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Analyzing body gesture-action relations in an Exertion Interface based on an Interactive Trampoline

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Abstract

The FuBIntLab of the UPF is collaborating with the company LimaCode to develop further and improve the company's Interactive Trampoline platform. In this context, the goal of this project has been to find design guidelines to achieve a range of engaging and meaningful Exergames for this platform.

This was done, on the one hand, by analysing the potential body motions that an average user can perform on this platform and comparing between them according to their frequency and difficulty. On the other hand, we analysed how users interpreted those body motions within the context of imaginary (or already existing) videogames, to give a meaning to those motions.

This led us to obtain two sets of motions and meanings. One that we called "Low Floor", which includes the easy, accessible and common body motions and their most common meanings. A second one that we called "High Ceiling", which includes the more difficult, demanding and less common motions with the less common meanings.

We developed two versions of the same Exergame, each one based on the two aforementioned sets, Low Floor & High Ceiling respectively. The two had the same game mechanics but used different motions/meanings sets.

To observe how both versions are experienced, we analysed the differences between the two Exergames with average teenagers by studying their performance in the game and the answers to the Experience Questionnaire that provided information on engagement and exertion.

Our results show that the proposed action sets, Low Floor & High Ceiling, are experienced in different ways. By one hand, Low Floor showed a higher score than High Ceiling. This suggests that both an easy entry-level and a challenging level were established properly, by composing the action sets according to the frequency and difficulty of the movements and meanings. On the other hand, the users reported differences in some of the dimensions of the Experience Questionnaire. Concretely, participants in the Low Floor version reported higher values in Game Experience, and lower values in Tiredness and Negative Experience.

Key words: Full-body Interaction; Exergame; Exertion Interface; Interactive Trampoline; Informant Design; Teenager; Computer Vision; Embodied Cognition.

Problem statement

LimaCode is an external company specialized in the design and development of interactive and immersive technology. Currently, they are seeking to enhance an Interactive Trampoline by implementing new Computer Vision technology and adapting the design process of their Exergame to their target users.

In this project, we have worked, in collaboration with LimaCode, with the aim of finding design guidelines to achieve a range of engaging and meaningful Exergame. These Exergames would improve the aforementioned Interactive Trampoline platform, getting to achieve keep players within a state of Flow during the play session.

To achieve this purpose, we have considered previous findings in near research areas such as Full-body Interaction, Embodied Cognition, engagement, and previous evidence in Exergames and Exertion Interfaces. Subsequently, we focused on the importance of the naturalness of the movements that compose the action sets with which control the videogame over the user's experience.

State of the art

Why Exergames?

Over the last two decades, with the advancement of technology, the source of entertainment of children has observed changes towards more sedentary leisure activities (Carson et al., 2016). Nowadays, children prefer to spend their spare time playing video games, surfing the Internet, or connecting with their friends through their smartphones, rather than doing physical activity. This can be problematic due to the fact that physical activity plays a key role in child growth by fostering energy expenditure and supporting the development of motor skills (Landry et al., 2013). As a result, this newly acquired sedentary behaviour has serious negative effects on children's health (Carson et al., 2016).

Many attempts, such as Nintendo Wii, Microsoft Kinect, or the new VR devices, pursue to counter this problem by using full-body interfaces. However, these kinds of active video games, so-called Exergames, that deliberately demand intense physical effort (Muller et al., 2003) require to consider a broad range of knowledge related to several scopes to reach a successful implementation. For instance, Berthouze (2012) shows how users of Wii Tennis performing shorter and faster movements can score higher than players simulating the full natural movements, thus promoting not just cheating but also harmful movements in the users.

Until 2011, Exergames had a low potential to achieve a notable impact on health (Barnet et al., 2011), but thanks to the efforts of researches in collaboration with many other experts in different fields, Exergames have improved significantly. For instance, Landry et al. (2013) in collaboration with physical education experts from INEFC (National Institute of Physical Education in Catalonia) designed an Exergame based on a list of suitable movements for an interactive slide thereby children users showed a broader range of movements associated with specific events compared with previous slide Exergames, including collaborative behaviour.

Moreover, through physical activity, Exergames can also facilitate introducing people and create social bonding over a distance. Mueller et al. (2003) developed an Exertion Interface called "Breakout for two", where two players in remote locations would play together a blend of soccer and tennis in order to break a virtual glass window projected on a wall by kicking the ball against it. In the study, they compared this exertion implementation of the game with a non-exertion implementation, which used a traditional

keyboard instead. The exertion group of participants reported a greater feeling of knowing the other person and a stronger social bond than the non-exertion group. Furthermore, the exertion group also perceived a higher video-conference quality and score higher questions about engagement.

Relationship between Exergames and Engagement

While the term "engagement" does not yet have a clear definition, it is an essential phenomenon in games closely linked to motivation and attention. According to Brockmyer et al. (2009), engagement serves as a generic indicator of game involvement. In this context, Bianchi-Berthouze (2013) showed that full-body controllers for Guitar Hero, a music game for PlayStation, cause a higher engagement level in the players than non-full-body controllers. Indeed, the guitar-shaped controller triggers movements related to a more enjoyed way of play rather than test their own skills, even though these movements get worse their game performance. Moreover, in a second study where participants used an exoskeleton to measure the amount of movements, they observed a clear positive correlation between amount of movements and engagement using full-body controllers.

Interactive Trampolines

In particular, trampolines lend us several advantages. On one hand, jumping on them is a physical activity that allows Full-body Interaction in a new context. At the same time, these reduce damage on the joint of legs compared to jogging or other physical activities that are characteristic of high impact. On the other hand, even as beginners, users can benefit from the jump impulse to feel as if they have super-powers. Furthermore, trampolining has become increasingly popular in several countries, being the most popular unorganized physical leisure activity among children aged six to 12 years old in Denmark (Karoff et al., 2012), and opening indoor trampoline parks in almost every town. Consequently, the research on Exergame also has addressed the possibilities that an Interactive Trampoline can provide us.

In an attempt to improve the commercialization of Trampobics, a Japanese aerobics training method using a mini trampoline, Shiratori et al. (2009) carried out a study to verify if, adding visual effects, the product would gain the general public's engagement

in a household context. Their results showed that users in real-time interaction with a virtual environment reported more exercise motivation, either in walking or jumping exercises than the control group who did the same activity but seeing a simple video of the VR scenery. However, open-ended questions revealed the interactive condition still has to consider many factors such as dynamic changes in the virtual environment, auditory immersion, or adding other actors to counter lonely feeling.

In a another study, Holsti et al. (2013) show how important it is to consider the kind of users and their previous experience with trampolines. In this study, they tested four Exertion Interface prototypes with two kinds of users: circus students (highly acquainted with trampolines) and normal users (lowly acquainted with trampolines). The four prototypes were: a platform jumping game (PG), where the goal was to jump higher and higher in the Exertion Interface controlling back and forth displacements; a virtual training space game (TG), designed to improve jump accuracy using two virtual walls as boundaries in the Exertion Interface; a simple delayed video feedback (DF); and, lastly, a blend of delayed video feedback in a virtual training space (DFTS). The results showed that, while circus students preferred the simple delayed video feedback, normal users preferred the platform jumping game (PG), since the delay is not useful if they cannot perform skills where it is not possible to keep one's eyes on the display.

As we can see, the research evidence shows that it is important to consider interests, experience with trampolines, goals and many other characteristics of the users in the design process. This design process can get complicated when the users are a public far away from the designers, as is the case of children. In previously designed Exergames, even considering several kinds of children and designing the game's activities based on them, proved that the encouragement is not maintained despite efforts of the Exergames to encourage physical activity. Instead, children get back to using the trampolines as a non-interactive device or find others ludic alternatives after a while (Karoff et al., 2012).

Design approaches with users: Informant Design

Because our goal is to design a successful Exergame for teenagers, we will adopt the Informant Design strategy, a sort of Participatory design method, as our design process. In short, Participatory design is a technique where the future users, usually children, are a part of the design process; not just as a tester, but as design partners that can let us know

about their personal preferences, taste and objectives, and even can develop low-tech prototypes of futures Exergames (Druin, 1999). Participatory design was applied in the aforementioned research (Landry et al., 2013) resulting in an engagement Exertion Interface for interactive slides, and previous research evidence supports its benefits in Full-body Interaction. In 2012, Landry et al. already used this technique to design Exertion Interfaces for the interactive slide dividing the process into four steps. First, children in teams of four had eight minutes to play a previous game and thus learn how the platform works. Subsequently, children wrote ideas individually related to 15 desirable movements in slides selected by professionals in physical education from INEFC and draw a game situation for each of these movements in a top-down view of the slide by 20 minutes. Thirdly, children again formed their team of four to discuss and merge their individual ideas, and come up with the design of a full game scenario in a template of the top-down view of the slide during 20 minutes. As a result, children designed a paper prototype of their game that was projected onto the sliding surface to allow them to test their prototypes in the fourth and last step. These prototypes showed the children's preferences on themes, objects, and game mechanics while proving that the desirable movements were compatible with them.

Designing playable Exergames: Theory of Flow

In addition to considering their own preferences, interests, and objectives of the target users to design an engagement Exergame, the developers ought to pay attention to game dynamics and engagement theories. To that end, Csikszentmihalyi proposed, with his Theory of Flow (Image 1), that to find the optimal experience where the user feels task-focused, fully immersed and engaged in the process of the activity, the level of challenging of the task and the skill level of the users for that specific activity must be in proper relation. This optimal experience was called the state of Flow, and may be hampered whether both factors do not match in status. Either too much skill level for an easy task, turning the state of Flow into a state of boredom, or a task too challenging for a beginner or non-experimented user, turning the state of Flow into a state of anxiety (Csikszentmihalyi & LeFevre, 1989).

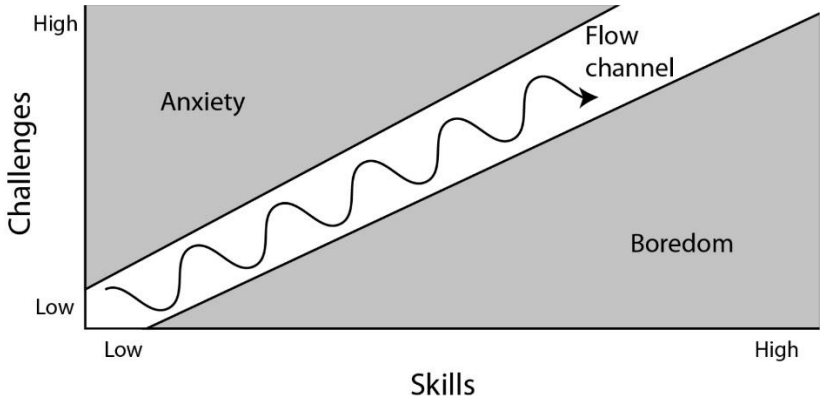

Image 1. Theory of Flow.

Designing for novice and expert users: Low Floor & High Ceiling

In order to find this adequate relation between user skills and challenging level of the task, Resnick & Silverman (2005) included in a list of 10 guiding principles for designing constructions kits for kids, the concepts of Low Floor, High Ceiling and Wide Walls. The two first terms were previously defined by Seymour Paper to highlight the importance of introducing the user into the task from an easy entry-level, namely, the Low Floor; and the importance of establishing increasingly sophisticated and challenging levels during which the users would become more expertise, namely, the High Ceiling. Subsequently, Mitchel Resnick, who was a mentee of Paper, coined the Wide Walls term to refer to a great variety of the game's factors in order to provide a wide range of different explorations.

Embodied Cognition & Full-Body Interaction

Finally, it is noteworthy to mention the importance of supporting this research on Embodied Cognition to better understand and design full-body interactive experiences. This position proposes that cognitive processes are so deeply rooted in the body's interactions that the perception and experience with the world depend on them (Wilson, 2002). This viewpoint is supported by the evidence in the research previously mentioned, and more concretely in the encouragement of the full-body controllers for (Bianchi-Berthouze, 2013). For instance, using gesture elicitation, a method to elaborate intuitive gesture sets for specific domains, Nacenta et al. (2013) showed that self-elaborated

gestures are easier to remember and are considered less effortful than a set of gestures elaborated by others.

It is also known that the meaning of abstract concepts can be expressed by gesturing using embodied metaphors. For example, for most western population, the concept of chronology time is expressed as forward or to the right for the future and backwards or to the left the past (Torralbo et al., 2006 and Santiago et al., 2007). At the same time, the meaning of abstract concepts can be given for bodily experiences. These bodily experiences, such as first steps when we learn how to walk, playing on a Teeter-Totters, or carrying a tray full of glasses, form an embodied schema, a simple structure with few basic components and relations, of the concept balance. This embodied schema can be applied to understand the abstract concept of social balance through embodied metaphors (Johnson, 1987).

A proof of the benefits of using full-body experiences to understand abstract concepts is NanoZoom, a full-body interactive experience to reinforce learning and understanding of the abstract concept of Nanoscale. NanoZoom consists of a multi-touch table where the users can find objects of different sizes not to scale with information related to their real size. These objects can be selected and then dropped into an area projected on the floor, allowing Full-body Interaction by letting the users use their own body as a referent for size. In a comparative study (Mora & Parés, 2014), with an adapted version for desktop using a regular monitor, keyboard and mouse, participants using NanoZoom showed better results sorting the different objects according to their scale.

General Methodology Applied

This project has taken place in collaboration with LimaCode company, which has been developing, among other interactive devices, Exertion Interfaces based in trampolines and specific Exergames to them. In previous versions, the body position was captured by a receptor using two wristband-shaped sensors and two ankle-shaped sensors. This technology provides information about just four points of the body and makes difficult to identify the whole body posture. In order to counter these shortcomings, LimaCode is now using a 3D camera able to recognize the different movements and poses that the users can perform during the jump.

Due to this new technology, LimaCode needs to define a collection of specifics jumps and movements for trampoline, performable by their average users, in order to develop the next Exergames. Furthermore, to offer to the user a balanced skill-challeng level where he/she stays within a state of Flow, these jumps and its possible meanings in an Exergame need to be categorized to establish different difficulty levels. The current project pretends to solve these issues dividing the process into two parts: A first explorative part focused on defining and categorizing the collection of jumps, movements and the meanings that are attributed to them. This allowed us to establish both a Low Floor and a High Ceiling sets of actions. In a second part focused on interaction design, two different versions of an Exergame were implemented based on the two different action sets and explored the performance and experience reported by average users in each of them.

- Research Questions

This project tries to find optimal answers for two different research questions (RQ):

RQ 1: What kind of jumps and meanings should compose two different actions sets (entry level and advanced level) in an Exergame for Interactive Trampolines?

RQ 2: Do average users experience in different ways two versions of the same trampoline-based Exergame depending on the actions and meanings sets with which they control it?

During the first part of the project, information was gathered to find what kind of jumps can be performed by average trampoline users, and what kind of meanings are attributed to them. While in the second part of the project the different action sets have been implemented in order to find information with which answer the research questions.

- Hypotheses

Regarding the first research question, we expect that a set of actions composed by the most frequent movements, found along the performance of several target users, will represent the Low Floor level, since most of the user will share the same basic

movements and, as in the studies of gesture elicitation (Nacenta et al., 2013), these movements will be easier to perform and understand.

By the other hand, a set of actions composed by the most unusual and specific movements will establish the High Ceiling level. Furthermore, we expect to see modulated the challenging level by the meanings that each movement represent. Once again, the most frequent meanings will become the different movements easier to perform and understand, while these same movements bounded to the rarest meanings will become harder. Therefore, the hypothesis for the RQ 1 is:

H1: The scores of the users playing in the game with the action set Low Floor will be significantly higher than the scores of the users playing with the action set High Ceiling.

To verify H1, game scores will be analyzed in the second part of the project, hoping to find a higher score in the group playing the Low Floor version, compared with the group playing the High Ceiling version.

Turning to the second research question, by using an Experience Questionnaire, we expect to see how the Low Floor version is experienced in a different way than the High Ceiling version, by average users. Specifically, we expect to find higher values in the group of participants playing the Low Floor version for dimensions such as Game Experience, Immersion, Competency and Positive Experience. Meanwhile, the group of participants playing the High Ceiling version will report higher values in the dimensions of Tiredness and Negative Experience. Thus, the hypotheses for our RQ2 are:

H2: Participants who played in the Low Floor version of the Exergame report higher values in the dimensions of Game Experience, Immersion, Competency and Positive experience.

H3: Participants who played in the High Ceiling version of the Exergame report higher values in the dimensions of Tiredness and Negative Experience.

Part 1. Finding gestures and actions, and their meanings

• Methodology

In the first part of the project, with the purpose of configuring a collection of movements, jumps and meanings able to perform by the average users of LimaCode company, has been established both a data gathering and data analysis procedures.

Along the data gathering procedure, teenagers aged from 12 to 15 years old, who would represent the LimaCode target users, have participated voluntarily and with the consent of their parents or legal tutors. This period is constituted by two different phases: the jumping phase and the analysis and interpretation phase.

During the jumping phase, the participants were filmed jumping in a normal trampoline for five minutes, in order to allow them to visualize their performance in the second phase, the analysis and interpretation phase. In this second phase, the participants in collaboration with the researcher analyzed physically their jumps and movements and attributed possible meaning for them in a game context. Moreover, this game context was defined by the participants providing useful information for a Participatory Design method.

Once both movements and meaning have been gathered, the data analysis procedure encodes, sorts and categorizes them according to their frequency along the performance of the participants, in order to compose the two different sets of actions: One to represent the Low Floor level, and another one to represent the High Ceiling level.

As a result of the data analysis procedure, the first part will finish providing to LimaCode company with a collection of movements, designed by their target users, able to control the next Exergames using the new technology set up. Furthermore, this procedure also provides us with the proposal of two actions sets differentiated in difficulty that we will test in the second part of the project, in order to find an easy entry-level for beginners and a challenging level for expertise users.

• Experimental design and set-up

In this first data gathering procedure, participated a total of seven teenagers aged from 12 to 15 years old, enrolled in the high school “Institut Salvador Espriu” from Barcelona. In

order to ensure the participation authorized, a consent form was drafted by us including general information about duration, tasks, confidentiality and other terms of the activity (Appendix 1). Teens handed over this consent form, signed on behalf of their parents or legal tutors, to their physical education teacher who, after recognized the signatures, deliver us these consent form.

Once the consent forms were delivered, scholars can participate in this after-school activity, carried out in the afternoon in our laboratory located in Campus del Poblenou from Universitat Pompeu Fabra, Barcelona. Generally, participants came to the University in pairs, and were received at the entrance by us, since underaged cannot get into the compound on their own.

In addition, because the teenagers interested in the activity showed high physical activity, a group of five undergraduate from the Universitat Pompeu Fabra, and aged between 18 and 20 years old, participated in the study with the expectancy of finding a more variety of athletic level. This participant signed out their own consent form already in the lab.

Inside the lab, participants were informed with general information about the activity, allowing them to formulate any question to the researcher or reject their participation in this moment or during the activity.

With the purpose of making the activity more enjoyable and to avoid keeping them waiting along the participation of his or her colleague, we have organized the data gathering procedure in the following manner: During the jumping phase, they are separated to avoid movements and jumps from being copied from one another. While one is carrying through the first task, the other one waits outside the lab. This established order will be maintained during the analysis and interpretation phase, however, during this part, while the first participant is involved in the task, the second participant can keep playing in the trampoline.

In the jumping phase, the participants were filmed continuously during their performance. This phase of jumping was divided into three segments with specific durations and instructions. In the first segment, participants should jump for two minutes performing natural and non-challenging movements involving arms and legs. In the second segment, participants should jump for a minute and a half trying more difficult movements or involving body parts previously neglected. In the third and last segment, participants

should jump imagining one or several video-game scenarios with the objective of translating specific game actions into a possible trampoline-based Exergame.

In the analysis and interpretation phase, an Informant Design was applied. Participant and researcher visualize the performance previously recorded. The video is displayed in the right half of the laptop screen while the other half is used to fill in a template where both analyse and interpret each of the jumps and movements (Appendix 2). Instructions were given to stop the video each time they identify a new movement or jump, then this action was physically described and interpreted. For the physical description, the researcher was helped by the participant to analyse properly his or her performance. The interpretation is solely up to the participant, the researcher just writes what he or she reports.

When participants finish both tasks were allowed to play in the trampoline for a while, then they were accompanied by the researcher until the entrance.

- Procedures used to obtain data

A camera Canon EOS 550d with a 10-22mm lens was used to film the user performance in the jumping phase, and a self-elaborated template was used to analyse and interpret the different movements and jumps performed (Appendix 2).

Thank those tools, a total of 218 movements were analysed. Having into account that some of these movements were performed by several participants, after calculating the frequency for each of the movements, a total of 101 different movements were listed. A final selection of 75 of those movements was appointed as safe movements to perform in trampolines, and categorized according to their difficulty. Frequency of the meanings was calculated for each of the movements.

- Results

Finally, both Low Floor and High Ceiling set of actions were composed considering the frequency and difficulty of movements and meanings as follows. How we can see in Figure 1, Low Floor set was composed by the most frequent and easiest movements, while High Ceiling set was composed of more difficult and unusual movements (Figure 2)

Figure 1. Frequency of Low Floor movements.

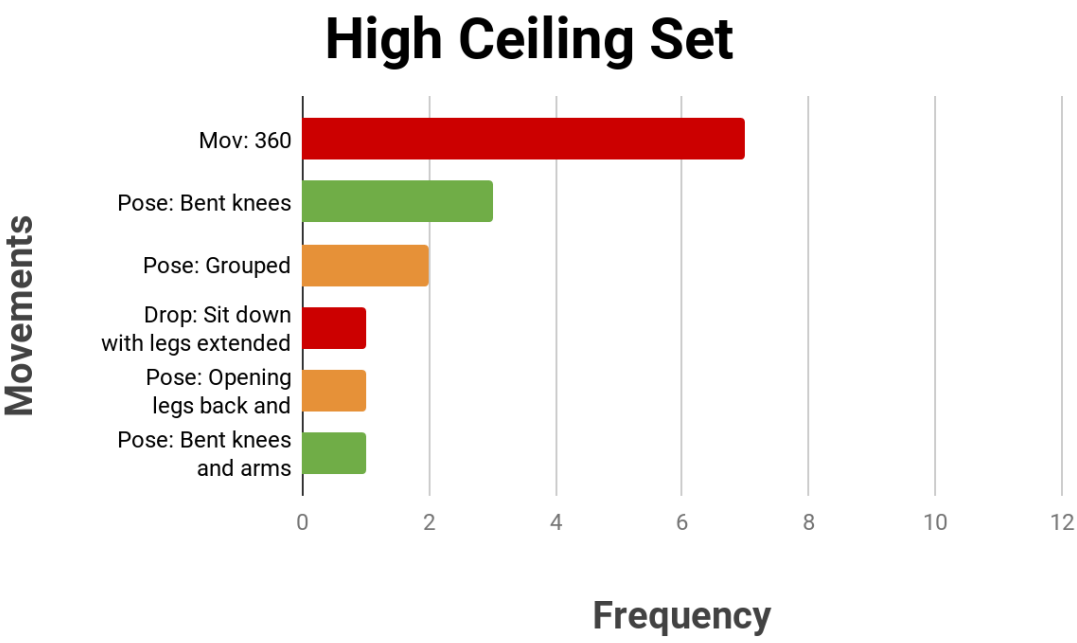

Figure 2. Frequency of High Ceiling movements.

Having established both actions sets, allow us to design the Exergame with which answer both research questions. Thus, both a Low Floor and High Ceiling versions were developed by bounding each of the movements to a meaning based on their frequency,

and trying to set matched game actions in both sets of movements. The full set of movements and meanings may be found in Appendix 3.

- ## Design & Development criteria and strategies of new Exergame

In order to answer the research questions, two different versions of the same Exergame were designed and developed. The design criteria of this Exergame, which adopted the name of "BouncingTramp", was based on the results found on the first part of the project. Specifically, we design the game mechanics based on the meanings and game context reported by the participants for each of their action, spotted in the analysis and interpretation phase. And we compose the different action sets, with which control the Exergame, according to the frequency and difficulty of the movements analysed in the first part of the project.

The development criteria depended on the technical features of the Computer Vision system. Thus, the previous C++ framework, based on OpenFrameworks, was adapted to the new 3D camera, an Intel RealSense Depth Camera D435, by adding the Nuitrack SDK library.

Finally, the Exergame developed consisted of a platform videogame where the user would be represented by a ball. This ball, by jumping laterally and in different grades of intensity, should progress vertically by jumping from a platform to one another higher platform until the last one, in a time limit of three minutes. While the user is reaching new platforms, these are dropping in such a way that the ball is always displayed in the middle vertical range of the screen. A total of 30 platforms were displayed and for each new platform reached, the participant summed five points to one's score (Image 2).

The movements related to the meaning of jump from the current platform to the next one was a free lateral jump, for the Low Floor version, and bending the knees in the air during the lateral jump, for the High Ceiling version.

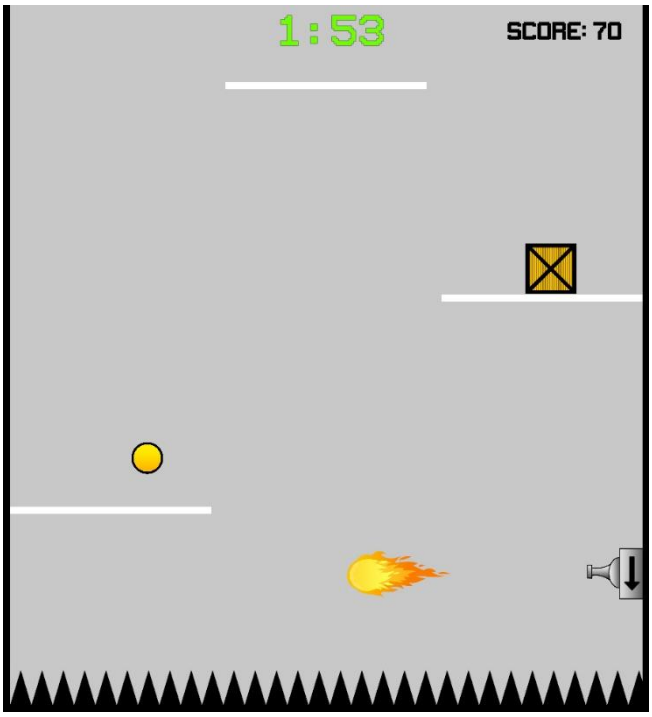

Image 2. BouncingTramp overview.

Moreover, to boost the user to implement other game actions, they would find along the way different virtual objects with which gain extra points by interacting with them. These virtual objects were:

Wooden boxes that save a stone (Image 3). The user should crack the box with the purpose of catching the stone. The movements related to the meaning of crack the box were tumbling on the knee, for the Low Floor version, and grouped in the air, for the High Ceiling version. Once broken the box, this one disappears and the stone is available.

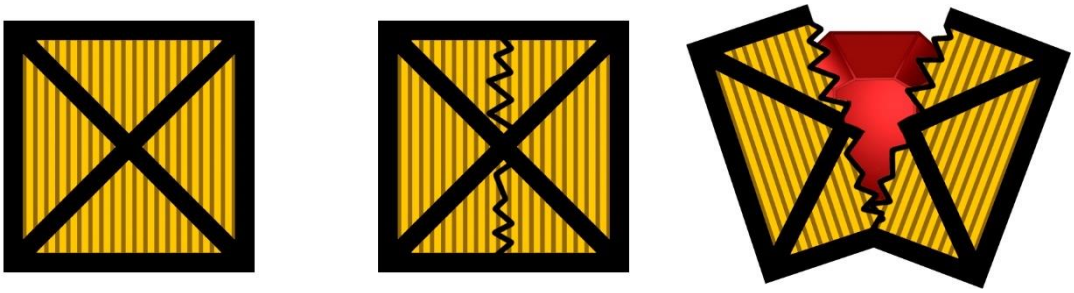

Image 3. Wooden box breaking progression.

The stone (Image 4). After breaking the wooden box, the users can gain 25 extra points by catching a stone. The movements related to the meaning of catching a stone were performing a start silhouette by opening legs laterally and extending the arms horizontally, for the Low Floor version, and doing a 360-degree turn, for the High Ceiling version. Once caught the stone, this one disappears and the 25 extra points are summed to the user score.

Image 4. Stone.

Fire guns and its fireballs (Image 5). Fire guns are located at the lateral edges of the screen, both on the left and on the right, with two different height. These fire guns trigger fireballs horizontally from one edge to the other one. If the ball representing the users during the jump collide with this fireball the game is over. In order to keep progressing on the game, users must avoid the fireballs that are moving toward them. Besides avoiding the fireballs, users could gain 25 extra points if they get to deactivate the fire guns by performing different actions depending on the version of the Exergame and the height of the fire guns.

Image 5. Right and low fire gun.

High fire guns, either on the left or on the right, could be deactivated by avoiding their fireballs from below tumbling in sit down position and with the support of their hands,

for the Low Floor version, or without supporting with their hands, in the High Ceiling version.

Meanwhile, low fire guns, either on the left or on the right, could be deactivated by avoiding their fireballs from above bending the knees, in the Low Floor version, or opening legs back and forth, for the High Ceiling version.

Moreover, arrows were drawn on the fire guns to provide clues about the direction to avoid their fireballs to deactivate it. Deactivated the fire gun, the user gains 25 extra points and the fire gun looked like broken and rusty (Image 6).

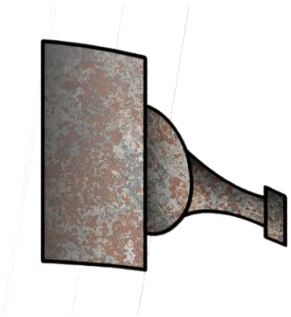

Image 6. Deactivated fire gun.

Finally, if the user achieved the last platform, a pipe emerged from the high edge of the screen (Image 7). At this point, the goal of the participants got into the pipe by jumping higher and extending their arms and legs vertically, for the Low Floor version, or bending their knees and extending their arms horizontally, for the High Ceiling version.

If the users achieved a certain height in the correct pose, the ball went up automatically through the pipe and the game ended up summing the rest of the non-spent seconds to the total score reached.

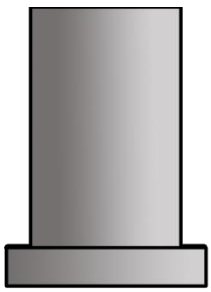

Image 7. Pipe.

Part 2. Comparing the experiences generated by the two set of actions and meanings

- Methodology

Once developed both versions of BouncingTramp, we are enabled to implement an Exergame testing procedure which, as the first part of the project, was composed of another data gathering period and its data analysis process. This second part of the project will provide us with the needed results to answer both previously posed research questions.

This second data-gathering period was split up into two phases. Firstly, a game phase where the participants tried the BouncingTramp Exergame, either in its Low Floor or High Ceiling version, while the researcher recorded his/her game performance. Secondly, the participants filled out an Experience Questionnaire in an assessment phase where they reported their own game experience while playing BouincinTramp in one of the two versions.

Once again, the participation was voluntary and consented by the parents or legal tutors of the underage participants. The resulted sample has participants aged between 11 to 18 years old, maintaining the target age user of LimaCode as the mean age for each group.

Finally, with the purpose of answering the research questions, the data analysis of the second part has explored differences between the Low Floor and the High Ceiling version, by comparing performance, experience reported and improvement.

- Experimental design and set-up

In the second part of the experiment, we counted on the collaboration of an external language academy named “The Green Monkey”, and a civic center named “Casal de Barri La Llacuna”. Thanks to these associations from Barcelona, a total of 30 participants aged between 11 and 18 years old took part in our study. Once again, the participation authorized was ensured by a consent form that included general information of the activity, such as duration, tasks, confidentiality, etc. (Appendix 4). However, this time the participants were cited in groups of four or five members and accompanied by the monitor of the organization, who deliver us the consents forms signed on behalf of the

participants' parents or legal tutors. Newly, the activity took part in our installation located in Campus del Poblenou from Universitat Pompeu Fabra, Barcelona.

Once the groups arrived at the lab, every participant fills out a sheet with their demographic data. Thus, the group was divided into two subgroups, either to play the Low Floor or the High Ceiling version, keeping the demographic data in balance. In order to maintain the naivety of the participants about the existence of two different conditions, while one subgroup was taking part in the study, the other subgroup was playing in the other side of the lab, separated by a curtain, to the "Land of Fog", an interactive videogame projected onto the floor that is part of another study of our lab.

Both subgroups completed the same task during the data gathering procedure of the second part, the only single different aspect in the groups' participation was the version displayed of the Exergame. As in the first part, the data gathering procedure was divided into two phases: the game phase and the questionnaire phase.

The game phase was split into three segments. In the beginning, the members of a subgroup together received information about the game mechanics of the Exergame and the specific actions implemented in it to control the version displayed. Once participants understood the game mechanics and their questions were answered, each of them had a minute to try the Exergame and receive feedback according to their performance. Finally, each participant played individually to the Exergame for six minutes. Along these six minutes, they were allowed to reinitiate the game each time they fail, until the six minutes were over, and ask whatever they need to the researcher. Along the game phase, the research was registering the number of trials, and time spent and score reached in each of the trials.

Finished the game phase for each of the members of the first subgroup, they got into the second phase by filling out an anonymous Experience Questionnaire provided by the researcher. They complete the task individually, just with the help of their monitor when they need to clarify some of the items. Once finalized the questionnaire they would start the extra activity of "Lands of fog".

While the participants of the first group were filling out their Experience Questionnaires, the second subgroup was called to start the game phase. The procedure carried out with the second subgroup was equal to the first one in both game and questionnaire phases, just the version of the Exergame was changed.

At the end of the participation of the second subgroup, in appreciation of the collaboration with the study, participants had the chance to play again until their monitor decide to finalize the activity.

- Procedures used to obtain data

During the game phase, data regarding participant code, number of trial, score and game time was gathered by the research filling out an excel template while the performance of the participants (Appendix X).

Experience Questionnaire was built specifically to fulfil our necessities. The creation of this one was based in two previous questionnaires. From the Game Experience Questionnaire (IJsselsteijn et al., 2013) a total of eight items were selected and modified to constitute the dimension Game Experience. This dimension informs about how the users are perceiving the several technical features of the Exergame. The next five dimensions, each of them constituted by four items, were inspired by the Presence Questionnaire (Witmer B. G. & Michael M. J., 1998). These five dimensions were:

Tiredness: Dimension to measure the physical and psychological fatigue of the user after playing the Exergame.

Immersion: Assess in which way the user has been playing the Exergame involving all their senses, neglecting external variables of the environment that do not play a role in the activity.

Competency: Evaluate the way in which the user is perceiving their own skill as adequate or not to play the Exergame.

Positive Experience: This dimension informs about the good feelings toward the Exergame played.

Negative Experience: Assess those bad feelings that the Exergame has produced in the user.

The next data analysis was carried out using Jupyter Notebook and Python programming language, and its dedicated libraries. To ensure the correct selection of the test with which compare the means of both Exergame versions', the normal distributions of the game scores and the different dimensions were tested by implementing the Shapiro-Wilk test.

Just the pair of dimensions Difficulty showed normality in its distribution, therefore, a T-test for independent samples was applied to compare Low Floor and High Ceiling. To compare the rest of the data, the non-parametric test Mann-Whitney U test was implemented.

- Results

After analysing the data gathered by the excel template, we find similar general game scores for both conditions. However, when we divided the performance of the participants into three thirds we can see how in the first third, which is clean of tiredness or practice effect, the scores for the Low Floor condition were better than the High Ceiling condition (13.22 vs 6.36, p = .020) (Figure 3).

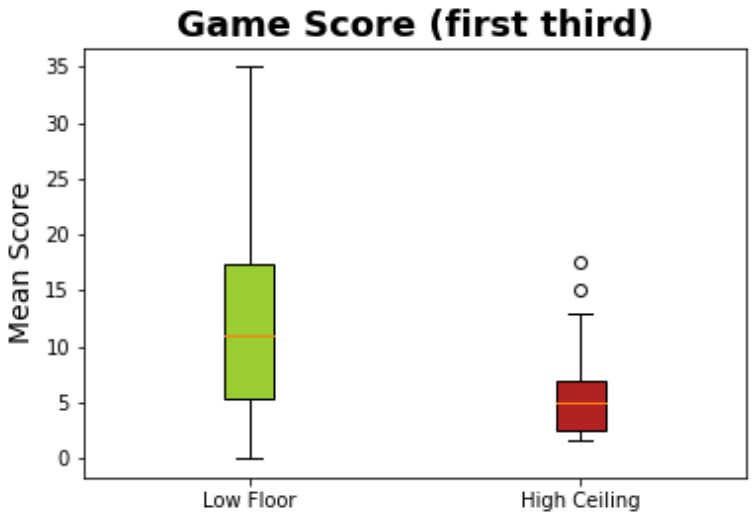

Figure 3. Game Score (first third).

Moreover, the improvement analysis by comparing the scores of both first and third thirds intra-groups disclosed a non-significant difference in the Low Floor condition, but significant for the High Ceiling condition (6.36 vs 18.41, p = .002) (Figure 4).

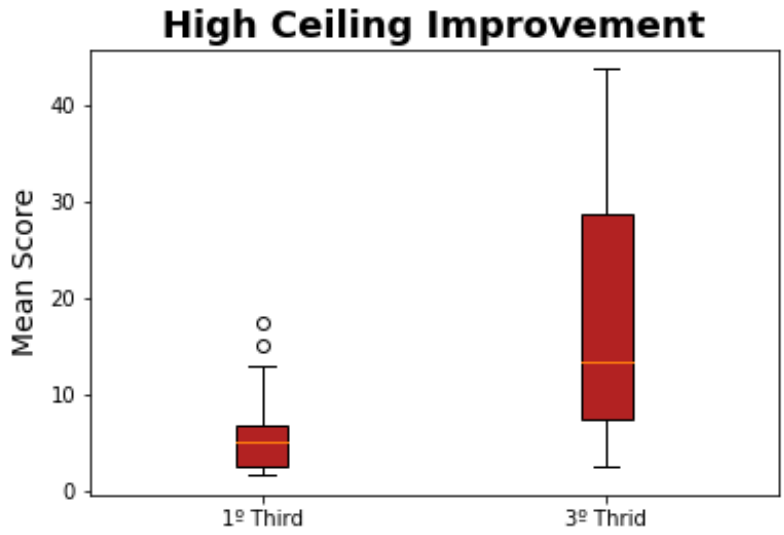

Figure 4. High Ceiling Improvement.

Regarding the information reported through the Experience questionnaire, significant differences were found for three of the six dimensions. Participants in Low Floor condition reported higher values in Game Experience (4.03 vs 3.7, p = .024) than participants from High Ceiling. Meanwhile, participants from High Ceiling condition reported higher values in Tiredness (2.65 vs 3.27, p = .028) and Negative Experience (1.43 vs 2, p = .003) than the participant that played the Low Floor version (Figures 5, 6 & 7).

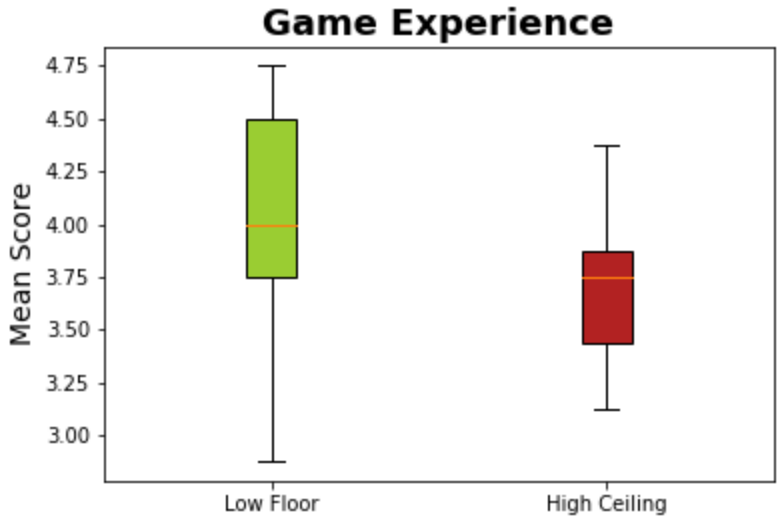

Figure 5. Game Experience.

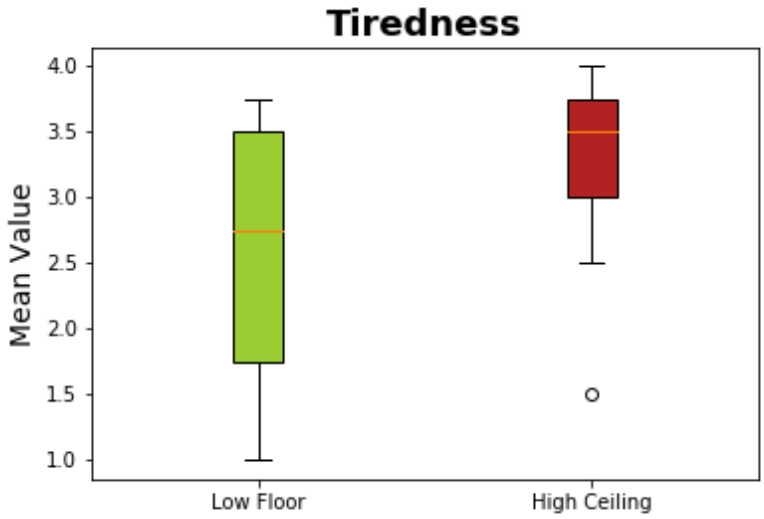

Figure 6. Tiredness.

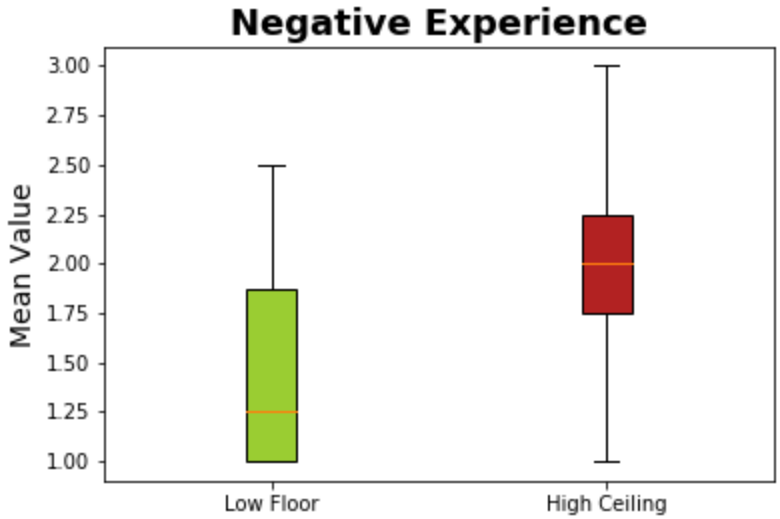

Figure 7. Negative Experience.

Additionally, a trend to significant effect was found in the dimension Difficulty. Participants that played the High Ceiling version found the Exergame harder than the participants in the Low Floor version (2.95 vs 3.37, p = .0.54) (Figure 8).

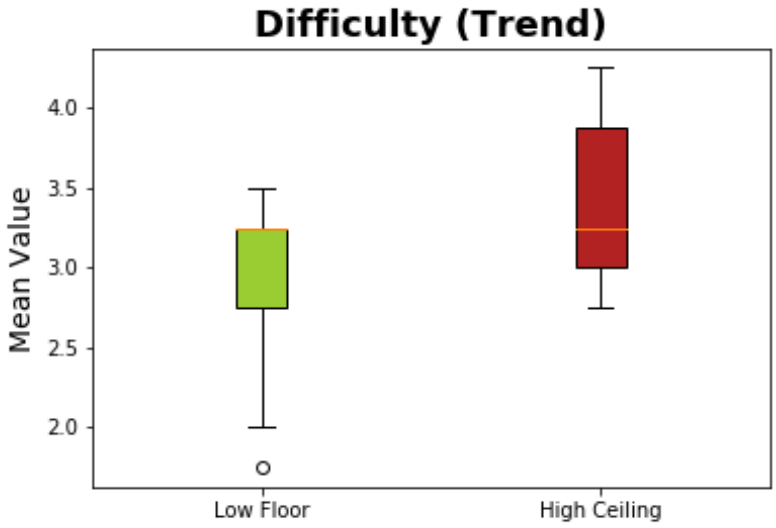

Figure 8. Difficulty (Trend).

The next bar plot (Figure 9) shows the mean values for those dimensions that did not show significant differences in their Mann-Whitney U test, which are Immersion, Competency and Positive Experience.

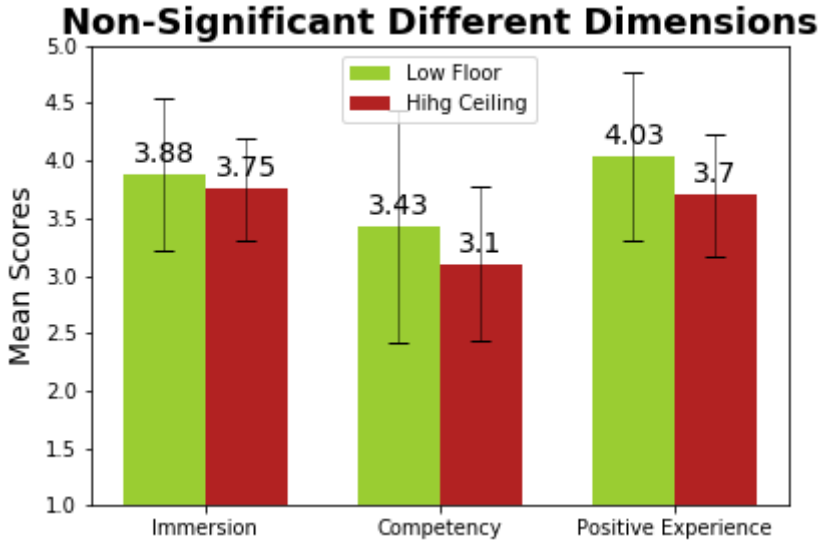

Figure 9. Non-Significant Different Dimensions

Discussion

The way we posed the study at the beginning of this project, our aim was to find answers to two research questions, which would provide us with useful information with which design and develop new Exergames for the Interactive Trampoline of LimaCode.

These research questions were:

RQ 1: What kind of jumps and meanings should compose two different actions sets in an Exergame for Interactive Trampolines?

RQ 2: Do average users experience in different ways two versions of the same trampoline-based Exergame depending on the actions and meanings sets with which they control it?

In order to answer our first RQ, we proposed two different action sets based on the concepts of Low Floor and High Ceiling (Resnick & Silverman, 2005). This was a useful approach the clearly helped us classify the feedback given by the users that contributed to analyse the full range of movements and meanings for the Interactive Trampoline platform. This therefore reflected both the available research evidence and the average user's performance.

After implementing these actions sets in the same Exergame, namely BouncingTramp, we can see how the global performance of the participants who played both versions do not differ from each other. At this point, we have to take into account that the global performance, which has a duration of six minutes, is influenced by variables such as practice or tiredness. Because of that, a better measurement of the performance depending exclusively on the actions implemented come from comparing just the two first segments of the trials of each group of participants (where each segment corresponds to a third of the duration of the trial).

How we suggest in our hypothesis, an entry-level seems to be given by the implementation of the more frequent and natural movements and meanings, since participants who played the Low Floor version showed higher scores in their first trials. In other words, when they are still novice players, they played significantly better in the Low Floor version, compared to the High Ceiling version. Interestingly, the trend found in the values of the Experience Questionnaire for the dimension of Difficulty seems to say that the users are aware of this difference.

Furthermore, the improvement on the performance in both conditions was analyzed by a comparison intra-groups of the first and last segments of their trials. On the one hand, the results do not show improvement in the Low Floor condition, which means that the participants are comfortable with the challenge level even when they are novices. On the other hand, participants in the High Ceiling version showed significantly better performance in their last segment, which reveals that in this condition the participant has to gain practice to control the Exergame.

Regarding the second RQ, the Experience Questionnaire showed that the participants experienced the Exergame in different ways, and not just in de Difficulty dimension. Participants in the Low Floor condition reported, through the Game Experience dimension, that the technical features of the Exergame work better, compared with the High Ceiling group. Although the Exergame works in exactly the same way in both versions, the difference found in the game experience perceived by the users is understandable, since participants in the High Ceiling version fail more frequently, attributing these fails to the Exergame.

Regarding the tiredness perceived by the users, despite the players in Low Floor condition player longer spans and their trials reaching higher scores, High Ceiling was the group who report higher values in this dimension. This also makes sense since the Tiredness items were related to different types of tiredness, not just physical but also psychological.

Participants in the High Ceiling condition also give higher values in Negative Experience than participants from the Low Floor group. Likely, this result is due to the High Ceiling version of BouncingTramp has not the most suitable balance between the challenging and the skills of the users to get into the Flow channel. Although, Positive Experience does not present a significant difference the Low Floor group gave higher values than the High Ceiling in this dimension, supporting this explanation.

In addition, Informant Design seems to be a good method with which design and develop Exergames for an Interactive Trampoline when the age of the target users are not represented in the design or development team. Both Low Floor and High Ceiling BouncingTramp versions received high values by the users in the Positive Experience dimensions and, although there is a difference in Negative Experience, we can say both groups of participants reported low values for this dimension.

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Appendices

Appendix 1. Consent Form (Part 1).

Appendix 2. Template for Analysis and Interpretation Phase.

Appendix 3. Data gathered in Part 1

Appendix 4. Consent Form (Part 2).

Appendix 5. Template for performance in Game Phase.

Appendix 6. Experience Questionnaire.

HOJA DE INFORMACIÓN Y CONSENTIMIENTO INFORMADO APPENDIX 1
Para Padres / Representantes legales

TÍTULO DEL ESTUDIO: Análisis de movimientos y gestos durante la práctica del salto en cama elástica para el futuro diseño de interfaces interactivas.

Investigadores: Prof. Narcís Parés (Investigador Principal) y Óscar Guerrero Rosado.

Este formulario de consentimiento forma parte del proceso de consentimiento informado. Si desea más detalles sobre algún aspecto, se le invita a que lo solicite al investigador del estudio. Tómese el tiempo necesario para leerlo detenidamente.

Desde la Universidad Pompeu Fabra, y en colaboración con CTRLight, se está llevando a cabo un estudio con participantes de edades comprendidas entre 12 y 15 años para el diseño de tecnología interactiva. En concreto, se pretende analizar los gestos y movimientos realizados por niños y niñas, durante el salto en trampolín (cama elástica), para el desarrollo de una versión interactiva de este.

Actividad del estudio: Esta actividad extraescolar se llevará a cabo en las instalaciones del campus Poblenou de la UPF por las tardes (horario no lectivo), durante una sola sesión de aproximadamente 20 minutos. En ella, el participante tendrá la posibilidad de saltar durante un tiempo restringido en nuestro trampolín, el cual dispone de todas las medidas de seguridad necesarias. La actividad del participante en el trampolín será filmada con el propósito de que el niño o niña, con ayuda del investigador, pueda describir e interpretar los diferentes movimientos y gestos que ha realizado durante el salto.

Tras describir y analizar los diferentes movimientos y gestos, el participante tendrá la oportunidad de obtener más información sobre el proyecto que se está llevando a cabo, y la labor del investigador en el diseño y desarrollo de tecnología interactiva.

Debe saber que su participación en este estudio es voluntaria y que puede decidir no participar, o retirar su consentimiento en cualquier momento del procedimiento, sin que por ello se altere la relación con los profesionales de la UPF.

Confidencialidad: El tratamiento, la comunicación y la cesión de los datos de carácter personal de todos los participantes se ajustarán a lo dispuesto en la legislación vigente. No obstante, participantes y sus tutores legales podrán requerir el acceso a esta información para su edición y borrado según les ampara el Real Decreto 1720/2007, Ley Orgánica de Protección de Datos de Carácter Personal 15/1999 and EU directive 2002/58/CE. El material audiovisual que se grabe durante las sesiones formará parte del archivo y posteriormente será custodiado por la UPF con las medidas legalmente establecidas.

No obstante, fragmentos de estos vídeos podrán utilizarse para la divulgación del proyecto tanto en foros especializados como congresos internacionales, como en noticias divulgativas en medio de comunicación globales. En estos casos, las caras de los participantes serán tratadas digitalmente de forma que no sean reconocibles.

Importante: Si desea que su hijo o hija participe en el estudio, o necesita más aclaraciones, por favor, contacte con el investigador Óscar Guerrero Rosado, mediante su correo: oscar.guerrero01@studiant.upf.edu, o mediante Whatsapp: +34 6XX XX XX XX para acordar una cita previa o realizar las preguntas que desee.

HOJA DE INFORMACIÓN Y CONSENTIMIENTO INFORMADO
Para Padres / Representantes legales

TÍTULO DEL ESTUDIO: Análisis de movimientos y gestos durante la práctica del salto en cama elástica para el futuro diseño de interfaces interactivas.

A RELLENAR SÓLO POR LOS PADRES / REPRESENTANTE (de su puño y letra)

Yo (nombre y apellidos)_____,
con correo electrónico o teléfono de contacto _____,
en calidad de (relación con el participante): _____ de
(nombre del participante) : _____

He leído y entendido la hoja de información que se me ha entregado.
He podido hacer preguntas sobre el estudio y se han contestado.
He recibido respuestas satisfactorias a mis preguntas.
He recibido suficiente información sobre el estudio.
Comprendo que la participación es voluntaria.
Comprendo que puedo retirarme del estudio:
1º. Cuando quiera.
2º. Sin tener que dar explicaciones.

Fecha:

Firma de los padres / representante:

_____

Nombre: APPENDIX 2

Edad:

Experiencia con trampolines:

Frecuencia con la que realiza actividades deportivas:

Primer Segmento

Minuto del vídeo	**Descripción del movimiento**	**Contexto – Videojuego**	**Efectos de la acción** **Interacción con otros** **Qué o quién recibe la acción** **Objetos asociados**

Segundo Segmento

Minuto del vídeo	**Descripción del movimiento**	**Contexto – Videojuego**	**Efectos de la acción** **Interacción con otros** **Qué o quién recibe la acción** **Objetos asociados**

Tercer Segmento

Minuto del vídeo	**Descripción del movimiento**	**Contexto – Videojuego**	**Efectos de la acción** **Interacción con otros** **Qué o quién recibe la acción** **Objetos asociados**

Data gathered in Part 1.

APPENDIX 3

Sit down tumbles.

Movement	Frequency	Contexts and Meanings
With extended legs – hands supporting	12	Mario Bross: Smash a mushroom. Subwaysurf: Avoid a high obstacle. To save to a fellow. Avoid an object thrown by a rival.
Combo: To the left and to the right	4	Smash something with more strength.
After 180, with extended legs – hands supporting	2	
Legs open	1	
With extended legs – hands no supporting	1	

Tumbles on the Knees.

Movement	Frequency	Contexts and Meanings
On the Knees – hands supporting	9	Mario Bross: Smash an object. Call of Duty: Shooting position. Goalkeeper: save a goal.
On the Knees – hands no supporting	1	

360 rotation.

Movement	Frequency	Contexts and Meanings
360	7	Get extra points while running.
360 with arms extended upwards	1	Go up by creating a twister.

Touching feet.

Movement	Frequency	Contexts and Meanings
Touching feet - Legs open	7	Gymnastic: get points. Double kick to a rival
Touching feet - Sit Down	3	Gymnastic: get points. Kick to a rival
Touching feet - One leg extended laterally	2	Pound to a rival
Legs shrunk to one side – one arm extended upward	1	

Kicks.

Movement	Frequency	Contexts and Meanings
Lateral kick	5	Pound a rival. Shoot to the goal.
180 High kick	2	Pound a rival. Shoot to the goal.
Double frontal kick	2	Pound a rival.
Jump forward with kick	2	
Combo: Punch + kick	1	Make the rival fall backward.
360 Low kick	1	Shoot to the goal.
Double kick, forward and backward	1	
Double lateral kick, dropping in that pose	1	Pound a rival.
Lateral kick + punch	1	Pound a rival.

Stick pose (Arms extended upward and legs closed).

Movement	Frequency	Contexts and Meanings
Stick pose	5	Mario Bross: reach a high object.
Stick pose with legs shrunk	1	Go up to a higher platform.

Lateral tumble.

Movement	Frequency	Contexts and Meanings
Lateral tumble	4	Brawl star: Avoid an attack. Catch something.

Star pose (Arms extended upward and separately as well as legs)

Movement	Frequency	Contexts and Meanings
Star pose	4	Goalkeeper: save a goal.
Star in lateral movement	1	Baseball: Signal to receive the ball
Star extending just one arm	1	

Knees bent.

Movement	Frequency	Contexts and Meanings
Knees bent	4	Avoid an obstacle. Athletics: Jump over a fence. Jump higher. Catch an object that provide extra energy.
Knees bent + Legs extended laterally	1	Plane: Fly.

Lateral jumps.

Movement	Frequency	Contexts and Meanings
Combo: lateral jumps	3	Space: Avoid holes inside of a pipe. Avoid lava in the floor. Avoid obstacles that come to you.
Combo: lateral + forward and backward jumps	2	Going to safe places. Introducing a password code to get into a place.
Go ahead in zigzag	1	Avoid obstacles in the floor, such as holes.

180 rotation.

Movement	Frequency	Contexts and Meanings
180	3	
Combo: 180 to the left and to the right	1	
180 with keens shrunk and hands over them	1	Get extra score.

Knees shrunk.

Movement	Frequency	Contexts and Meanings
Knees shrunk and open	3	Parkour: Jump from a roof to another one.
Knees shrunk and hands over them	2	Volley: Jump higher. Drop with more weight, breaking the floor.
Knees shrunk and open + arms extended between them	2	Frog jumping from one stone to another one in a river.
Knees shrunk and touching feet	1	

Punches.

Movement	Frequency	Contexts and Meanings
Combo: Several punches	2	Pound to a rival.
360 Punch	1	

Wield an imaginary sword.

Movement	Frequency	Contexts and Meanings
Wield a sword	2	Pound to a rival.
Wield a sword jumping forward	1	

Running (in the air).

Movement	Frequency	Contexts and Meanings
Running pose	2	Run. Mario Bross: hit a brick that provide a recompense.
Wield a sword jumping forward	1	Parkour: Jump from a roof to another one.

Grouped (Bringing knees to the chest and holding them with the arms)

Movement	Frequency	Contexts and Meanings
Grouped pose	2	Manhunt: Jump over someone and scape. Avoid a low obstacle.
Grouped tumble	1	Mario Bross: Break the floor to fall down in a lower room.
One side of the body grouped	1	Drop with more strength.

Open legs (laterally).

Movement	Frequency	Contexts and Meanings
Open legs (laterally)	2	Inazuma Eleven: Super-technique. Avoid a low obstacle that come to us.
Open legs (laterally) + arms extended downward	1	Jump over an obstacle.
Open legs (laterally) + one arm extended upward and the other hand in the hip	1	

Basketball shot (imaginary ball).

Movement	Frequency	Contexts and Meanings
Basketball shot	2	Basketball: get points.

Arm performing high.

Movement	Frequency	Contexts and Meanings
Grab something	1	Basketball: catch a ball.
Hit something	1	Kill a big monster.
Hit something while jumping forward	1	

Putting together feet.

Movement	Frequency	Contexts and Meanings
Putting together the soles	1	
Putting together the ankles	1	
Putting together the ankles repeatedly	1	Super-powers: gain extra energy.

Crossed legs.

Movement	Frequency	Contexts and Meanings
Sit down with crossed legs	1	
Tumble with crossed legs	1	

Open legs (forward and backward).

Movement	Frequency	Contexts and Meanings
Open legs (forward and backward)	1	Jump over an obstacle.
Open legs (forward and backward) + hands touching feet	1	

Muay thai movements.

Movement	Frequency	Contexts and Meanings
Hit with the elbow	1	Pound to a rival.
Hit with the knees	1	Pound to a rival.

Projectile simulation.

Movement	Frequency	Contexts and Meanings
Throw an arrow with an imaginary arch	1	League of Legends: Shoot to a rival.
Shooting with an imaginary gun	1	Counter Strike: Shoot to a rival.

Movements non-grouped.

Movement	Frequency	Contexts and Meanings
Tumble over a knee and punching the floor	1	Explosion to keep rivals far.
Tumble over knees and hands	1	
From the rebound of a tumble, Superman pose	1	Superheroes: Fly.
Shoot a goal with the head	1	Shoot a goal.
540 rotation	1	

HOJA DE INFORMACIÓN Y CONSENTIMIENTO INFORMADO APPENDIX 4

Para Padres / Representantes legales

TÍTULO DEL ESTUDIO: Análisis de movimientos y gestos durante la práctica del salto en cama elástica para el futuro diseño de interfaces interactivas.

Investigadores: Prof. Narcís Parés (Investigador Principal) y Óscar Guerrero Rosado.

Este formulario de consentimiento forma parte del proceso de consentimiento informado. Si desea más detalles sobre algún aspecto, se le invita a que lo solicite al investigador del estudio. Tómese el tiempo necesario para leerlo detenidamente.

Desde la Universidad Pompeu Fabra, y en colaboración con LimaCodePlay, se está llevando a cabo un estudio con participantes de edades comprendidas entre 12 y 15 años para el diseño de tecnología interactiva. En concreto, se pretende poner a prueba de los participantes un videojuego adaptado a camas elásticas.

Actividad del estudio: Esta actividad extraescolar se llevará a cabo en las instalaciones del campus Poblenou de la UPF (Carrer de Roc Boronat, 138, 08018 Barcelona) por las tardes (horario no lectivo), durante una sola sesión de 20 minutos aprox. En ella, el participante tendrá la posibilidad de probar el videojuego durante un tiempo restringido en nuestro trampolín, el cual dispone de todas las medidas de seguridad necesarias. Una vez finalizado el periodo de juego, un cuestionario le será suministrado con el objetivo de describir su experiencia durante el videojuego. Este cuestionario es anónimo, de manera que la información proporcionada no podrá ser vinculada con la persona.

Debe saber que su participación en este estudio es voluntaria y que puede decidir no participar, o retirar su consentimiento en cualquier momento del procedimiento, sin que por ello se altere la relación con los profesionales de la UPF.

Importante: Si desea que su hijo o hija participe en el estudio, o necesita más aclaraciones, por favor, contacte con el investigador Óscar Guerrero Rosado, mediante su correo: oscar.guerrero01@studiant.upf.edu, o mediante Whatsapp: +34 618 20 83 45 para acordar una cita previa o realizar las preguntas que desee.

HOJA DE INFORMACIÓN Y CONSENTIMIENTO INFORMADO

Para Padres / Representantes legales

TÍTULO DEL ESTUDIO: Análisis de movimientos y gestos durante la práctica del salto en cama elástica para el futuro diseño de interfaces interactivas.

A RELLENAR SÓLO POR LOS PADRES / REPRESENTANTE (de su puño y letra)

Yo (nombre y apellidos) _____,
con correo electrónico o teléfono de contacto _____,
en calidad de (relación con el participante): _____
de (nombre del participante):
_____

He leído y entendido la hoja de información que se me ha entregado.
He podido hacer preguntas sobre el estudio y se han contestado.
He recibido respuestas satisfactorias a mis preguntas.
He recibido suficiente información sobre el estudio.
Comprendo que la participación es voluntaria.
Comprendo que puedo retirarme del estudio:
1º. Cuando quiera.
2º. Sin tener que dar explicaciones.

Fecha:

Firma de los padres / representante:

_____

Template for performance in Game Phase.

APPENDIX 4

ID	Child/ Adult	Age	Gender	Tramp Exp	Freq in sport	Sport	N Jump	Movement	Meaning
XX	C	14	Male	2	3	Volley	1	Grouped	Be safe
XX	C	14	Male	2	3	Volley	2	180	Turn left
XX	C	14	Male	2	3	Volley	3	Lateral kick	Pound a rival

APPENDIX 6

Cuestionario de Participación

Edad: _____

Experiencia con trampolines:

☐	☐	☐	☐	☐
He saltado 1 vez anteriormente	He saltado menos de 5 veces en mi vida	He saltado menos de 15 veces en mi vida	Salto de forma habitual	Soy experto en salto de trampolín

Frecuencia con la que practica deporte:

☐	☐	☐	☐	☐
Practico deporte tan sólo de vez en cuando	Practico deporte quincenalmente de manera informal	Practico deporte semanalmente pero de manera informal	Estoy federado/a pero practico el deporte de forma amateur	Estoy federado/a y practico deporte de forma oficial e intensa

Tipo de Deporte:_____

1. El juego ha respondido a las acciones que he realizado.

☐	☐	☐	☐	☐
Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo

2. Los movimientos que he realizado me han permitido controlar el juego con naturalidad.

☐	☐	☐	☐	☐
Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo

3. He sido capaz de anticipar las consecuencias de las acciones de juego que he realizado.

☐	☐	☐	☐	☐
Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo

4. La experiencia de movimiento dentro del escenario de juego ha sido satisfactoria.

☐	☐	☐	☐	☐
Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo

5. La interacción con los diferentes objetos del juego ha sido adecuada.

☐	☐	☐	☐	☐
Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo

6. He experimentado retardo entre la acción realizada y el resultado esperado.

☐	☐	☐	☐	☐
Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo

7. Me he adaptado con rapidez a la dinámica del juego.

☐	☐	☐	☐	☐
Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo

8. A medida que avanzaba en el juego mi desempeño ha mejorado.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

9. Al finalizar el juego me he sentido físicamente cansado/a.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

10. Al finalizar el juego me he sentido mentalmente cansado/a.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

11. Al finalizar el juego me sentía con fuerzas para jugar de nuevo.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

12. Tras finalizar el juego he necesitado tomar un tiempo para recuperarme.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

13. He sido consciente de los eventos externos al juego que han ocurrido a mi alrededor.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

14. Me he sentido inmerso/a en el juego.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

15. Me he sentido tan involucrado/a en el juego que he perdido la noción del tiempo.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

16. Durante la actividad he estado completamente ocupado/a en el juego.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

17. He obtenido una puntuación mayor a la media.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

18. Tengo buenas habilidades para jugar a este juego.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

19. Se me ha dado bien el juego.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

20. No me siento satisfecho/a con cómo he jugado.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

21. El juego ha supuesto una experiencia desafiante para mí.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

22. El tiempo de juego no ha sido suficiente.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

23. El juego es muy difícil.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

24. No es necesario tener experiencia previa para jugar a este juego.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

25 Tras jugar tengo sensación de victoria.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

26. El juego me ha parecido divertido.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

27. Durante el juego me he sentido motivado/a a alcanzar una alta puntuación.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

28. Estoy orgulloso/a de cómo he jugado.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

29. Me siento peor que antes de haber jugado.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

30. Esta actividad ha sido una pérdida de tiempo.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

31. El juego es aburrido.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐

32. No recomendaría el juego a otras personas.

Totalmente en desacuerdo	En desacuerdo	Ni de acuerdo ni desacuerdo	De acuerdo	Totalmente de acuerdo
☐	☐	☐	☐	☐