a virtual pet on the smartphone, will then react according to the eating behavior, including choice of food. Picky eating will result in making the panda cry in the game. As the children build up empathy towards the panda, a healthier eating habit can be achieved through the fork and the game. It is a proof that children’s eating habit can be improved if persuasive as well as pervasive technology is introduced in daily life.

2.3.3 Casual Pervasive Game Guidelines

Sofia Reis and Nuno Correia\textsuperscript{25} proposed utilizing several real world elements as part of casual game players’ attribute such that fictional game world merges with the reality. Sound, video, physiological data, accelerometer data, weather and the player’s location were focuses in the paper. They emphasized that casual players tend not to invest money on equipments or specialized hardware. Therefore, including real world elements into games, we should make use of capabilities already available on smartphones and personal computers. Through prototypes of pervasive casual games, they proposed a set of guidelines for including pervasive components in casual games. Potential problems includes: problems in data collection and processing, calibration, privacy, battery drain and dependence from external providers, should be taken in consideration while designing a casual pervasive game. Sound, arousal, and the accelerometer serve best as they merge the

\textsuperscript{24}Kadomura, Azusa, Cheng-yuan Li, Koji Tsukada, Hao-hua Chu, Itiro Siio, and Information Engineering. 2014. Persuasive Technology to Improve Eating Behavior Using a Sensor-Embedded Fork, 31929. (Kadomura, Li, Tsukada, Chu, Siio, and Engineering 2014)

games naturally with the player’s everyday activities.

*Rhythm Satellite* tries to bring forward the idea of pervasive casual game that has potential to reach a mass market and propose the idea of changing behaviors of the players through a pervasive game lifestyle. Furthermore, how multi-device can be utilized in a casual game is also demonstrated.

### 2.4. Contribution of This Research

Different from the previous research in enhancing wake-up experience, serious and pervasive game design, this research presents an approach to design a game with morning-exclusive gameplay to engage young adults to wake up on time in the morning. Instead of focusing on just the moment when the alarm sounds, a richer experience covering before the alarm, during the alarm and after the alarm is proposed. Such experience aims to guarantee an individual to wake up feeling more awake. In order to guarantee such experience, game design and pervasive technology driven gameplay will be the triggers, motivators as well as experience generators. Different from the approaches with the intention to persuade the player to an unusual process with game or through gamification, a serious game that aims to provide entertainment as the first priority is asserted here. Once the players get immersed into the game, pervasive game modes that facilitate behavior change come into place. The design process and the implementation to realize this vision will be explained in the next chapter.
Chapter 3

Design

The design of Rhythm Satellite is based on the intention that it is not a gamification of waking up. It is a game that can be played anytime. Waking up is only an extension of the gameplay. Therefore, the design problems lie in designing an intriguing game such that the players will be willing to play voluntarily and designing a persuasive gameplay that motivates the player to get up and ultimately change their wake-up behavior. In the following sections, the concept of the game will first be explained, followed by the design process involved. Finally, the implementation of the game prototype will also be discussed.

3.1. Concept

The design concept of Rhythm Satellite is a gameplay that engages the players to wake up and perform simple awakening stretching seamlessly through the game. Rhythm Satellite is a rhythm, music game that involves physical exercise and multi-player gameplay. The player uses a smartphone to input commands through arm motions to control the character, displayed on a computer screen, to perform the same rhythmic moves as the player does. The character is customizable and so it is representing the player in the virtual world. How well the player performs is mirrored to the character through its levels, skills and equipped items. If the game is played in the morning, warm-up stretching can be achieved.

The player can set a preferred wake-up time in game on the smartphone. An alarm will sound, followed by a guided wake-up gameplay in the next morning.
The computer and the smartphone detect whether he/she gets out of bed. As the player approaches to the game screen of the computer, he/she is then matched with other players who wake up at the same time for a morning session game. This ensures that the player gets out of bed and start playing a game that has awakening effect.

Through playing *Rhythm Satellite*, waking up becomes an enjoyable experience. Becoming a player of the game can guarantee waking up on time. As simple physical exercise is involved in the gameplay, the player should feel more awake and less sleepy in the morning. Despite all these values, it provides entertainment through music, rhythm and interactive gameplay as a game.

The approach used to change a player’s behavior is through an extension of a gameplay. The basic entertaining gameplay is extended to a designed behavior-changing gameplay. The behavior-changing gameplay provides persuasive mechanisms on top of the basic game mechanics, such as rules, goals and rewards, and is part of the overall gameplay experience. In other words, solving the “serious” problem is not the main goal in the gameplay, it is, instead, only a part of the it.
Different from other serious games, *Rhythm Satellite* can be enjoyed any time whenever a player wants to. The behavior intervention does not necessarily appear in the gameplay all the time. It is can be played casually like normal games. However, if a player wants to be more competitive, the morning limited game mode allows him/her to gain extra game points such as experience, virtual currency and items to become an advanced player. A change from re-sleeping behavior is anticipated with such motivation as well as the physical exercise involved in the gameplay.

In the long run, if a player continues to play *Rhythm Satellite* as one of his morning routines every day, the following experience is expected.

- Being able to maintain a simple exercise routing every morning
- Maintaining a regular sleep-wake rhythm
- Less daytime sleepiness, better working performance

In the next section, the design process of *Rhythm Satellite* will be described in detail.
3.2. Ethnography

This research started based on a vision for a game that motivates young adults to get up once alarm sounds. To ensure no returning to bed and re-sleeping, incorporating physical exercise was anticipated. In order to create a context about morning exercise for inspiration and concept making, fieldwork of Rajio Taiso (radio calisthenics in English) was conducted.

Rajio Taiso is a set of rhythmic warm-up exercise popular in Japan. They serve as some warm-up exercises to raise the energy level in the morning. It is chosen for ethnography because the experience proposed in this project has similarities in it. It can be a model for study as there is a large population who wake up to practice Rajio Taiso every morning. Radio Taiso practicers are from across different ages. From elementary school children to retired elderlies. Guiding video and audio are broadcast by NHK on television and radio respectively every morning. It starts from from 6:30 a.m. and lasts for about 10 minutes. Some people will do it at home while looking at the television or listening to the radio. Most of the practicers, however, would choose to gather in a park nearby and practice with other neighbors.

The focus of the fieldwork was to observe what are the elements present specifically in the park with a large group of Rajio Taiso practicers. An elderly who has been practising Rajio Taiso for years was expected to be a fieldwork master for observation.

3.2.1 Fieldwork

The fieldwork was conducted on 24th July, 2014 at Komazawa Olympic Park,[1] a popular place for Rajio Taiso in Tokyo. There is a specific area for Rajio Taiso and around 100 people gather there every morning. During the fieldwork, it was discovered that there are various motivations for practicing Rajio Taiso for different practicer groups. Elderlies practice it every day to stay healthy and avoid unnecessary medical expenses. Families with little children want to build up healthy habits for their children through Rajio Taiso. Children are encouraged to participate every morning so that they can collected stamps on a stamp card.

and receive gifts with them. There are also people whose main exercise is jogging but join the big crowd for Radio Taiso.

During the fieldwork, both verbal and non-verbal communications between neighbors, family members and couples were observed. Before Rajio Taiso had started, practicers, especially elderlies who have been doing this every morning, talked to each other as Rajio Taiso friends. Once they heard the starting announcement on the radio, they first secured enough space around themselves. After that, they all looked at the same direction, where the Rajio Taiso leading was located. Music, verbal instructions and demonstrations were cues for each Rajio Taiso move. Although most of the practicers remember most of the moves, they looked at each other as reference to ensure that they are performing the same move at the same time. As the moves are all performed according to the pace and the beats of the music, the practicers enjoyed each move very much. Being in sync with the music as well as all other practicers seemed to be an important element for enjoyment.

![Figure 3.3: Elderlies Practising Rajio Taiso](image)

A retired elderly who has been practising Rajio Taiso for a long time was picked randomly as a fieldwork master for understanding the behaviors of Rajio Taiso practicers. The master aged around 70 years old. He lives 20 minutes of walk away from the park. He has been practising Rajio Taiso for 15 years. He is
healthy in general and he believes that human is supposed to move more as we are “ani”-mals. He worked in the transportation industry before his retirement. His job involved a lot of heavy loads conveying but he thinks those are just burdens instead of healthy exercises. He wants to keep himself healthy so that the expense on health care or medical treatment can be minimized. Meeting friends in the morning is also important to him.
the sequence model of the master once he arrives the park.

Figure 3.6: Sequence Model

Figure 3.7 is the flow model showing how different Rajio Taiso practicers communicate, both verbally and non-verbally, with each other before, during and after Rajio Taiso.

Figure 3.7: Flow Model
Figure 3.8 shows the physical environment that allows Rajio Taiso happen in Komazawa Olympic Park. The interesting point is that the elderlies and family groups are separated in a large distance. It seems that the elderlies were letting the family groups get closer to the Rajio Taiso leader because children are less experienced and need more guidance from the leader.

![Physical Model](image)

Figure 3.8: Physical Model

The items shown Figure 3.9 are the artifacts that the master brought with him for Rajio Taiso. The master brought his own radio even there are speakers in the park broadcasting Rajio Taiso every day.

Cultural model described in Figure 3.10 explained the relationship between different people and parties involved in Rajio Taiso at the fieldwork venue. It seems that the Rajio Taiso friends are great motivators for him to come for Rajio Taiso every morning as he is really happy to see them.
Figure 3.9: Artifact Model

Figure 3.10: Cultural Model
### 3.2.2 Mental Model

Through analysis of the observation and conversation done during the fieldwork, some unconscious patterns of his action were spotted. When he thinks about how expensive the medication in Japan is, he wants to keep himself healthy. When he sees his friends, he greets them. When he hears the starting announcement, he increases the volume of the radio so that he himself and the people nearby can hear it. As he stands up, he finds an open space big enough for stretching his body. As he finds his spot, he faces to the direction of the Taiso leader even though he is far away from him. When he hears the instructions, he immediately knows what to do next. When he hears the change in music pattern, he immediately changes to the next move. Once Rajio Taiso is over, he leaves the park.

A mental model (Table 3.1) was extracted from these observations. Then, an abstract mental model (Table 3.2) was created based on it.

<table>
<thead>
<tr>
<th>Cognition</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Think about how expensive the medication is</td>
<td>Want to keep himself healthy</td>
</tr>
<tr>
<td>Sees his friends</td>
<td>Greet them</td>
</tr>
<tr>
<td>Hear the starting announcement</td>
<td>Increase the volume of the radio</td>
</tr>
<tr>
<td>Stand up</td>
<td>Find an open space</td>
</tr>
<tr>
<td>Before Rajio Taiso start</td>
<td>Face to the direction of the leader</td>
</tr>
<tr>
<td>Hear instructions</td>
<td>Do the corresponding moves</td>
</tr>
<tr>
<td>Hear the change of music pattern</td>
<td>Change to the next move</td>
</tr>
<tr>
<td>Rajio Taiso is over</td>
<td>Go home</td>
</tr>
</tbody>
</table>

Table 3.1: Fieldwork Master Mental Model
### Table 3.2: Abstract Mental Model

<table>
<thead>
<tr>
<th>Cognition</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Think about unnecessary expense or loss</td>
<td>Try hard to avoid it</td>
</tr>
<tr>
<td>Possess something that benefits the group</td>
<td>Share it</td>
</tr>
<tr>
<td>See a friend</td>
<td>Greet him</td>
</tr>
<tr>
<td>As a routine starts</td>
<td>Get the body prepared</td>
</tr>
<tr>
<td>Do something in a group</td>
<td>Look at the others as reference</td>
</tr>
<tr>
<td>Receive a cue</td>
<td>Act accordingly based on memory</td>
</tr>
</tbody>
</table>

#### 3.2.3 Target Persona

A target persona (Figure 3.11) who will possibly play the game to change his wake-up behavior was created. Kosuke Fujikawa is a 24-year-old young man born in Hokkaido. He is now working for a design company as a user interface designer. Every morning he experiences difficulties to wake up and go to work on time. He wants to be able to wake up on time every morning but he just cannot wake up no matter how many alarms he sets. He also tries to put his smartphone away from his bed so that he will be forced to get out of bed to turn off the alarm. However, he still cannot resist to go back to his bed after turning off the alarm. He is always sleepy and it seems that no matter how much he sleeps, he still feels groggy all day. His boss is always annoyed by his poor punctuality and work efficiency which result in unnecessary overnight work.
Kosuke Fujikawa
Age: 24
Gender: M
City: Tokyo
Hometown: Hokkaido
Job: Web Designer

**Personal Profile**
He is now working for a design company as a user interface designer. He likes playing games, going to concerts, traveling, going to karaoke with friends, drinking beer and snowboarding. He has been single for two years. He is very reluctant to get up in the morning. He sets more than five alarms every morning to make sure he can wake up on time but he never actually be able to do so. Fortunately the company he is working for has a relatively late working hours. Although the official working time is from 10 A.M., he is always late for work.

**Working Profile**
He always feels sleepy while he is working during the day. His low efficiency and careless mistakes made always annoy his boss. His boss knows he is talented but he is never performing at his best. His boss also nags him about his punctuality and his unnecessary over-night work. After talking to other colleagues and reading some articles online, he realizes that the problem roots from his poor sleep-wake habit.

**Goals**
- To be able to wake up once the alarm goes off
- No more late for work
- To be energized to go to work every morning

Figure 3.11: Target Persona

The target persona was created so that it serves as a basis for later brainstorm-
ing and creating concepts. Concepts created can then use the target persona to evaluate whether they are catering the needs and providing appropriate value proposition for the persona.

The mental model extracted from the Rajio Taiso master was applied to the designed target persona based on his interests as follows (Table 3.3).

<table>
<thead>
<tr>
<th>Cognition</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Think about losing game points</td>
<td>Try hard in game to avoid it</td>
</tr>
<tr>
<td>See a friend in a game</td>
<td>Greet him</td>
</tr>
<tr>
<td>Before a concert starts</td>
<td>Find the best possible place</td>
</tr>
<tr>
<td>While waving hand during a concert</td>
<td>Look at other people to ensure the right timing</td>
</tr>
<tr>
<td>Once the intro of a song starts</td>
<td>Perform a specific choreography for that song</td>
</tr>
</tbody>
</table>

Table 3.3: Persona’s Mental Model

3.3. Ideation

After conducting a fieldwork and creating a target persona, a brainstorming session was conducted. Based on the ideas generated, an initial concept was created.

3.3.1 Brainstorming

In order to have greater diversities for generating ideas, three individuals, including the author of this thesis, participated in the brainstorming session. Each individual came from different backgrounds and different chrono-types. The mental model and target persona were shared among the group before the brainstorming session so that each of the participants understood the context for brainstorming.

There are some rules applied to the brainstorming session. (1) Everyone had to draw their idea with some short captions. (2) Three minutes for brainstorm for each round and repeat until more than 100 ideas are generated. (3) No judging and criticizing the ideas. (4) Be open to abnormal ideas.
After some discussion within the group, there are three areas of focus for ideation: (1) Gameplay for the night before; (2) Alarm mechanism; (3) Gameplay after the alarm to ensure awakening.

Over a hundred of ideas (Figure 3.12) were generated and they are categorized into three categories mentioned above and sub-categorizing for different approaches under each category.

![Image: Ideation with Stickies (Graphics)](image)

Figure 3.12: Brainstorming with Graphics

### 3.3.2 Concept Making

Based on the ideas generated in the brainstorming session, an initial concept for the experience to change wake-up behavior was created. Such concept was evaluated for its value proposition based on the target persona created. The concept was also used as a starting point for creating the game world, game characters and the main gameplay.

The original concept created is an online dating, exercise game. Every morning a player will be matched to another player of the opponent sex. The matched couple will then compete against another couple in a tournament. Matched couple can add each other as friends and can decide to participate in the tournament together. Smartphone is used as an alarm and the matched players can wake up each other using real-time voice communication. Bluetooth is used to enable
smartphone to detect whether a player leaves the bed and comes close to a personal computer with the game running. The personal computer is the main game screen and smartphone is used as a motion controller for the game. The game involves some physical movements so that the player will be more awake through playing the game. After the game, a water bottle with Bluetooth and motion sensor detects whether a player drinks some water to wake himself/herself up.

Figure 3.13: Concept Sketch 1

Figure 3.14: Concept Sketch 2
Figure 3.15: Concept Sketch 3

Figure 3.16: Concept Sketch 4
There were struggles in whether to use the motion sensors in a smartphone to
detect the motion or to use a camera, such as Microsoft Kinet, to track the motion
of a player. In the concept, a seamless change from wake up to start playing the
game is aimed. If camera is used, calibration might be needed and the camera
view angle might limit the position of the game device if one is not living in a
spacious room.

At this stage, the game contents including gameplay concept and game world
were still undefined. However, after defining the gameplay and the game world, the
overall concept was simplified and evolved to the concept illustrated in Section 3.1
after a few iteration of design.

3.4. Game World Design

Based on the concept created, a game world and game character were designed
through mind-mapping and sketching respectively.

3.4.1 Game World

To create a virtual world that fits into the context of waking up in the morning,
a few mind maps with a keyword related to it as starting nodes. The follow-
ing images show the mind maps created from “morning” (Figure 3.17), “farm”
(Figure 3.18), “sun” (Figure 3.19), and “music” (Figure 3.20).

At the beginning, it was started with “morning”. Then it is found that some
nodes were of common nature. A mind map for “farm” was then created. Such
process was repeated two more times and a concept for game world was created
out of the nodes appeared on the mind maps.

Concept

The game is taken place on Rhythm Satellite. It is a satellite responsible for
generating energy for its planet. The citizens living on this satellite has an ability
to generate energy from the solar energy they absorbed to the body. Every citizen
on the satellite has the responsibility participate in the Norinori Assembly to
Figure 3.17: Mindmap of “Morning”
Figure 3.18: Mindmap of “Farm”
Figure 3.19: Mindmap of “Sun”
Figure 3.20: Mindmap of “Music”
generate energy for the whole satellite and the planet every morning. Extra energy generated, can be used as a currency, called sollar, to trade things with others.

The Planet of the Darkness has been a threat to the satellite. It does not have enough supply of energy and they are unable to generate energy in an efficient way like Rhythm Satellite does. Kurara, the soldiers of the Planet of the Darkness has been stealing energy from Rhythm Satellite. Therefore, during Norinori Assembly, the citizens are also trained to fight against the Kuraras to prevent energy being stolen.

3.4.2 Game Character

The character concept was created through extending the game world concept. There were a few iterations of the concept together with the gameplay design which will be discussed in Section 3.5. The following is the latest game character concept.

Concept

The citizens living on Rhythm Satellite are called Nori. They have the ability to generate energy by one million times by rhythmic motion while they are absorbing the solar energy to their bodies. They have a thunder-like shaped horn on top of their head which can transfer the energy they generated. They will do rhythmic moves every morning to gather and generate energy and send the generated energy to an energy tower nearby. They can also used the energy generated to attack or to protect themselves from the attacks from Kuraras.

There is a set of gestures that a Nori has to perform in order to use the energy for attack and protection. Every morning after the Norinori Assembly, there is a tournament of Norinori Battle, in which Noris will get matched and compete with each other using their skills of NoriNori Battle. Winners will be awarded for their excellent skills that can be applied to fight against Kuraras.

Design

Different ideas (Figure 3.21 and 3.22) of the character were sketched based on the concept defined above. There are two criteria when it was designed: (1) Cute and
(2) simple for customization.

Figure 3.21: Character Idea Sketch 1

Figure 3.22: Character Idea Sketch 2

The design of the character aims to build up attachment with a player. Nori is used as an mirror to its player. For example, if the player cannot wake up in the
morning, his/her Nori will also behave the same; The arm motions done by the player are also reflected on the character. This can help a player to get immersed into the world of Rhythm Satellite more easily.

With the game world and game character concept, the game was finally titled as *Rhythm Satellite*.

![Rhythm Satellite Logo](image)

**Figure 3.23: Rhythm Satellite Logo**

### 3.5. Gameplay Design

#### 3.5.1 Inspirations

Some of the existing well-known commercial games are referenced for inspiration to design *Rhythm Satellite*’s gameplay. Some of the gameplay elements of *Rhythm Satellite* were inspired from the following games.

**Space Channel 5**[^1] is a rhythm game released on Dreamcast in 1999. The game takes place five hundred years in the future. The main character, Ulala, is a news reporter of an interstellar television station. She was sent to report the news of hostages being kidnapped by an alien race and at the same to save the hostages.

kidnapped. In the gameplay, there are only 4 input commands: Up, Down, Left, Right, and Shoot. the player has to reproduce the sequence of commands spelled out by the aliens in time to the rhythm by pressing the corresponding buttons. The gameplay is simple but the entertainment value is extremely high with interesting story, catchy rhythms and musics.

*Patapon*[^3] is a rhythm game released on PlayStation Portable in 2007. Patapon Tribe experienced tragic loss to the Zigoton Empire. The player, taking the role of the Patapons’ god, uses war drums: Pata, Pon, Chaka, and Don to direct the Patapon warriors in the battles to recover their land. Each war drum corresponds to one button as input. Each command for the action of the Patapons requires of a specific sequence of four drum beats. For example, Pata, Pata, Pata, Pon makes the Patapons to march forward and Pon, Pon, Pata, Pon makes them attack. During a battle, the player has to remember the input combinations for different actions and input them in beats to direct the Patapons to victories. The enjoyment of this game comes from the decision making while the player is inputting drum beats in rhythm to control the Patapons. Remembering the input sequence and making decision for the next actions makes the game more challenging.

*Metal Gear Online*[^4] is a PlayStation 3 exclusive online multiplayer, third-person shooting game spinned off from the Metal Gear Solid series. It allows up to 16 players to participate in online tactical warfare. There are different rules of play such as Team Deathmatch, Rescue Mission, Base Mission, Bomb Mission and etc. Each player can create their own soldier with customizable gears and outfits. Combat skills can be equipped to aid the combats. There is a survival mode and a tournament mode held in limited time period 3 days a week. Reward points and tournament exclusive items are awarded to teams who can win streak of matches. Such game modes draw players, who want to be a better player or get more outfits, to play the game in specific time frames. Survival mode can be joined freely while tournament modes requires reservation. This draws commitment of the players.

*Puzzle and Dragons*[^5] is a popular mobile puzzle game in Japan. Each player has a collection of monsters to help conquer different dungeons. In order to challenge

difficult dungeons, a player has to collect stronger monsters through lucky draw or defeating bosses of some special dungeons. Lucky draw requires five magic stones and almost every day one magic stone will be rewarded for daily login. The players, therefore, play the game every day to collect magic stones so that they can draw some stronger monsters. High retention can be achieved through daily rewards.

3.5.2 Game System

Based on some of the inspirations from other successful commercial games and the concept created, there are some directions guiding the design of the gameplay of *Rhythm Satellite*:

- Using smartphone to detect arm motion as input, to wake up the player with music and to detect physical location at home
- Three to four inputs while focusing on catching beats and rhythm
- A time-specific game mode
- Rewards for playing the game every morning
- Multiplayer gameplay for peer support and more excitement.
- Customizable appearance and abilities of the character.

Game Platform

In order to implement a multi-device, pervasive gameplay, the game runs on an Apple Macintosh\(^6\) machine with Mac OS X\(^7\) in combination with an Apple iPhone\(^8\) running iOS\(^9\). Both devices have to have *Rhythm Satellite* installed. IPhone is used as a motion controller to detect player’s motion input while Mac machine is used as a gaming console, outputting visual and audio feedbacks in game. Besides,

---


\(^7\) Apple - OS X Yosemite [https://www.apple.com/osx/](https://www.apple.com/osx/)

\(^8\) Apple - iPhone [https://www.apple.com/iphone/](https://www.apple.com/iphone/)

the iPhone application is used as an interface to interact with the character and an alarm clock to wake up the user in the morning. Fitting the devices into the game world concept, iPhone screen serves as a mobile underground home for Nori while Mac machine displays maps and the outdoors (Figure 3.24). Bringing the character from the underground home to the outside is one of the concepts that can be implemented with multi-devices.

Main Game Mechanics

The main game mechanics design had gone through a few iterations. At first, a mechanics similar to ordinary music game like Taiko no Tatsujin\textsuperscript{10} was adopted. There are notes flying from one side to the other and the player has to hit the notes at the correct timing with a gesture accordingly. However, after creating a rapid prototype and testing it, it was not as exciting and intriguing as expected. Then, a mechanics which ties closely to the game world concept was tried out. There are energy balls falling from the sky and the player has to control the character to catch them. However, it was also not that interesting to play with.

After some evaluation of some existing games and research about game design, “game experience has to incorporate not just explicit interactivity, but meaningful

\begin{footnote}{10}Taiko no Tatsujin http://taiko.namco-ch.net/taiko/\end{footnote}
choice\textsuperscript{11} was the conclusion. Therefore, a game mechanics that allows player to make decisions, and to even create strategies was targeted. Getting inspiration from Patapon mentioned in Section 3.5.1 NoriNori Battle which will be explained in detail in Section 3.5.3 was designed.

Game Modes

![Game Modes Diagram](image)

Figure 3.25: Game Modes

There are three game modes based on one main game mechanics, NoriNori Battle. The story mode is a single player game which requires a player to defeat the aliens in different NoriNori Battles. The free-play mode is a multiplayer which can be played anytime with other players. The morning game mode consists of NoriNori Assembly and NoriNori Tournament which allow the players who get up at the same time to practice the Actions commands and to compete in NoriNori Battles with each other. Winners of the tournament will receive more rewards and experience so that their Noris will have faster growth than the others. This provides more motivation to the players to get up at the designated wake-up time.

The higher the level of the character, the more HP and the higher attack damage the character has. The character can also purchase skills such as more powerful attacks with the rewards gained in NoriNori battles. The character

can also be customized (Figure 3.26) so that stronger attachment can be created between the character and the player.

### 3.5.3 NoriNori Battle

The main gameplay is a one-to-one battle, called NoriNori Battle, a game similar to the simplest, yet most famous analog game “Stone-Paper-Scissors”. Instead of Stone, Paper and Scissors, 3 Actions: Attack, Block, and Charge are used. To Attack, prior Charge is required. Block can be used any time to lessen the
damage from the Attack of the opponent. If a player gets attacked while he/she
is charging, large damage will be received. The game is over when either one of
the player has zero Hit Point (HP) or the round limit is over. In each round,
the players have to play an psychological mind game in real time. Immediate
strategies can be built based on the opponent’s HP, Charge stocks, opponent’s
Attack damage and prediction of the next move.

To perform each Action, a player has to hold the iPhone in hand and wave
his/her arm Up, Side, or Down as, input commands, in rhythm for four continuous
beats. Each Action corresponds to a sequence of four commands inputting in
rhythm. For example, Down, Down, Down, Down will trigger a Block Action by
default. Each round of a battle consists of eight beats. Figure 3.28 and Figure 3.29
show the three gesture commands and three basic Actions that can be performed
in the game. During the first four beats the players have to input their gestures
with iPhone and the last four beats are for showing the Actions and the round
results on screens. Music will be played as the battle starts. The players have to
catch the rhythm of the music to input each gesture at the correct timing. The
continuous rhythmic inputs can then act as some physical exercises.

Based on the defining traits of a game suggested by Jane McGonigal\textsuperscript{12} the

\textsuperscript{12}McGonigal, Jane. 2011. \textit{Reality Is Broken: Why Games Make Us Better and How They
Can Change the World.} Penguin. 22-27. \textsuperscript{[McGonigal 2011]}

50
goal, rules, and the feedback system of NoriNori Battle are defined as follows:

Goals

- Attack until the opponent has 0 HP
- Having more HP than the opponent does

Rules

- 3 Inputs: Up, Sides, Down
- Only inputs that are hitting the beat are successful inputs
- Each round has a specific number of rounds. (16 rounds for default)
- Each round consists of eight beats
- Only the first four beats are available for input
- Upon successful input of four consecutive command, the corresponding Action will be performed
- Attack cannot be carried out without Charge
- Attacking a Charging or input failure opponent causes a big damage
- Blocking an Attack lessens the damage

Interactive System

- To start the game, a player has to swipe the character on the iPhone from bottom to top to send the character to the computer screen
- Once the players are ready, the music and the battle starts
- Sound effect to indicate that the next beat is the first beat for input
- Each motion input is immediately reproduced by the character
- Each motion input has its sound effect as feedback
• Input timing is displayed through visual effect and lighting effect (if Philips Hue is installed) as feedback

• Each Action has its visual and sound effect as feedback

• HP and Charge stock changes are shown using bars and icons.

• When one of the players has 0 HP or the number of rounds left is 0, the battle ends.

• When a battle has finished, the character will leave the screen and come back to the iPhone

3.5.4 Morning Exclusive Mode (Wake-up Intervention)

According to the game world settings, Nori’s have to wake up in the morning to participate in NoriNori Assembly. The players can make use of the game help themselves to wake up through helping the character in Rhythm Satellite. However, during the first few minutes after waking up, our decision making abilities are poor. Referring to the behavior model for persuasive design suggested by BJ Fogg\(^{13}\), our ability to achieve a target behavior is very low. Therefore, when designing a gameplay that is motivating the player during the first few minutes after awakening, a simple game mechanics which does not require much thinking and physical effort is necessary.

The morning game mode can be played from 5 A.M. to 9 A.M. local time (Figure 3.30). Players can set their own preferred time to participate in it. Music will be played as an alarm on iPhone to wake up the player at the preferred time. He/she has to wave the iPhone in rhythm to wake up his/her character. Once the character is also awake, the player should have his/her body warmed up a little bit, no matter he/she has left the bed or not (Figure 3.31).

The goals, rules, and interactive system of the wake-up gameplay are defined as follows:

Figure 3.30: Setting Wake-up Time

Figure 3.31: Asking Player to Wake Nori Up
Goals

• Waking up the character

Rules

• By default, 32 rhythmic shakes with the iPhone is required to wake up the character

• Shakes that align with the beats of the music are registered

Interactive System

• As the alarm sounds, a message asking the player to wake up the character will be displayed

• Sounds effects for successful input as feedback

• The character says “Good Morning!” when he wakes up

After waking up, the character will ask the player to bring him to the NoriNori Assembly (Figure 3.32). The player has to bring the iPhone with the character in front of the screen of a Mac, which is located away from the bed, with Rhythm Satellite running. This can ensure that the player to leave his/her bed. Once the player checks into the game, he/she will be matched with other players and start playing the game. NoriNori Assembly is a daily energy-generated responsibility in the game world. During the 1-minute assembly, the basic Action inputs will be practiced and energy will be collected to an energy tower at the same time. A player will be awarded with coins for generating the basic quota of energy for the satellite.

The followings are the goals, rules, and interactive system of NoriNori Assembly:

Goals

• Reaching to the physical gaming location

• Collect as much energy as possible through rhythmic motion inputs
Figure 3.32: Asking Player to Bring Nori to Assembly

Rules

- Player has to check in to the NoriNori Assembly within 5 minutes after the alarm sounds
- All inputs have to be hitting the beats of the music
- Player must input the commands as instructed
- First four beats are for instructions, last four beats are for input
- 16 correct inputs are required to pass the lowest requirement of the goal
- NoriNori Assembly lasts for about one minute.

Interactive System

- Once the player checks into the NoriNori Assembly, the alarm will stop
- The player will be matched to other players once checking in
- Players can greet each other using the “greet” button
• Music for the assembly will sound when the game starts

• Instructions are displayed in icons in accordance to the rhythm

• Energy collected will be displayed with a progress bar

• All inputs have similar feedbacks found in NoriNori Battle

After the NoriNori Assembly, the player will be asked if he/she wants to participate in the NoriNori Tournament, which consists of a series of NoriNori Battle against other players. Extra rewards will be offered to those who win two consecutive games.

After about two to five minutes of gameplay, the player will be physically and mentally awake due to the physical exercise encouraged through motion inputs and the mind game involved. Returning to bed is more unlikely to happen. Getting engaged in the morning game mode would lead he/she to be able to wake up as planned and more time will be earned for their morning routines before going to work or school.
3.5.5 Key Path Scenario

At 7:00am
Rhythm Satellite
Music is played

Nori asking for some rhythms to wake up

Figure 3.33: Key Path Scenario 1-2

Shake iPhone in rhythm with the music [warm-up]

Nori asking the player to bring him to the game

Figure 3.34: Key Path Scenario 3-4
Figure 3.35: Key Path Scenario 5-6

Player approaches the computer with Nori on iPhone

Slide up to send out Nori to the computer

Figure 3.36: Key Path Scenario 7-8

Nori is shown on the computer screen immediately

Player starts to play the game with combinations of motion
Figure 3.37: Key Path Scenario 9-10

At 7:05am
Player feels awake after the game

Player has time for shower and breakfast at home

Figure 3.38: Key Path Scenario 11

At 7:45am
Player is well-prepared to set off for work
3.5.6 Game Elements For Sustainability

The sustainability to have players playing the game every morning for a long period of time relies on the game itself as the motivation. There has been many existing game design elements that can keep the players “loyal” to a game. Rhythm Satellite is using some common ones such as character customization, character levels and stages.

Character Customization

The character is designed to be highly customizable such that the character can be a personality reflection, a pet or a buddy that provides strong attachment to the players. There will be a virtual shop that allows the player to buy customizable parts for their characters in game. The game world currency can be earned through playing any game modes and a larger sum can be earned during NoriNori Assembly every morning. Special parts can also be rewards during the morning exclusive gameplay. Besides personalization, the parts will also provide extra abilities during battle.

Character Levels

Every gameplay can earn experience points to level up the character. The higher the level of the character, the more powerful and competitive it is. Special moves such as more powerful Attack which consumes two Charges will be acquired at certain levels. Some stages can be unlocked as a player reaches certain levels.

Staged Based Story Mode

Through software update, stages for single player mode can be added after launching. Players can then continue to get new challenges when the new ones are out.
3.6. Implementation

The concept of the game design requires multi-device, pervasive computing compatibility so that gameplay on a smartphone can smoothly transfer to a personal computer. Apple iOS and Mac OS platforms were chosen because both platforms are basically under the same the development environment and their application programming interfaces (APIs) are rich enough to realize the concept. Xcode\textsuperscript{14}, the Apple official software development kit (SDK) for iOS and Mac OS was used. Within one project, both the Mac application and iPhone application can be compiled. Source files and game assets can also be shared across the two applications for their respective devices. It is a comprehensive solution.

Although, there are different game engines and tools that can speed up the process of game development in the market, there is no suitable one which can provide a comprehensive development environment for both iOS and Mac OS, as well as API supports for Bluetooth and motion sensing. Therefore, SpriteKit API\textsuperscript{15} was used to create the applications on both platforms.

SpriteKit is an API created by Apple to allow developers of both Mac OS and iOS to develop 2D games. With native support for Core Bluetooth\textsuperscript{16} and Core Motion\textsuperscript{17}, a game that makes use of these two technologies becomes possible.

The prototype created for evaluation has implemented the three main features of the concept which is enough for validation of this thesis: NoriNori Battle, motion interactivity, and morning alarm function. These three features provides the core concept of “creating an enjoyable wake-up experience through a game”. Other game elements such as rewards and customization features are extra motivators for a player to continue to play the game. Figure 3.39 shows the game flow

\textsuperscript{14}Xcode\url{https://developer.apple.com/xcode/}
\textsuperscript{16}Core Bluetooth Programming Guide \url{https://developer.apple.com/library/ios/documentation/NetworkingInternetWeb/Conceptual/CoreBluetooth_concepts/AboutCoreBluetooth/Introduction.html}
\textsuperscript{17}Core Motion Framework Reference \url{https://developer.apple.com/library/ios/documentation/CoreMotion/Reference/CoreMotion_Reference/index.html}
of the prototype.

Under normal situation, a player can play NoriNori Battle anytime. After the alarm sounds in the morning, the game mode will become NoriNori Assembly if the player plays the game after waking up the character. After NoriNori Assembly, the player will be asked to continue to also play NoriNori Battle. If the player chooses not to play, the game will return to idle status.

### 3.6.1 Program Structure

Figure 3.40 displays briefly the relationship between different objects in *Rhythm Satellite*. The arrows represent the “has” relationship. The objects in the middle are shared among the two platforms. Bluetooth managing objects are singletons in both applications so that there is only one of each object shared throughout the game. Game controller object using motion sensing is also a singleton so that it is accessible in different scenes and states.

**iOS States**

Figure 3.41 is the state diagram of *Rhythm Satellite* on iOS. When *Rhythm Satellite* on iOS starts running, it will be in the “Idle” state. When a player is ready
to play the game, the Bluetooth modules will be turned on. Once a Mac OS with *Rhythm Satellite* running is detected, a connection will be established. When the player sends a start command (swiping the character upwards in the case of the prototype), the iOS device will become a motion game controller. Idle state will be returned when the Bluetooth communication is disconnected after the game. A player can set a wake-up time with *Rhythm Satellite* on iOS device as if it is an alarm clock. The character, Nori, falls asleep seven hours prior to the wake-up time. In the next morning at the designated time, the alarm sounds with music. Then, the player has to wake up himself/herself and wake up Nori in rhythm. When Nori is awake, the state will directly go to “Advertising” to get ready for NoriNori Assembly.

**Mac OS States**

For the states of *Rhythm Satellite* on Mac OS (Figure 3.42), it enters to the “Scanning” state to scan for iOS running *Rhythm Satellite* once it is executed. When there is a device nearby, it connects and subscribe to the device so that when there it will always get updated when there is new data ready. When the Bluetooth module receives a start command, the scene changes to a scene for NoriNori Assembly if the player starts the game within 15 minutes after the

Figure 3.40: Object Diagram
wake-up time, otherwise, it changes to the NoriNori Battle scene. When the game has finished, the results are processed and displayed to the player. After that, it disconnects from the device and back to the “Scanning” state.
Motion Sensing

Core Motion Frameworks is used for programming motion detection. Class `CMDeviceMotion` is a class developed by Apple to supply processed motion data from accelerometer and gyroscope data. It is used to get the pure acceleration done by the player’s motion, omitting the gravitational acceleration. Every time when the game gets update, the latest values of user acceleration and gravity is acquire from the sensors.

To ensure the game has some exercising effects, the threshold to detect a valid motion is set to be two gravitational acceleration such that the player has to wave the iPhone faster than such acceleration to successfully input. The values of gravity acting on x, y, and z axes are used for detecting the orientation of iOS device. With the combination of the acceleration and gravitational values, “Up”, “Down” and “Sides” gestures can be detected. (Figure 3.43)

```swift
if (newAccelerationX < ACCELERATION_THRESHOLD && prevAccelerationX < 0) {
    if (gravityY <= -GRAVITY_THRESHOLD) {
        [self setInput:@"UP" ];
    } else if (gravityY > GRAVITY_THRESHOLD) {
        [self setInput:@"DOWN" ];
    } else if (gravityZ > GRAVITY_THRESHOLD) {
        [self setInput:@"RIGHT" ];
    } else if (gravityZ <= -GRAVITY_THRESHOLD) {
        [self setInput:@"LEFT" ];
    } else {
        [self setInput:@"SHAKE" ];
    }

    // avoid unintended input
    _canRegister = NO;
} else if (self.triggeredCommand.input == TAP) {
    _canRegister = NO;
} else {
    [self setInput:@"NEUTRAL" ];
}
```

Figure 3.43: Motion Detection

The motion controller object handles the motion detecting part as well as transforming them into game commands. When there is no input, the command

18 `CMDeviceMotion Class Reference`  

19 Accelerometer is a sensor to detect acceleration

20 Gyroscope is a sensor to detect rotation speed

65
triggered will be set to “Neutral”. Otherwise, motion commands “Up”, “Down” and “Sides” are assigned as the trigger. When the game scene on iOS detects touch gestures, it can also force triggered commands such as “Tap” and “Start” to the game controller.

For each update of the game, if the triggered command is “Neutral”, it is ignored. Otherwise, the command will be sent to the Mac OS machine connected if the Bluetooth connection is established.

Bluetooth Communication

**Rhythm Satellite** uses Bluetooth v4.0\(^{21}\) to link iOS and Mac OS devices together. There are two roles in Bluetooth communication: central and peripheral. Central is for receiving data from connected peripherals. Multiple peripherals can be connected to a central. Peripheral is for sending data to a central. Since iOS device is used as an motion input controller, iOS device is a peripheral and Mac OS machine is a central most of the time in Rhythm Satellite. When a game is over and updates the parameters of a character, the roles are switched so that Mac OS machine can send data back to iOS device.

![Figure 3.44: Connecting to a Close-enough Device](http://www.bluetooth.com/Pages/Bluetooth-Smart.aspx)

\(^{21}\)Bluetooth Technology Website [http://www.bluetooth.com/Pages/Bluetooth-Smart.aspx](http://www.bluetooth.com/Pages/Bluetooth-Smart.aspx)
Besides utilizing Bluetooth to send motion commands from iOS device to Mac OS machine, it is also used for detecting the physical location of a player. A player has to be close enough to a Mac OS machine with an iOS device in his/her hand to start playing *Rhythm Satellite*. This feature can be used as proximity sensing between devices. The received signal strength indicator (RSSI) is used to achieve so. In the prototype, it is not calibrated to resolve a physical distance value but the value of RSSI at range between about -22 and -55 (Figure 3.44) is generally within a reasonable distance for playing *Rhythm Satellite*.

Testing

The prototype was brought to two testing phases to validate the design of the game. In Chapter 4, the evaluation of the prototype will be discussed in detail.
3.7. Design Summary

To summarize the design of *Rhythm Satellite*, it is a game that engages the players to wake up and perform simple awakening stretching seamlessly through the gameplay. *Rhythm Satellite* is a rhythm, music game that involves physical exercise and multi-player gameplay in which:

- The player uses a smartphone to input commands through arm motions to control the character to perform the same rhythmic moves as the player does
- The player can set a preferred wake-up time in game on the smartphone and an alarm will sound, followed by a guided wake-up gameplay in the morning
- Proximity between computer and smartphone detect whether he/she gets out of bed
- As the player plays the game in the morning, he/she is then matched with other players who wake up at the same time for a morning session game

With *Rhythm Satellite*, it can:

- Provide entertainment through music, rhythm and interactive gameplay
- Turn waking up into an enjoyable experience
- Guarantee waking up on time
- Make the player feel more awake in the morning

The design process involved is as follows:

1. Define a vision for direction
2. Conduct ethnography of related experience
3. Create target persona(s) and mental models
4. Ideate and create concepts for the behavior intervention
5. Create concepts for the game and design the gameplay and its contents
6. Test and iterate

7. Evaluate the overall experience

In the next chapter, the evaluation of the prototype of *Rhythm Satellite* will be discussed.
Chapter 4

Evaluation

The aim of this research is to create a game with morning-exclusive gameplay to engage young adults to wake up as planned. In the design of *Rhythm Satellite*, the core concept is a gameplay that engages the players to wake up and perform simple awakening stretching seamlessly through the game. There are three main features supporting it. They are: (1) using a smartphone to input commands through arm motions to control the character to perform the same rhythmic moves as the player does; (2) an alarm, followed by a guided wake-up gameplay in the morning; and (3) proximity between computer and smartphone to detect whether the player gets out of bed. An initial working prototype which implemented the above concept was developed to demonstrate the feasibility of it.

The prototype had the basic features with wake-up mode and NoriNori Battle as the implementation of the concepts mentioned above. There was a specific button on the iPhone screen for starting the alarm immediately. Once the alarm went off, the player has to turn it off by shaking the iPhone and waking up the character in rhythm for 16 times. After that, the player will be asked by the character to go in front of the television to start playing NoriNori Battle. The player can choose to play the battle as many times as they want. The game ends when the player quits after the battle.

The evaluation aimed to prove that *Rhythm Satellite* is (1) entertaining and engaging, and hence (2) helps the player to wake up. As it was mentioned in the previous chapter, the game itself has to be entertaining. Players are expected to enjoy and get engaged in the game first, before the intervention comes into place.
The game was exhibited during KMD Forum, an open-house event of Graduate School of Keio Media Design, on 22nd November, 2014. It was a public event, and over 400 visitors came.

4.1. Methodology

The evaluation was done in a qualitative way which involved observation of players playing the game followed by interviews after the game. Visitors of KMD Forum who came to Rhythm Satellite’s booth were invited to experience the game starting at the bed. Those who participated were instructed along the gameplay and were carefully observed how they interacted with the game. Observations were done mainly to the visitors who only played the game of NoriNori Battle without experiencing waking up with the game whilst an additional in-depth interview was conducted for those who experienced both wake-up gameplay and Norinori Battle.

There are two focus points during observation: (1) players’ body gesture and arm motions; and (2) their engagement behaviors. Through the observation, the gameplay which includes: interactive system, playability and the engagement level of Rhythm Satellite were evaluated.

Focused and contextual interviews suggested by Jonathan Lazar was conducted for those who experienced the whole wake-up process with Rhythm Satellite. In the interview, the interviewee would be asked about his/her personal background, his/her chrono-type, his/her current situation of waking up in the morning, comments of the gameplay design, character design, morning-exclusive gameplay and the overall experience of Rhythm Satellite. The above was just a brief structure but not a set of fixed questions of the interview. Immediate follow-up questions were also asked based on the answers provided. By understanding the current situation of the players and asking about comments they have for Rhythm Satellite, a more comprehensive analysis could be done to evaluate whether Rhythm Satellite helps waking-up the players.

Settings

The area used for displaying the game is decorated as a Japanese style home with tatami. Nine sheets of tatami which made up 13.77 square meters of area. This gave the visitors a feeling of being in a living space. A bed and a television connected to a Mac Mini was placed on two ends of the tatamis to let the visitors experience the game starting from the bed and ending with playing *Rhythm Satellite* in front of the television. (Figure 4.1)

![Figure 4.1: Living Room Settings](image)

There is an instructions board (Figure 4.2) placed next to the bed so that visitors can understand the gameplay at the bed. The instructions board walks through the game flow from having the alarm going off, waking up the character with rhythmic shaking and leaving the bed to get ready for the main gameplay, NoriNori Battle.

On the other end, gameplay instructions board (Figure 4.2) was placed on top of the television. A television with a 48-inch screen was used as the game screen so that visitors could easily see it even if the room was crowded. Since tutorials or guides of basic gameplay were not implemented in the prototype, the instructions board showing the possible inputs and the commands required in the gameplay could help players to understand the rules and the controls in a short time.
Figure 4.2: Bedside Instruction

Figure 4.3: Rhythm Satellite Screen and Instructions
4.2. Observations

Visitors’ attentions were totally not drawn when the television screen was only showing the logo whilst no one is playing the game. However, when someone is trying out the game, visitors would pay attention to the screen. Therefore, visitors were invited proactively to try the game to start the chain effect for drawing more attention. When the visitors first saw the character, Nori, most of them said “cute”. They showed more interests in the game after seeing it. Figure 4.4 shows Rhythm Satellite drawing much attention from the crowd.

![Crowd Looking at Rhythm Satellite](image)

Figure 4.4: The Crowd Looking at Rhythm Satellite

Since the prototype implemented limited variations of correct input motions and no in-game instructions or tutorials, almost all of the visitors did not know how to play the game at the very beginning. After some explanation with the instructions board and direct face-to-face instructions, most of them managed to learned and master the inputs in a few rounds of NoriNori Battle.

Some visitors were too strained about moving their arm in the correct way while following the rhythms. When they were told to relax and move more naturally, they started to be able to catch the beat and input correctly.

Most of the visitors played three to four time. They used the first two rounds to get used to the inputs and rules. Then they started to be able to control the
character at will and wanted to play one to two more times.

There was a child (Figure 4.5) at the age of around eight years old. He managed to master the basic gameplay in three games with the help of the instructions board. Once he understood how to play it, he kept playing it until his parents finally forced him to leave.

![Figure 4.5: A Child Cannot Stop Playing](image)

Although the motion sensing was set to be a bit sensitive, most of the visitors unconsciously move their arms forcefully. As a result, the game seemed to became some warm up exercises and they started to feel warm and more energetic. Some of them tried to cool down with their hands by inducing airflow. They all looked happy after playing the game.

### 4.3. User Test Studies

In-depth interviews were conducted with player who experienced the wake-up process from stopping the alarm to finishing NoriNori Battle. Besides their comments towards the game, their habits of waking up, setting alarms and snoozing in the morning were recorded.

#### 4.3.1 Interview 1

The first interviewee was a 26 years old, male, master’s student. He is a evening-type person. He finds waking up in the morning difficult. The strategy he used
to get up in the morning is by multiple alarms. (Figure 4.6)

Figure 4.6: Multiple Alarms to Ensure Waking Up

If he has class or work in the morning, he must set the alarm shown in Figure 4.6. Starting at 8:00 A.M., every 10 minutes an extra alarm was set until 8:40 A.M.. He wants to wake up at 8:00 A.M., but can hardly leave his bed. He usually keep stopping and snoozing the alarms during the time between 8:00 A.M. to 8:40 A.M. and, therefore, the alarms are very annoying in the morning. Although he does not feel stressed, positive emotion is absent in the morning. Sometimes, he is awake in bed and stops the 8:10 A.M. and 8:20 A.M. alarm. But soon after that he starts to check out SNS applications and falls asleep again to wait for the
last two alarms. If he remembers to set the alarm, he must be able to get up at 8:40 A.M. and he is seldom late for work or school. Despite that, he still wants to wake up at 8:00 A.M. to play safe but he just lacks a sound motivation to do so.

He thinks that Rhythm Satellite is a very fun game. He likes the interaction where a player’s motion is mirrored by the character. He also feels great about music gameplay in which rhythms are driving his body to move. He thinks that the character is cute and he likes the shape of the character. He suggested adding more expression but he thinks that the character can induce positive emotions in general. He likes the feature of bring the character from iPhone to Mac because bringing virtual characters across different media is a very fresh idea. When he was asked about how effective in waking him up does he think the game can be, he said he is not sure without truly testing it at home in the morning. He thinks that once he gets engaged in the game in morning, he will definitely not return to bed to sleep though.

4.3.2 Interview 2

The second interviewee (Figure 4.7) is a 24 years old, female, master’s student. She is an evening-type person. She has always been wishing that she could be a morning person because she believes that being able to get up early can provide her more time to utilize and more productivity every day. Every morning she has difficulties to wake up. She presses the snooze button with 8 minutes interval for at least 10 times before she can really gets up. However, if there is an important event in the morning, she can wake up immediately.

When she was around the Japanese style home settings, she was first attracted by the sound effects and the music of Rhythm Satellite. She thinks the character is cute with the big eyes but since there is no mouth, it is difficult to understand its emotion. She also commented that the character looks like a morning-type person. Although she could not manage to get the correct motion inputs and catch the rhythms, she foresees that once she is guided with a simple tutorial, she can enjoy it very much. She thinks that the wake-up guiding gameplay is good because it provides motivation for her to wake up. In normal situation, she mainly struggles between getting up or returning to sleep. She basically chooses returning to sleep most of the time because it feels better for her. If there is an
option that can allow her to wake up feeling positive, returning to bed should be less likely.

4.3.3 Interview 3

The third interviewee is a 25 years old, male, master’s student. He is a morning-type person and he feels good about it. He does not use any alarm but he wakes up naturally at 6:00 A.M. sharp every day. He began such wake-up habit since he was in middle-school due to mental stress and hormone changes in puberty. Even though he is awake at such an early time, he still struggles about not being able to get out of bed. To avoid staying in bed for too long, he plays electronic music with strong beats to help waking up. In addition, he sometimes uses his smartphone to look for some sexy women pictures to create a guilty feeling in his mind. Once he feels bad about himself, he get out of bed so that he can stop looking at those photos.

He loves the character with the little blush on its face, the soft trapezium shape and the three-head body scale. He also likes the graphics with flat styles as he can focus on the most important things with minimum visual information displayed. He believes that the current character design can definitely build up
Figure 4.8: The Third Interviewee Playing *Rhythm Satellite*
attachment with the players. The gameplay to him is simple yet fun. Although the motion input was unclear at the beginning, he thinks that a tutorial with some guidance will definitely be enough for a player to learn the controls. He likes the idea of transferring the character from one device to another because it feels like digital character actually exists in the physical world. He knows that stretching muscles in the morning can increase blood flow and hence help waking up in the morning. Therefore, he strongly buys the idea of the gameplay triggered by an alarm that guides a player to move his body seamlessly. He also thinks that the character design and the rhythmic exercise game player are very important. They can provide positive feelings which can then become positive motivations, instead of his current negative ones, to wake up every morning.

4.4. Proof of Concept

From the observation, most of the visitors who tried Rhythm Satellite enjoyed it very much. They also had positive feedbacks such as saying the character design and the sound effects are cute when they saw the game. This shows that the visual and audio contents of the game are generating positive emotions for the players. Furthermore, most of the visitors tried three times or more. In the first two trials, they were not so familiar with the controls but they were willing to learn and tried a few more times. This shows that the game mechanics have a certain level of difficulty whilst it is not too difficult that the game becomes unplayable. It is at a level that the players feel achievable and are willing to continue to challenge. Once they completed the challenge of getting the correct inputs in rhythms, they started to move on to the next challenge which is defeating the computer opponent with simple strategies. The continuous play shows that they had attained the state of flow\(^2\) which is a state of having pleasure and happiness. These observations prove that the game succeeded in entertaining and engaging the players and validate the concepts of the interactive gameplay.

The in-depth interviews covers three different types of samples within the target user group. The interviewees consists of both evening-type and morning-type...
type people and they all have different habits and strategies to get up. Although the morning-type sample is not afraid of waking up in the morning, he still has problem of being unable to leave his bed, just like the other two evening-type samples. They all agreed that motivation is the most defining factors to achieve it. While the third sample creates motivation by himself through self-criticism, the first two samples were simply forced to wake up in the last minute due to important events, school or work. In the interviews, they all agreed that Rhythm Satellite can provide motivation for getting out of bed. Based on the experience of the third sample, moving and stretching body which enhance blood flow in the morning can make him feel more awake. The first sample also thinks that he is very unlikely to return to his bed after playing Rhythm Satellite which involves physical exercises. This shows that Rhythm Satellite can actually be a motivator which motivates a player to wake up and leave the bed at a designated time. The third sample also pointed out that although the alarm and the game seem to be obstacles, the music, the character and the gameplay designs are creating positive emotion which actually makes a player want to get up. All these comments validates the concepts of using an alarm which seamlessly connects to a game which encourages physical exercises out of bed.

In conclusion, through observations and interviews in the evaluation, the initial working prototype has shown that Rhythm Satellite is a game with morning-exclusive gameplay that can engage young adults to wake up as planned. Although there are still a lot of designs and features to be improved, the basic concepts were proved to be positive in supporting the goal of the design of Rhythm Satellite.
Chapter 5

Conclusion

5.1. *Rhythm Satellite* Lifestyle

It is Monday morning. A typical daytime working young adult is sound asleep in bed. The clock reads 6:45 A.M. and the alarm sounds with strong beats. The young adult stretches out his arm and grabs his smartphone next to his bed. He can barely open his eyes but he saw his Nori asking him to wake it up with rhythm on his smartphone. He sits up strict and starts to follow the music rhythm to shake his smartphone. After 30 seconds of rhythmic shaking, the music fades out and he hears the Nori saying “Good Morning” to him. He does some stretching and leaves his bedroom with his smartphone.

As soon as he approaches his computer in the living room, the screen of it turns on with *Rhythm Satellite* running. It shows a game scene with sun rising. He swipes the character upwards with a finger and his Nori is sent to the scene. Immediately, there are three other Nori’s appearing in the scene. He presses the greet button shown on his smartphone to say “Good Morning” to other Nori’s. The game and the music then start and he immerses himself into the game.

After the game, he feels physically and mentally awake. He looks at the clock and it is 6:53 A.M. He then goes to the bathroom to freshen up. At 7:10 A.M., he makes a toast and has a cup of coffee for breakfast. He gets changed and leaves home at 7:35 A.M.. He feels energetic and happy.

When he arrives the office, most of his colleagues are still one their ways. He sits in his desk and gets prepared for the regular meeting. During the meeting, he
pays great attention and suggests some breakthrough ideas to his team. His boss is very impressed with his performance.

At night, he comes home after work. He is very happy with his productivity at work during the day. He wants to relax for a while before he sleeps, so he starts to play *Rhythm Satellite*. He encounters a boss which he fails to defeat. It is already 11:45 P.M. and his Nori notifies him that it has fallen asleep. He commits himself to waking up on time and play the game so that his Nori can grow stronger to defeat the boss as soon as possible. He also feels tired, so he turns off the lights and goes to bed.

**Impact of *Rhythm Satellite***

Comparing the scenario illustrated above to the one in the Introduction (Section 1) of this thesis, the wake up behavior is totally changed with *Rhythm Satellite*. Instead of a snooze button and multiple alarms which never really help the user to get up, there is only one music alarm with strong beats and a player is engaged to move his/her body in *Rhythm Satellite*. Instead of snoozing which actually causes more sleepiness after waking up, a game that involves simple physical exercises that can wake up a player physically and mentally is played after getting out of bed. Being able to wake up earlier without re-sleeping allows more time for morning routines and preparation for work. Without being in a hurry in the morning, one should have more positive emotion and less stressed. By the time when he/she arrives office, he/she should have less sleepiness and better alertness since he/she has been awake for a while already. This leads to better daytime working and learning performance than those who “snooze” until the last minute. A player of *Rhythm Satellite* will also be anticipating to play the game every morning. Waking up will no longer be an unpleasant experience, but an enjoyable routine.
5.2. Discussion

Design Approach

The design approach employed for this research is different from other serious games in the academia. Instead of heavily focusing on scientific theories, human-centered design factors are considered. Therefore, ethnography was conducted, followed by a concept design that ensures values to a target persona. Although the gameplay was designed last, it is one of the most important parts of Rhythm Satellite because a game has to be fun and draws voluntary participation without being told by somebody else. Instead of requiring the players to be self-efficacious in changing a behavior, a serious game should be helping the players to change the behavior despite of their abilities and determination.

The evaluation of Rhythm Satellite shows that two important factors, character design and interactivity, contribute in engaging players. A game character should, of course, be appealing to look at but other elements such as sound effects, voice and animations of a character should not be ignored. The interaction between a player and the virtual world also has to be designed carefully. In terms of interactivity, immediate visual and audio feedback, timing, and input-output relevance are proved to be the important elements in Rhythm Satellite. Representation of digital character transporting in between different digital media is also an favorable feature that touches a player’s heart. Every detail of design contributes to the overall experience of a game, and hence affecting players’ engagement.

Sustainability

Although there will be character training features, customization, battles and other elements to engage the players to play the game almost every day and for a long period, some people may get bored with the contents very quickly or the contents simply do not fit their taste. In order to cater such group of players, a game that provides similar experience may be needed. Based on the concept created for Rhythm Satellite, a design pattern or framework can be created such that games with different game world designs and gameplay designs can adopt the pattern and still provide triggers and motivations to engage and wake up the players.
Game for Lifestyle

While many researches about serious game have been focusing on clinical use, *Rhythm Satellite* is exploring how the future of casual game can be developed to persuade and change players’ behavior for a better lifestyle. Exercise games such as Wii Sports had successfully transformed exercises to be a more entertaining activity which does not require certain level of skills to enjoy. The next possible direction is envisioned to be games that are embedded seamlessly in our daily activities. They not only provide entertainment, but also guide us to a more healthy and fruitful lifestyle. While gadgets, smartphones, and computers no long work separately in the Post-PC era, the design of *Rhythm Satellite* can act as a hint for the future of entertaining experience design across different devices and platforms.

Limitations

This research focuses on providing young adults joyful experience to engage them to wake up on time in the morning. Maintaining a regular waking time can consequently be achieved through playing *Rhythm Satellite* and hence a healthier sleep-wake habit can be acquired. However, it does not provide a comprehensive solution, which includes intervention in both sleep and wake, to change one’s behavior for better sleep quality. Besides, the current proposed design targets only day-time workers and university students and assumes that they do not have an extreme nocturnal lifestyle and are not working for mid-night shifts. Only those who suffer from a small social jet lag is consider. Furthermore, the current implementation of *Rhythm Satellite* is heavily dependent to the latest Apple products. People who do not have an Apple PC and a smartphone with the latest updates, cannot be benefited. Lastly, *Rhythm Satellite* is positioned as a casual game. Those who do not like playing games are also out of the target user group.

Concerning the approach of using a time-exclusive game mode to trigger a gameplay for behavior change, this thesis has shown that it is an effective way to provide joyful experience to engage players to perform desired behavior. This approach, however, may only limit to target behaviors which are (1) time-specific daily activities and (2) not under a hurry situation. A behavior that one may
not perform regularly or requires immediate result may not be suitable for such approach.

5.3. Future Discussion

Prototype Development

The evaluation was conducted through observations and interviews for an initial working prototype in this thesis. The development of an alpha or beta version of Rhythm Satellite is expected so that more thorough testing and evaluation which involve both qualitative and quantitative evaluation methods can be carried out to ensure the validity of Rhythm Satellite.

Based on the feedbacks received in the evaluation, there are few points that should be improved immediately in the current prototype. First, more expression and reaction should be added to the character so that the character can be more humane and the players can have a better grasp of what do they do right and wrong in the game. Second, a step-by-step tutorial for explaining the basic inputs and game rules to the players is needed. Third, more flexible motion detection should be implemented so that players can perform certain motion inputs in a way that they feel natural with their own gesture preferences.

Possible Extension

Rhythm Satellite displays an approach to use game to engage and to change young adults’ wake-up behavior. There are two main directions can be explored for future research based on Rhythm Satellite.

First, Rhythm Satellite can be expanded to be a virtual world where different kinds of daily healthy and ideal behaviors are encouraged through different sub-gameplay in the game. For example, a Nori may encounter some problems in the virtual work and require its player take a break from his/her work for a stroll or some body stretching and the HP level of Nori is affected by the walking steps of its player. The everyday life of a player can be guided through interacting with the virtual world.

The other direction is to incorporate more context-aware technologies, such
as smart watches or even sensor network in our living spaces, to keep track of all the activities of a player and data of the physical environment. By doing so, the virtual world can understand more about the physical world and create a direct mapping or translation to it. Different gameplay and game contents can be provided accordingly. Such direction can lead to a greater variety of interactions such that intervention will not be limited only to motion-related behaviors.

To conclude, gaming consoles, personal computers and mobile phones have created at least two generations of gamers in the past 30 years. Over the next half-century, video games are going to become a part of everyone’s daily experience as television, radio, automobiles and home appliances. With the emerging technologies, video game, or simply electronic game, is foreseen to be embedded in our daily activities as a lifestyle that not only provides entertainment but also learning and support for life wellness.

---

Acknowledgements

It would not have been possible to accomplish my research without the guidance of my supervisors, help and encouragement from KMD comrades, and love from my family.

I would like to express my deepest gratitude to my supervisor, Professor Naohito Okude, for his support and guidance in these two and a half years in KMD. His depth and width of knowledge opened up my eyes to the field of Design, Innovation and Philosophy. His Design Thinking process has enlightened me with the ability to create from 0 to 1, which is a goal I have been pursuing. I would like to also thank my co-supervisors, Professor Masahiko Inami and Associate Professor Kazumori Sugiura for their support and advice to my research. Last but not least, I would like to thank Assistant Professor Chihiro Sato, who gave me advice throughout the research project and thesis writing.

I am most grateful to the GID-KMD faculty for letting me participate in the first year of Global Innovation Design (GID) exchange program which possibly changed the rest of my life. It provided me not only design skills, but also opportunities to understand the world, as well as myself more in a one-year journey.

I would like to thank my project teammate, Han Hsiang Tsai who ideated and evaluated the game designs with me throughout the project and Chih Chun Lan for her cute voice which contributed to the success of the prototype. I would also like to thank Dixon Lo, Code KatsuZane Chaiwat and Keita Saito for brain-storming some crazy ideas for me. I would also like to express my special thanks to all OIKOS Thesis Workshop members: Shotaro Fujii, Yuki Nishijima, Moeko Shimasaki, Hiromasa Osaki, Ito Kotaro, Miki Asatani and Niya Sherif who have gone through the toughest four months with me; and Takahiro Yoshimoto and Terrence Chan who always dined out with me so that I could take a break from
the thesis writing.

Finally, my deepest appreciation goes to my family in Hong Kong and my sister’s family in Japan. Thank you for all the unconditional love and support since I moved to Japan four years ago. I am in debt to my parents for always allowing me to pursue the best I can be. I will try my best to repay for everything after my graduation.
Bibliography


