FitMirror: A Smart Mirror For Positive Affect in Everyday User Morning Routines

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ABSTRACT

This paper will discuss the concept of a smart mirror for healthier living, the FitMirror. Many people have serious problems to get up after sleeping, to get motivated for the day, or are tired and in a bad mood in the morning. The goal of FitMirror is to positively affect the user's feelings by increasing his/her motivation, mood and feeling of fitness. While concepts for these isolated problems exist, none of these combine them into one system. FitMirror is implemented to combine them and evaluate them in a study. It consists of a monitor with spy-foil, a Microsoft Kinect v2 and a Wii Balance Board and can recognize users and their gestures with these elements. Several hypotheses about the system regarding motivation, fun, difficulty and getting awake were investigated. Participants were grouped by the factors sportspersons and morning persons to investigate the effect based on these aspects. Results show that FitMirror can help users get awake in the morning, raise their motivation to do sports and motivate them for the day.

CCS Concepts

•Human-centered computing → User studies; Empirical studies in HCI; *Graphical user interfaces; Sound-based input / output; Touch screens; HCI theory, concepts and models; Gestural input;*

Keywords

smart mirror; human-computer interaction; emotion

1. INTRODUCTION

In recent years, companies[1] and scientists [3, 17] have developed smart mirrors, whether in a smart home context, only to display information, or for consumers in boutiques or shopping malls. These mirrors were only developed to either show general information, or 3D visualizations of a person. So far, no smart mirror that offers added value has been developed. Moreover, none of the already mentioned mirrors is able to recognize fitness exercises and offer interaction. This paper presents a smart mirror that provides a combination of several functions and input modalities (cf. Fig. 1). It includes displaying information, such as weight and other health data, as well as recognition of sports exercises for affecting the users' feelings positively and motivate them. This raises the question how the feeling of a user can be manipulated. The implemented smart-mirror, the so-called FitMirror, provides the user with normal and fun exercises. These exercises are intended to increase the motivation, happiness and fitness of the user after getting up in the morning. The concept of FitMirror should be regarded as part of a smart home. Before it is described in detail, related work that is relevant for the concept of FitMirror and the underlying technology is presented. These projects are the basis for the concept of FitMirror and show what kind of technologies are available. Afterward, the concept is presented and evaluation results are reported. The paper closes with ideas for future projects.

Figure 1: A user performing the exercise "Boxing" in front of FitMirror.

2. RELATED WORK

In the following, some similar projects in the area of smart mirrors or magic mirrors, which already exist or have been described in theory, will be briefly described and discussed. In addition, the topics "Activity Tracking", "Emotions", "Interactive Games" and further important points for the concept of FitMirror and its study are discussed.

[1] e. g., http://memorymirror.com/

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2.1 Smart Mirrors

Several "smart mirrors" or "magic mirrors" have already been invented[2], evaluated in studies [15, 10] or written as a theory [4]. They display information, or show the user itself on a standard screen or a reflective screen with a spy-foil. In this section, some of these mirror concepts are presented and described based on a category of two different types: augmentation and information.

2.1.1 Augmentation

Augmentation mirrors are smart mirrors which render additional information, e.g. makeup or dresses, on 3d visualizations of the user.

Iwabuchi et al. [10] developed a makeup mirror, which helps women when putting on make up. This mirror uses a camera with a resolution of 1624 x 1224 pixels and 30 fps to take the pictures of the women. The system's algorithm is only trained for women. The recorded pictures are shown on a monitor. When a woman is close to the monitor and camera, the displayed picture becomes blurred, because the camera has no integrated auto focus. To compensate that, an automatic zoom was implemented that reacts when the woman is using a specific control marker. The marker is recognized by another camera. Different lighting modes provide the women with different views of the makeup they used (bright light, dark light and so on). Another function of this makeup mirror is displaying pictures of the woman before and after she used makeup.

2.1.2 Information

Another type of smart mirrors are the so called "magic mirrors", which allow displaying information.

In their project, Blum et al. [3] demonstrate a magic mirror for teaching anatomy. They used a display device, color camera, depth camera and the Microsoft Kinect v1 from the Xbox 360 gaming console. When the user stands in front of the display, the mirror loads computed tomographic visualizations or 3D models of organs to give the user *"the illusion to look into his body"*. With simple hand-gestures the user can change the slices or zoom in and out.

Further magic mirrors use single board computer technologies, e.g. the Raspberry Pi, and monitors with spy-foil. In most instances, those mirrors simply show nothing but information. An example for such a mirror is presented by Stückler [17].

2.2 Activity Tracking

In a self-monitoring context of daily activities, the tracking of physical activities is indispensable. Lester et al. [13] developed a system for recognizing physical activities. They put multiple sensors on a multi-sensor board which enabled them to recognize physical activities such as standing, walking, climbing stairs, brushing teeth, and similar. Today, nearly ten years later, it is not necessary to develop a new system for this aspect. In recent years the number of commercial fitness trackers such as the Jawbone, Fitbit or the Runtastic Orbit has increased. They all advertise their ability to track the users' activities and calculate their energy expenditure in terms of burned calories. A review by Yang and Hsu [19] compared seven wearable motion detectors for physical activity monitoring in order to test their accuracy. After giving an overview about the development of wearable accelerometer-based motion detectors they review their selection. According to the review all seven products are relatively reliable when it comes to measuring the steps of the user and calculating the energy expenditure.

2.3 Emotions

There is a great deal of research about smiling and facial expressions [16, 2, 9]. The study of Strack et al. [16] reveals that activating the same facial muscles involved in smiling manipulates the decision making of the participants. Cartoons were assessed funnier by the participants who had activated their smiling muscles. However, not every smile is equal. Ekman [5] suggests there are about 50 different kinds of smiles. These smiles are differentiated in "genuine" and "standard" according to the muscle activated near the eye and mouth. Zygomaticus major muscles around the mouth were stimulated by the "standard" smile and the "genuine" smile stimulated the orbicularis oculi muscle near the eye as well the zygomaticus muscles [7]. In addition, brain regions liable for positive effects are activated while smiling in the "genuine" type of smiling [6]. Kraft and Pressman [12] checked the different stress reduction between three participant groups ("standard" smile, "genuine" smile, no smile) after executing a stressful task. The result implied that the participants, especially those with "genuine" smiling, had a more relaxed heartbeat than the participants who did not smile.

2.4 Interactive Games

The following project describes the benefits of interactive games compared with conventional exercises. The study of Monedero et al. [14] compared the benefits between normal cycling and interactive video cycling. They came to the conclusion that the participants had a higher enjoyment during interactive video cycling than during conventional cycling. In addition, the participants worked on a higher intensity in the interactive video game than in the conventional way of cycling.

In their paper Aarhus et al. [1] report the fitness effects of senior citizens while they are using Nintendo Wii Fit for a period of six months. To observe their progress, the participants had to execute a few fitness exercises, for example biceps curls. The results show that there is a positive trend to physical improvement. However, the motivation of the participants increased, too. But that does not mean that the Nintendo Wii Fit games replace normal exercise, but they can be a supplement. They can also be a supplement to physiotherapy or be used "as an instrument for rehabilitative activity". The study of Theng et al. [18] also comes to the conclusion that the use of Nintendo Wii can improve the motor skills and hand-eye coordination of seniors.

3. CONCEPT AND USE CASES

The FitMirror system integrates a smart mirror in the users' daily morning routine without bothering them. Additionally it should increase the users' motivation, happiness and fitness for the day by preforming fun and fitness exercises in front of the mirror (cf. FitMirror Video[3]).

[2]http://www.areamobile.de/news/36473-magic-mirrorgoogle-now-auf-dem-badezimmer-spiegel-zum-selberbaue

[3]FitMirror Video – https://youtu.be/gRLoKyeOzSw

After getting up, the user enters the bathroom. When he/she steps in front of FitMirror, it detects the user and displays the interface. The user logs in and FitMirror loads step and calorie data from the user's smartphone. After loading the data, the user begins to interact with the system. He/she has the possibility to check his/her performance, the performances of other users, doing some exercises and challenge other users. When the user is not in front of the mirror for at least two minutes it turns off.

3.1 Features

FitMirror recognizes the presence of a user with the Balance Board and the Kinect v2. When the Balance Board detects a user stepping on it, it sends a message to the main application to turn on the display and activates the Kinect camera. At this point the Kinect checks if the user is still standing in front of the mirror. When the user is not standing in front of the mirror for a while, the Kinect recognizes that and sends a message to the main application to turn off FitMirror. To distinguish which user stands in front of the camera, the mac address of the user's smartphone is loaded.

In order to avoid extra stress for the user, the interaction with the mirror should be as simple and natural as possible. For this reason the user has the opportunity to either use touch or speech commands to interact with the system. As output modality for visual and audio of the mirror system, the mirror's display and loudspeakers are used.

During synchronization to FitMirror with a smartphone, the FitMirror App loads the steps and burnt calories data from the GoogleFit database and sends them to the main application where this data is stored in a database. In addition, the Balance Board measures the user's weight and sends the measured values to the main application where it will be stored in the same database as the other data.

The stored data can be shown as diagrams. For this feature, the main application of the FitMirror loads the data from the last seven days and displays it. The data that is displayed are the measured weight, steps and burnt calories of the user.

FitMirror offers ten different exercises that the users can execute in front of the mirror. These ten exercise are divided into two types: fun exercises and normal exercises. The fun exercises are intended to increase the user's happiness and the normal exercises are intended to increase the user's motivation and fitness.

With the aid of the Kinect camera and the Balance Board, FitMirror can recognize the different exercises. The Kinect camera scans the user's skeleton and can differ between various implemented gestures. The Balance Board measures changes in the user's weight distribution to detect particular patterns of movement to determine the exercises.

The performance of each exercise of the user is saved in a highscore list. The users can look at all of their performances of the exercises in that list. Moreover, the user can look at the performances of the other registered users in FitMirror to compare them with his/her own performances.

Another feature of the FitMirror is that the users can challenge other users with an exercise. After a user has completed an exercise, he/she can challenge another user with the achieved score by choosing a user from the user list. When the challenged user uses FitMirror, he/she gets a notification about a challenge request. They can accept or decline the request.

3.2 Use Cases

There are several use cases based around FitMirror, which are described in this section.

Registering a new user.

An unregistered user steps in front of the mirror which turns on and the user connects his/her smartphone with the mirror. The user's smartphone is detected but not recognized by the system, which causes the mirror to open the registration dialog for the new user. He/She can either decline registration which closes the dialogue or accept registration. If the user chooses to accept, he/she is asked to enter his/her first and last name.

Unregistered user uses FitMirror.

An unregistered user, either without a smartphone or one that has previously declined registration or connection, steps in front of the mirror. The mirror turns on, but only shows the current time, since all other features are unavailable for this user.

Recognition of a user.

If a user steps on the Balance Board in front of FitMirror, the Mirror turns on and the user pairs his/her smartphone, so FitMirror can load his/her specific data. During synchronization, the FitMirror app loads step and calorie data from the Google-Fit database, sends it to the main application and the Balance Board measures the user's weight and sends the measured value to the main application. Once synchronization is finished, FitMirror displays its interface.

Overview of past day or week statistic.

To check the current status, the user can look at his/her data of steps, burnt calories and weight measurements of the current day, last day or week. By explicit interaction with the mirror, the user calls up the statistic menu to view his/her past day or week statistics (steps, calories, weight). This is important because the users can check their performances of the last days and at the same time it should motivate them to walk more steps or burn more calories by doing more sports.

Challenges.

To manipulate the users' emotional state, they perform challenges in front of the mirror. The mirror challenges the user from time to time. This happens either randomized or if a friend challenges them. The user can now either accept or decline the challenge via touch or speech. When the user accepts a challenge, he/she gets a textual instruction and a video how to execute the exercise correctly. If a challenge is started, the necessary sensors have to be activated and the challenge's patterns must be recognized. This means analyzing weight distribution and position of the user's limbs. While performing the challenge, repetitions are counted. Once the user has finished the challenge, the result is displayed on the screen and written to the database. After performing the activity the system adjusts the difficulty level of future challenges in form of more repetitions according to the user's achieved repetitions.

3.3 Multi-User

In modern times, people want to connect with each other, especially with their friends. They want to exchange and compete with others. Because of this, the mirror is able to show profiles of the user's friends, similar to social networks. On these profiles the user can see their statistics on challenges. Playing alone is not as much fun as competing with others, so the user is able to challenge either himself or one of his friends with an activity. For this action he/she can activate a multiplayer option on a specific activity or dare his/her friends on their profiles. After choosing the challenge and player-mode, the user has to do the activity him/herself, whether or not he/she picked single or multiplayer mode.

4. IMPLEMENTATION

This chapter shows the implementation of the FitMirror system. The hardware an software used for FitMirror are described as well as all implemented exercises.

4.1 Hardware

A 42" monitor was used as the mirror's screen. In order to get a reflection of a user like a mirror does, spy-foil was used. Because of its electronic conduction the foil cannot be fixed directly to a capacitive touch monitor. Therefore the foil was fixed to an Actalyst infrared camera touch-panel from SMART Technologies Inc. in front of the monitor. Body recognition is provided by the Microsoft Kinect v2. It is used to detect and recognize persons, their facial expressions and gestures or exercises. In order to measure weight and sports activity, the Wii Balance Board "E.A. Sports Active Edition" was used. The four sensors in each corner allow the detection of movement and shifting of weight, as well as normal weight measurement. In other studies or projects [8], the Balance Board was proven to be very useful.

4.2 Software

The main application as well as the exercise recognition applications were programmed in C#. The Kinect SDK was used to aid in easier development of the application, since it provides automatic recognition of pre-defined gestures, which speeded up development. The other part for recognizing exercises is the Balance Board. To get the data from the Balance Board's sensors, the "Wii Device Library" was used.

To track the steps and calories of a user during his/her daily life, Android smartphones with the Google Fit app were used. Android was used because it is open source and the Fit API is a good way to receive already existing fitness data. During development the LG Nexus 5X running Android 6.0 and a Samsung Galaxy S4 running Android 4.2 were used. The mobile application was programmed with Android Studio.

Communication between software components was realized using a message oriented middleware based on ActiveMQ. Data for user identification and exercise history is stored using an SQLite Database.

4.3 Exercises

This section describes the possible exercises which are provided. They are separated in two categories: *fun* and *normal* exercises.

4.3.1 Fun Exercises

The first fun exercise is called *Ball*. The Kinect tracks the position of the user's feet. The location is displayed as a bar at the bottom of the screen. A Ball bounces off walls and the bar. The goal is to keep the ball in the air above the bar.

While *Balancing* the user stands on the Balance Board and his/her position is displayed through a cursor on the screen. By shifting his/her weight one can move the cursor in order to hit randomly appearing targets.

For eye-hand coordination the exercise *Boxing* was included. Hand tracing is provided by the Kinect. The hands are displayed as cursors and like during balancing, the user has to hit a random target with the cursor.

In order to affect the emotion of the user in a positive way *Smiling* was implemented. The user has to smile repeatedly. His/her facial expression is recognized by the Kinect.

The last exercise in this category is *Stretching* the body. Body recognition is enabled by the Kinect and the user has to stretch his/her arms repeatedly above his head.

4.3.2 Normal Exercises

To move the whole body of the user, the exercise *Jogging* was provided. Here the user has to jog on the Balance Board which also counts the steps.

In order to train the user's arms, the exercise *Barbell Curls* is implemented. The user has to execute a biceps curl with a given object, e.g. a bottle. The execution is tracked by the Kinect in form of a learned gesture.

Pushups train the arms and the chest. The user has to place his hands on the sides of the Balance Board which tracks peaks in weight progression. Because of the small width of the Balance Board the Pushups are more likely training the triceps of the user than the biceps.

Like Pushups, the Balance Board tracks peaks with the exercise *Squats*. The user has to stand on the Board and do as many squats as possible.

For the purpose of training calves and balance the last normal exercise is *Raise Calves*. Again the Balance Board tracks weight progression, especially weight differences in upper and lower regions of the board. A peak is marked as a repetition.

5. HYPOTHESES

The following hypotheses were evaluated with the study:

H1: Users are feeling motivated to do sports by using FitMirror.

H2: An increase in the level of difficulty motivates the user.

H3: People who have problems to wake up experience FitMirror as useful.

H4: Fun exercises are more popular than normal exercises.

H5: After fun exercises the user feels happier than before.

6. EXPERIMENTAL DESIGN

While performing the study, two kinds of explicit interaction were used: touch and speech. To feel most comfortable, the participants were allowed to choose the mode of interaction on their own. Even a switch between the modes within the study was allowed.

The preparation of the lab, where the study was conducted, was also an important aspect. Lights were dimmed and cool lighting was turned on, which should imitate a bathroom atmosphere and support the participant in immersing them in a bathroom situation. Some toiletries were also put up next to the mirror to support this feeling.

In order to avoid frustration of a participant if the system is not running well or doing something different than it should do during use, the decision was made to implement an additional Wizard of Oz (WoZ) scenario, where observers in a separate room control the behaviors of the system while the exercises are executed. When the participant executed an exercise, the observers counted the repetitions, so that the participants thought that everything worked fine. The observers paid attention that all exercises were executed in the same way by each participant. If a participant executed an exercise in the incorrect way, the observers did not count the repetition until the participant performed it correctly. This should ensure that each participant was treated equally. Only exercises that were based on repetition (squats, pushups, raising calves, barbell, stretching) were realized by the WoZ. All exercises based on live data were not faked (jogging, hit box, boxing, ball). Smiling recognition was also real, even though it was a repetition exercise. This was due to the fact that manual counting was not possible here.

The length of the study for each participants was about 45 to 60 minutes. They were paid 10 Euros for their participation in the study.

6.1 Participants

43 participants (19 f, 24 m) were recruited on university campus, all of them were students. The average age of the participants was 24.21 (SD=2.2). Students were from various study courses such as computer science, psychology, and biology. Due to the broad distribution of course of studies, the study did not only deal with computer experts but also with unskilled computer users. Except for one student, all students were native speakers.

6.2 Experimental Procedure

First of all the participants were greeted by the examiner in the lab and were asked to read and sign the declaration of consent. Afterward, they had to fill out a demographic form about their properties including age, gender and the single question if one is a morning person or not[4]. After the demographic form, they had to fill out "Sport AMS" (Achievement Motives Scale-Sport[5]) and "TA-EG" (Technology affinity for electronic devices [11]) forms. When all questionnaires were answered the examiner explained the functions of FitMirror and the procedure of the study. In addition the participants were given a short introduction about the speech command control. In case they forgot the speech commands, a list of all speech commands was hung under the Mirror. The procedure started when the participants agreed they had understood all introductions and stepped on the Balance Board.

Each participant had to execute 10 exercises twice in random order to avoid learning effects. At the second round, the level of difficulty was raised in the form of suggestions to beat the last score with 10% more repetitions in the same time. To avoid different variants between the participants, we did not change time in the second round. After every exercise they had to fill out a small form about their current feelings (motivation, happiness, fun and feeling about difficulty level).

During the execution of the exercises, the observers in the separate operator-room were observing the participants. If they had done all exercises and both runs, the participants were asked to fill out the last form about ranking exercises subjected to fun and difficulty level. They were also allowed to give some general feedback.

At the end, they were informed about the WoZ procedure and asked to keep it as a secret until the end of the study.

7. RESULTS

From the 43 participants 839 valid sets of exercise data were retrieved. However, due to technical problems the data from two participants could not be used for all hypotheses. This reduces the amount for most research questions to 41 participants.

Based on the results of the Sport AMS form, the participants were grouped into three different kinds of sportsperson: 26.83% (11 participants) had high, 58.54% middle (24) and 14.63% low degrees (6) of sports motivation.

7.1 H1: Sports motivation

The results regarding our first hypothesis show that 62.79% of participants (27) found that the system motivated them to exercise in the early morning. Only 13.95% (6) reported that FitMirror did not motivate them and the remaining 23.26% (10) were indifferent. All different sportsperson types answered FitMirror did motivate them in general. Especially amongst high and low motivated types 80% (9) and 66.67% (4) participants agreed, respectivley. From the middle motivated type 55.56% (13) did agree, which is still more than the half of them (see Fig. 2).

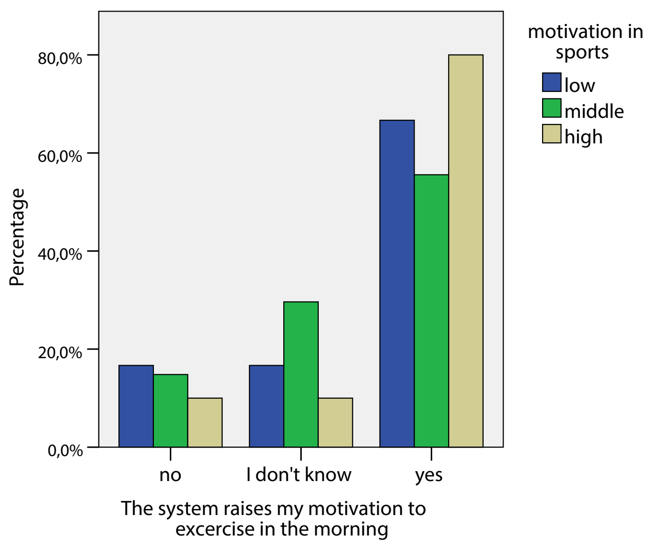

Figure 2: High and low motivated sportspersons show high motivation to exercise using FitMirror.

Concerning the question, whether the participants believe that the system would raise their motivation for the day, 70%

[4]A morning person has no problems getting up or is in a good mood after awakening from sleep in the morning.

[5]http://www.bisp-sportpsychologie.de/SpoPsy/DE/Diagnostikportal/Motivation/Sportlerfrageboegen/ams/ams.html

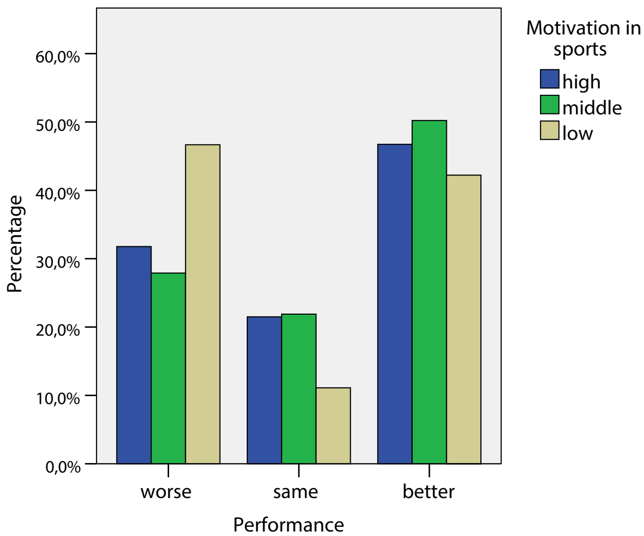

Figure 3: Comparison of performance in the second round based on sports motivation. Only low motivated participants performed noticeably worse.

of participants (30) answered the question with an agreement, 4.65% (2) disagreed and the remaining 25% (11) abstained from that question.

7.2 H2: Difficulty Level

Answering the questions for the hypothesis about if the automatic increase of the difficulty level motivated the participants, they had to choose between "too difficult", "difficult", "appropriate", "easy" and "too easy". No participants stated that exercises were too difficult and 1 participant (2.38%) experienced them as difficult. 57.14% of participants (24) regarded the exercises as appropriate and 30.95% (13) as easy. By comparing the first and the second round, we could check if participants performed worse, equal or better. As Fig. 3 shows, about half of every sports motivation group performed better in the second round. Only low motivated sports persons performed noticeably worse.

Motivation of the different sportsperson types between the two runs shows that agreement among highly motivated participants rises to full agreement and participants with low sports motivation got a minor increase of motivation.

7.3 H3: Effect on (non) morning persons

The amount of morning persons and non morning persons in our study is quite equal. There were 22 participants (52.38%) who have no problems to wake up in the morning (the morning persons) and 20 (47.62%) who have problems in the morning (the non morning persons).

When asked whether FitMirror can give the participants a feeling of awakening, they could answer with "yes", "no" or "I do not know". According to that, there was a mutual and clear consent of agreement from both types of morning persons. Especially the morning persons believed that they got a feeling of awakening by using FitMirror. The data reveals that both groups believed that the system could support them in their morning process (awaking from sleep, getting into a good mood, becoming motivated).

On the question if the FitMirror makes the participants happier, an obvious approval was available in both groups (morning persons: 86.36% (19), non morning persons: 85% (17)). Regarding the question if the system raises their motivation to do sports in the morning, both groups agreed (morning persons: 60%(12), non morning persons: 62% (14) see Fig. 4). The participants also agreed on the question, if the system would motivate them for the day.

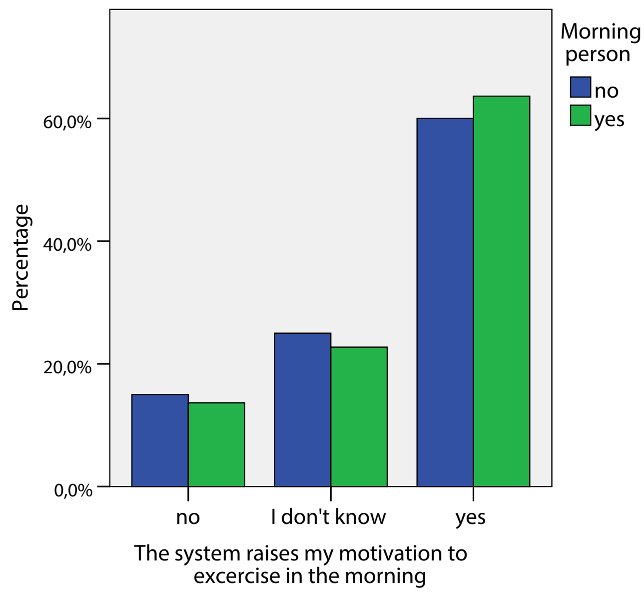

Figure 4: Motivation to do sports in the morning per morning person type.

7.4 H4: Fun exercises vs. normal exercises

In order to find out whether FitMirror achieves the hypothesis, the participants were asked to rank the exercises in descending order from fun to no fun. Rank 1 and 2 were mostly fun exercises (70% and 50% of exercises), however, rank 9 and 10 were also rated with fun exercises (55% and 77% of exercises), which seems paradox (see Fig. 5). On the middle ranks there was no clear preference of exercise type.

7.5 H5: Happiness after fun exercises

Participants are a bit happier after fun exercises than after normal exercises. The result of the less motivated sportspersons had the biggest difference, although this was not statistically significant. At the same time, the value of happiness is quite high in all of the exercises (see Fig. 6). The values on the question if the exercise was fun are not significantly different. Participants seemed to have a lot of fun in both types of exercises. The differences between the values of the less motivated sportsperson are the biggest, but are also very small and not significant.

8. DISCUSSION

The results of the use of the FitMirror shows some aspects which confirm or partially prove our hypotheses.

Concerning H1 *"Users are feeling motivated to do sport by using the FitMirror"*, the system tends to motivate the user, as all participants showed high levels of agreement.

The results relating to the difficulty levels imply that the difficulty levels for morning activation is appropriate or

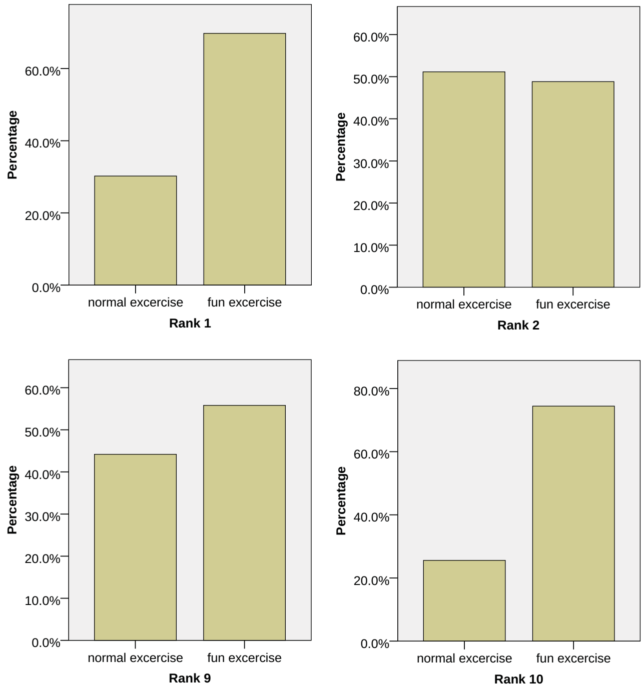

Figure 5: Rank 1 and 2 show high agreement for fun exercises (right bar), as did, unexpectedly, rank 9 and 10.

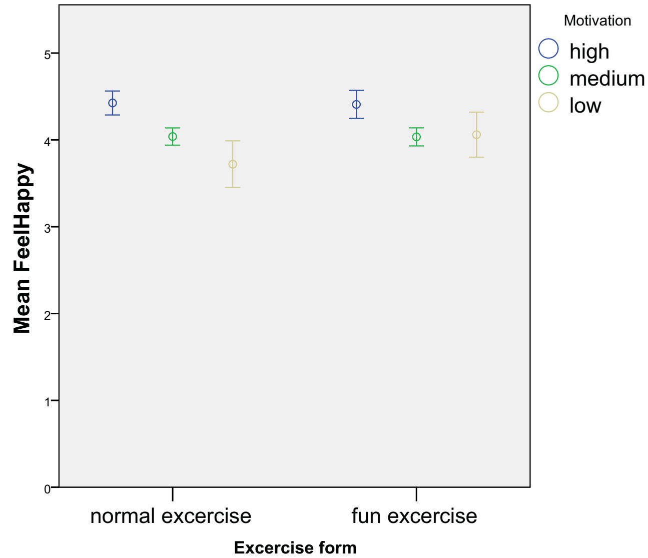

Figure 6: Happiness after exercise type per sports motivation. There is no clear effect noticeable.

somewhat easy for the users. This includes the automatic increase of the difficulty levels. Another point is that the participants with middle and high motivation (over 80% of the participants) achieved better scores after the FitMirror proposed a goal to them. The conclusion of this is that we can say the FitMirror's automatic increase of difficulty levels does motivate the user. This is also supported by the agreement of the participants when asked directly.

We can also confirm that there is a positive effect on the mood of non-morning persons. This results in the outcome of our questions if the system could help in the process of waking up. However, it does not matter too much, if a user is a morning-person or not, because the system equally works for both types.

With regards to the paradox about the rankings of the exercises we come to a few assumptions. While the participants executed the fun exercises "Smiling" and "Ball" they had many more problems than compared to other exercises. We presume that "Smiling" is one reason for the problems, because the counter did not work correctly all time[6]. The irregular counting confused and frustrated them as they could not imagine what they did wrong. The reason for this miscounting is incorrect differentiation between mouth gestures of the Kinect. The camera did not always provide good smile recognition.

In spite of the given instructions on the exercise "Ball", the participants still had many problems during execution. So they had the impression that the system did not work correctly, whereas they just did not move in the way they should have. We assume that the user should have a longer training period, which we couldn't integrate in the study routine due to time limitations. So it is understandable that the participants had a few problems and were frustrated with the ball exercise. These facts could be explanations for the already mentioned paradox from section 7.4. With these values and perceptions, we suppose that fun exercises could be more popular than normal exercises when they are well implemented and when the users get enough time to learn or if a training period is not needed as in "Balancing" and "Boxing".

Because of the little differences in the values regarding H5 *"After fun exercises the user feels happier than before"*, we cannot definitely say that fun exercises made the participants happier in our scenario.

So overall, FitMirror is able to motivate the user to exercise, motivate them with proposed goals and is a general support to the morning process of getting motivated.

9. SUMMARY AND OUTLOOK

FitMirror was created as an interactive device in mind. We thought about the use cases of a mirror and came to the conclusion that a mirror is part of one's morning routine. Hence we decided to make a mirror which recognizes small exercises and motivates the user for the day. We achieved this by fixing a spy-foil on a monitor and implementing exercise recognition with the help of the Kinect v2 and a Wii Balance Board. The mirror should not only affect one's fitness but also the mood of a user. Therefore we built recognition for fun and normal exercises.

In order to analyze the FitMirror system we ran a study. One result of this study is that FitMirror is able to help non-morning persons as well as morning persons in the process of getting up and motivates for the day. It was also noticeable that participants felt not only motivated for the day, but also to do sports during the use of the FitMirror.

The most remarkable result was that all types of morning-persons believe that the system supports their morning process. Furthermore, we revealed that middle and low motivated sportsperson achieve better scores when the system

[6]According to some participants' post-test statements

proposed them a target, which means they were more motivated. Judging from this, the users feel motivated to do sports while using FitMirror.

It is important to get robust recognition systems, as the faulty smiling exercise clearly induced frustration in some of the participants. In addition, it should be considered whether more intensive exercises like ball should be replaced by lighter exercises, if the instructions for the user should be performed longer and included with workouts. Furthermore, a long term study should be conducted to check if these kinds of systems lead the users to feel fitter the longer they are using them.

Another use case that could be examined is to use such a mirror as a supporting and instructive companion for athletes in gyms. One could integrate an electronic coach into the mirror that exactly explains how athletes have to execute an exercise correctly, and what they have to consider to reduce injuries. Also in point of rehabilitation one could use such a mirror. A lot of patients need to do exercises at home but without any supervisor. To compensate the supervisor, a fitness mirror could be used that not only checks whether the patient executes his/her exercises in a correct way, but also sends a report about the results and progress of the patient to his/her medical doctor.

Such smart mirrors could also be integrated in a real smart home concept by connecting the mirror with other components. So the mirror could provide users with the opportunity to select a recipe for breakfast and send it to a smart kitchen, that, regarding the received recipe, prepares the pans and ingredients. Or the user would manage his day in the bathroom by using the mirror. Thereby the mirror would be connected with the user's calendar.

10. ACKNOWLEDGMENTS

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