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Abstract:

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Playing me, playing him: Embodying a player character and its effect on decision-making in video games

Master's programme for Medialogy 2019, 4th semester

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ABSTRACT

The goal of this project is to investigate if the sense of embodiment affects the decisions players makes in a video game. For this study, a game with decision-making as a primary component for two different platforms was created. One that is played on a standard PC setup and one that is played using a VR setup. Additionally, two different versions with varying degrees of narrativity was developed for each platform. This is done to investigate the effects of embodiment alone and to see if the addition of a narrative nullifies the potential effects of embodiment in this context. The study had a total of 72 participants and data was gathered on what decisions they made, why they made said decision as well as how difficult they found the decision. The findings suggests that the sense of embodiment has no significant effect on decision-making in video games. However, these findings lack the desired reliability and further investigation is therefore needed for a more conclusive answer.

Keywords

Embodiment, Sense of Embodiment, Decision-making, Choices, Video games, Virtual reality, Narrativity

1. INTRODUCTION

In 1971 the text-based video game *The Oregon Trail* [16] was released, and with it players were introduced to the concept of decision making in video games. Since then a plethora of games have been released which incorporates decision making of various degrees. These choices range from deciding on which way to go in an open world as seen in *The Elder Scrolls V: Skyrim* [4], to choosing between multiple consequence-heavy dialogue options in games like *Fallout 3* [3]. The degree to which these choices have an effect on the game and how often they are presented varies, but more often than not, these choices have a direct impact on the narrative. The use of choices in games are most commonly found in interactive novels such as *Choices: Stories You Play* [18] or interactive dramas and adventures games such as *The Walking Dead* [24] and *Until Dawn* [23], where decision making is the main mechanic and the consequences of these choices primarily has an effect on the narrative. Other games, such as the action-adventure game *Infamous* [22], have taken the consequences of these choices even further by having the player choose between committing good or evil actions, which in turn not only affects the story of the game, but also smaller details such as the physical appearance of the player character and how the populace reacts towards the player.

With the increase of video games using decision making as its main mechanic, it is not surprising to see authors conducting research in regards to decision making in video games. In 2017 Jakobsen M. et al. published their paper on "How Knowledge of the Player Character's Alignment Affect Decision Making in an Interactive Narrative" [12] their research found that when introducing information about the player character's inner thoughts and ideals, the player is more inclined to alter their behaviour and make decisions which deviates from the goal of the game. Although not concerned with video games, other researcher are increasingly making use of Virtual Reality (VR) as a platform for investigating moral dilemmas and decision-making [20, 9, 19]. This aforementioned system does however bring new considerations, such as its increased capability to facilitate a sense of immersion, presence and embodiment. These properties of a VR platform and their possible effect on decision-making is however not considered in the aforementioned research, bringing forth a need to investigate said properties to ensure the reliability of current as well as any future work in regards to VR and decision-making.

By surveying the field of VR a lack of research was found in regards to how it affects decision making. Within the research area of VR there are however three very common phenomenons often mentioned; immersion, presence and embodiment. Investigating how each of these concepts independently affects decision making would be out of scope for this paper. As an initial step towards understanding their effect on decision making, this paper investigates if an increased sense of embodiment can affect how players make choices in video games.

2. DECISION-MAKING AND EMBODIMENT

The following section covers what a choice is in the context of video games and how are they created and used. Additionally, it covers theory on what embodiment is and how this theory applies to video games.

2.1 Choices in video games

2.1.1 Meaningful Choices

Adding decision-making to a game can have a positive effect on appreciation. However, this only applies if the choices are perceived as meaningful [11]. But what makes a choice meaningful? Brice Morrison [1] stated that meaning-

ful choices consists of four components:

Awareness
Making sure that a player is aware that they are making a choice [1].

Gameplay Consequences
A choice should affect the gameplay or narrative, e.g. deciding between picking up two different items with individual abilities or siding with one of multiple characters in an argument affecting the future narrative [1].

Reminders
As the name suggests, the player is reminded of past choices in order to induce a sense of regret or pride in regards to said choice [1].

Permanence
The fact that a player cannot undo their choice after facing the consequences [1].

In research conducted by Dechering and Bakkes [6] they looked at two decision-making games, The Walking Dead and Life Is Strange, which contains choices fulfilling the four criteria mentioned above. They found that the most recurring themes of the meaningful choices revolve around sacrificing or killing non-player characters (NPC). This correlates with research conducted by Kremar and Cingel [14] who found that the majority of decisions made in video games were based on the moral foundation of harm/care. Decisions based on the remaining four moral foundations from most to least frequent are; authority/respect, fairness/reciprocity, in-group/loyalty and purity/sanctity [14]. Additionally, a literature review conducted by Iten et al. in 2018 [11], found that meaningful choices are not only about the moral and ethical dilemmas that significantly affect the course of the game, but also the choice itself. An example of this, as given by Iten et al. [11], can be found in the telltale game The Walking Dead [24] where the player must choose how to let a wounded animal die, either by letting it suffer and slowly die or kill it quickly. Here the meaningfulness lies within the choice itself as the outcome is the same. Besides the aforementioned aspects of what makes a choice meaningful, it is mentioned that from "an educational and psychological perspective, choices are considered meaningful when people can decide autonomously", meaning that a person needs to understand what the potential outcomes of a choice is before it can be experienced as meaningful [11].

2.1.2 Types of Choices

Besides the importance of how to make choices meaningful, it is also important to understand what type of choices are used in video games. Stacey Mason [15] suggests that there are two different types of choices in an interactive narrative, namely diegetic choices and extra-diegetic choices: "diegetic choices are those that a player makes as a character or presence within a story world that affect story, while extra-diegetic choices are those that a reader makes as a removed observer that affect discourse." [15] This would suggest that most, if not all, video games introduces diegetic choices. However, as suggested by Formosa et al. diegetic choices can be further divided into two different types of choices; the systemic choices and the scripted choices. The systemic choices are related to the game mechanics and is more or less hidden from the player such as the reputation scale in Infamous [22]. In contrast, the scripted choices are usually presented as a crossroads moment where the player has to decide between two or more choices affecting the story and often resulting in a branching narrative, e.g. to save or to kill a character [8].

2.2 Embodiment

In 2012 Kilteni et al. [13] wrote a paper regarding the sense of embodiment in VR. In their review of literature on embodiment they address the fact that the term embodiment is used within many research areas and, therefore, is referred to differently within these disciplines. Kilteni et al. [13] then refers to embodiment as "sense of embodiment" (SoE) and adopts the definition: "SoE toward a body B is the sense that emerges when B's properties are processed as if they were the properties of one's own biological body." Additionally, based on their literature review, they found that embodiment is frequently associated with the sense of self-location, sense of agency, and sense of body ownership, which are all properties of one's biological body [13].

2.2.1 Self-location

Kilteni et al. [13] refers to sense of self-location as one's spatial experience of being inside a body. Furthermore, they make a clear distinction between self-location and presence, with self-location being the relationship between one's self and one's body and presence being the relationship between one's self and the environment. A given example of self-location is when one feels that one's self is located inside a biological body or a virtual avatar [13]. Self-location is determined by the visuospatial perspective and research have shown that the perspective of a person (either first- or third-person perspective) influences physiological responses to threats, with first-person perspective causing the measurement to be greater [17].

To enhance the sense of self-location one should place the origin of the visual perspective to a first-person perspective of the player character, and it can then be further strengthen through visuotactile correlations [13].

2.2.2 Agency

Sense of agency is the sense of having motor control, including the subjective experience of action, control and intention. Gregersen et al. [10] mentions the difference between minimal actions such as the movement of a finger pressing a button resulting in the avatar jumping, and maximal actions such as the full swing of an arm resulting in serving a tennis ball. In both cases there is a sense of agency. The degree is however depended on how the physical action of the user maps to the virtual avatar from minimal to maximal. This is further supported by Kilteni et al. [13] who states that "the development of agency depends on the synchronicity of visuomotor correlations" and that studies have shown that the feeling of agency is affected negatively when the visual feedback and the actual movement does not correlate. Research by Steptoe et al. [21] suggests that the sense of agency and body ownership also extends to parts or limbs which a normal human body does not have, such as tails and wings. Through their research they tested a group of participants experiencing no agency over their body extension,

i.e. the tail would move at random, versus a group with agency over their body extension, i.e. by moving their hip. It was found that the visuomotor synchrony, or increased agency over the tail through hip movement, induced a more convincing perception of body ownership.

To enhance the sense of agency the temporal difference between one's actions and the visual feedback should be lowered i.e. strengthen visuomotor correlations. The sense of agency is therefore especially strong in VR where motions such as head movement and controller movement are tracked and mapped to the virtual body [13].

2.2.3 Body ownership

Sense of body ownership refers to one's self-attribution of a body and emerges from a combination of top-down and bottom-up influences. Bottom-up refers to information that arrives to our brain from sensory organs, e.g. tactile and visual input, and top-down refers to the cognitive processes that influences the processing of sensory stimuli, e.g. existence of human likeness in an artificial body causing one to presume it as being one's own body. Studies have found that the sense of body ownership can be strengthen depending on the similarities between the real and "fake" body and the spatial configuration between them, as well as visuotactile correlations between the real and the "fake" body/limb [13].

To enhance the sense of body ownership one can synchronise the haptic and visual stimulation between the physical and virtual body. Body ownership can also be enhanced by maximizing the visuomotor correlation between one's physical body and the virtual body [13]. This is supported by another study which found that a perceived difference in the sense of agency and body ownership does not occur before the delay is greater than 125ms [25].

2.3 SoE in Decision-Making Games

As mentioned in section 2.1.2 video games primarily introduces scripted and systemic choices. To get an idea of the degree to which commercially available video games with scripted and systemic choices induce a sense of embodiment, this section looks at some of the newer and well received games through the lens of the proposed subcomponents; self-location, agency and body ownership.

2.3.1 Choices: Stories You Play

Visual novel games such as Choices: Stories You Play [18] usually presents the user with scripted choices in the form of text-based dialogue or action options. In visual novel games it is very common to present the user with a visual representation of the player character they are in control of, while maintaining a spectator view of the scene. This game view does not allow for the player to see the world through the player characters eyes and the sense of self-location in regards to the virtual avatar is not enhanced and transferred into the virtual world, but stays in the real world tied to your own biological body. Although the visual novel genre provides great control over the narrative through scripted choices, the sense of agency is practically nonexistent as the player does not have any control over the movements of the character. The player might control where the character goes through scripted choices, but this movement is then a consequence of the choice made by the player and not the result of a physical action from the player being mapped to the virtual character. Finally, the player may get the option of customizing the visual representation of the player character. This might help in identifying with the character, as the player can match qualities such as gender and hair colour to that of their own. However, it does not create a sense of body ownership. Based on these observations, it can be concluded that the SoE in visual novel games is very low at best.

2.3.2 Until Dawn and Life is Strange

Examples of video games that, in comparison to the visual novel games, induce a higher SoE are games such as Until Dawn [23] and Life is Strange [7]. Similarly to Choices: Stories you Play, the choices available to the player in Until Dawn and Life is Strange are predominantly scripted choices and each decision you make has consequences on how the story unfolds. The choices one can make in Life is Strange and Until Dawn is often presented as text-based option and the decision is made by the click of a button. Adventure games like these, which incorporates decision making as their primary mechanic, are usually played in a third-person perspective resulting in the sense of self-location related to the player character being low to non-existing. However, a player is able to move around in the virtual world by means of a game controller or mouse and keyboard, previously described as minimal actions, which increases the sense of agency slightly compared to the visual novel games. The sense of agency is, however, still low since the player is only given control over the character through minimal actions such as moving a thumbstick to make the character walk and interacting with objects that is specifically related to the story by the click of a button. As these games are not designed to enhance the sense of body ownership, combined with the sense of self-location and sense of agency being low overall, results in a low SoE in these games albeit higher than visual novel games.

2.3.3 The Elder Scrolls V: Skyrim and Fallout 4

Games, such as The Elder Scrolls V: Skyrim [4] and Fallout 4 [5], often contains both scripted and systemic choices both affecting the course of the game. An example of a systemic choice can be found in Skyrim where one is able to kill characters who would later give the player a quest. As a consequence of killing them the quest is no longer obtainable, thereby changing the course of the game. Furthermore, what is often seen in role-playing games in general are concepts such as skill-trees in which players can decide to strengthen specific traits, such as luck or perception, which can then affect the outcome of occurring events. Unlike the other games previously mentioned, games like Skyrim and Fallout 4 gives the player the ability to choose between playing with a third- and first-person view, which means it is up to the player to decide if they wish to enhance the sense of self-location by playing with a first-person view. Furthermore, mechanics such as jumping, fighting and dodging are often seen in action role-playing games which, even though they afford the player greater control over the actions of the player character, are still considered minimal actions, and therefore does not increase the sense of agency any further. Since these types of games are usually played with either game controllers or mouse and keyboard the visuomotor cor-

relation is limited to aspects such as moving the thumbstick forward on a controller resulting in the character walking forward as well. Similarly, the visuotactile correlations are limited to vibrations of the game controller corresponding to event happening in the game. This means that the sense of body ownership is low if apparent at all. However, with the possible increase in regards to the sense of self-location the overall SoE, at least compared to the previously mentioned games, is higher, but still very limited.

The aforementioned games (Skyrim and Fallout 4) have both been ported to VR. In these versions the player does not just experience the game through a first person perspective, but combines that perspective with a head mounted display allowing for the player to experience the illusion of being inside the body of the player character and seeing the world through their eyes, which effectively enhances the sense of self-location. The sense of agency is also further enhanced as the player now controls many aspects of the player character through maximal actions, e.g. the camera view is controlled with head movements and the movement of hands and held items of the player character are controlled by physically moving the controllers around. Unlike the PC versions, a sense of body ownership is induced as the visuomotor correlation are being maximized. However, the degree to which this sense of body ownership is induced can be questioned as the visual representation of the virtual body is very limited in these games. In Fallout 4 VR, the weapons held, although controlled by the player, are merely floating in the air. The same experience is found in the VR version of Skyrim, but in this game the player is given virtual hands when wielding magic. Whether the presence of these virtual hands further enhances the sense of body ownership depends on the individuals experience of the similarities between the real and virtual hands [13].

The observations made across the different games, which incorporates decision-making, clearly suggests that the SoE can be enhanced by the way the content is designed and developed, e.g. by implementing a first-person view. It is however also found that the system on which the game is being played has an even larger impact on the SoE. Using a fully immersive VR system allows for an enhanced SoE unobtainable by other systems such as consoles and PCs alone.

2.4 Research Question

From the information gathered and presented in this section, it is clear that many games incorporates decision making to various degrees. It was also found that the three components of the SoE are on the lower end of the spectrum for most commercially available PC games and that the SoE is heightened when a game is played in VR. This leads to the research question for this paper:

How does an enhanced sense of embodiment affect decision-making in video games?

3. DESIGN & IMPLEMENTATION

To answer the problem formulation four different versions of the same game were developed. One version, which is meant to induce a low SoE, was developed for a regular PC setup using a PC monitor and mouse and keyboard to control the player character. The second version, which is meant to induce a greater SoE, was developed for the HTC VIVE using the HMD and VIVE controllers for controlling the player character. Each of the two versions will have a version with high narrativity and low narrativity. The four versions created are then:

- PC + high narrativity
- PC + low narrativity
- VR + high narrativity
- VR + low narrativity

The reason for including different levels of narrativity is because, as previously mentioned, many if not all video games created with choices as a primary component have a high narrativity. Adding to that, a study conducted by Paul Zak [26] found that a simple narrative that follows the dramatic arc can evoke powerful empathic responses in people, which then result in actions such as donating money. Lack of a dramatic arc results in the opposite. Namely, the absence of said actions. It is therefore important to investigate if the possible impact of a heightened SoE is affected by the level of narrativity when making decisions in video games or if the degree of the SoE has a measurable impact alone.

In the following sections the design of the game and the difference in SoE between the two versions are presented. A more detailed description of the development of the game, such as code and animation documentation, can be found in the worksheets.

3.1 Game Design

In this section the design of the game is presented. The section is split into four subsection, (1) tutorial, which describes the tutorial of the game, (2) dog room, (3) underwater room and (4) blender room, which are the three rooms the player goes through after completing the tutorial.

3.1.1 Tutorial

When the game starts the player is introduced to a tutorial in which they will learn how to interact in the game. The interactions are explained in such a way that they apply to both the PC and VR version. In the low narrativity version the auditory narration is a generic robotic voice explaining the tutorial with short sentences. In the high narrativity version the auditory narration is explaining the tutorial in relation to a setting and a story; namely, that the player has just woken up in a laboratory after taking a blow to the head and is now going through a tutorial to see "whether their cognitive abilities are still intact". The auditory narration was made to resemble a mad scientist performing an experiment on a human subject (the player).

3.1.2 The Three Rooms

After the tutorial is over the player will be able to enter one of the three rooms; the dog room, the underwater room or the blender room. There is a total of 6 different orders that the room can be loaded. In each of the three rooms the player is left with the decision between (a) an altruistic choice or (b) a selfish choice. The choices designed for this experiment are scripted choices that focuses on the moral

foundation of harm/care, since it was found to be the most reoccurring theme for decision making in video games as described in section 2.1.1.

In the dog room, the player finds a dying dog lying on the floor whining in pain and next to the dog is a knife (see Figure 1). The player is then presented with the choice of either (a) ending the dog's suffering by killing it with the knife or (b) proceeding to the next room and leaving the dog to die slowly and painfully.

Figure 1: The dog room as presented to the player in the PC versions.

In the underwater room, the player finds a body of water and a lift that can be used to enter said water (see Figure 2). The player is given the options of either (a) saving a woman who is located at the bottom of the pool of water with a shark circling around her or (b) proceeding to the next room.

Figure 2: The underwater room as presented to the player in the PC versions.

In the blender room, the player finds a man in a glass cage and a blender in front of the cage (see Figure 3). The player has the options of either (a) blending their hand until the blender is filled with blood or (b) proceeding to the next room.

Figure 3: The blender room as presented to the player in the PC versions.

Whether the player decides to perform the actions required for the altruistic option (a) or proceed to the next room (b) has no consequences on the game itself but the difference lies in the feelings that the player may be left with based on their decision (e.g. fear or guilt). After having been through all rooms, the player is told that the experiment was all a simulation and that it is now finished.

Just like in the tutorial, the voice-over of the low narrativity version is a robotic voice presenting the choices in a short sentence, whereas the voice-over of the high narrativity version is an acted voice presenting the choices in relation to a story about the dog, a story about the woman in the water and a story about the man in the cage. These stories about the dog, the woman and the man are presented to the player on an in-game cinema screen before being presented with the choices in the high narrativity version (see Figure 4). This was done in order to add some background story to the NPC in the room and create a dramatic arc with the choice being the climax. All narration and text present in the game is in English.

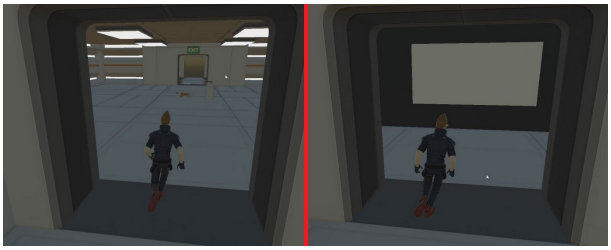

Figure 4: (Left) The player will enter the room with the choices immediately present in the low narrativity version. (Right) The player will be presented with a cinematic story about the NPC before being presented with the choices.

It is imagined that the sense of agency plays a major role in the dog room, due to the unpleasant feeling it may evoke being able to kill the dog with heightened agency (in the VR version). The sense of self-location is imagined to play a major role in the underwater room, due to the unpleasant feeling it may evoke being submerged in water with a shark (in the VR version). And, finally, the sense of body-ownership is imagined to play a major role in the blender room, due to the unpleasant feeling it may evoke sticking your hand in a blender (in the VR version). One should of course keep in mind that the sense of agency, self-location

and body-ownership are all intercorrelated and it is not to say that the player will not experience sense of self-location or body ownership in e.g. the dog scene, but merely that the sense of agency is imagined to play a major role in the decision making for that specific room.

3.2 Differences in SoE

In this section the differences in SoE between the PC version and the VR version is discussed.

3.2.1 Sense of Self-location

The PC version of the game has a forced third-person view, which, combined with the user playing the game on a PC monitor, ensures that the sense of self-location is kept to a minimum. The VR version has users playing the game from a first-person perspective and by using an HMD, their spatial experience of being inside the body of the player character is enhanced, in turn enhancing the sense of self-location.

3.2.2 Sense of Agency

To further widen the gap of SoE between the two designs, the sense of agency is kept at a minimum for the PC version where the player character is controlled with a mouse and keyboard, which are considered minimal actions. In contrast, the player character in the VR version is controlled with maximal actions through an HMD and motion tracking controllers, which directly maps the head- and hand movement of the physical body to the virtual body and thereby creating a greater sense of agency.

3.2.3 Sense of Body Ownership

Due to the limitations of the study, the degree to which the player experiences a sense of body ownership will mainly be determined based on the visuomotor correlations. It is imagined that the enhanced sense of self-location and agency could have an effect on the sense of body ownership as mentioned by Kilteni et al. [13]

Since the PC version is played with a third-person view, a visual representation of the player character is available with this platform. The VR version on the other hand is played using a first-person perspective and tracking is limited to head and hands, therefore the visual representation of the player character is limited to the hands. This is done in order to avoid any mismatch of spatial positioning between the physical and virtual body, which would decrease the sense of body ownership.

By limiting the experience of the three subcomponents for the PC version, while enhancing them for the VR version, the SoE is expected to be vastly different.

4. EVALUATION

This section describes the method and procedure of the experiment as well as the demographic information gathered from the participants. As the last part of this section, the results of the experiment is presented.

4.1 Method

As mentioned in section 3 there is a total of four treatments:

- PC + high narrativity
- PC + low narrativity
- VR + high narrativity
- VR + low narrativity

In each of the four treatments the participant was be exposed to a tutorial and three different rooms with two choices in each. Each of these rooms are independent of one another, which allowed for a randomized order of the presented choices. There is a total of 6 orders, including:

- The dog room, the underwater room, the blender room
- The dog room, the blender room, the underwater room
- The underwater room, the dog room, the blender room
- The underwater room, the blender room, the dog room
- The blender room, the dog room, the underwater room
- The blender room, the underwater room, the dog room

This was done in order avoid the possibility of the previous rooms having an effect on the decision making in the following rooms.

During the experiment the system logged the participants decisions (altruistic or selfish) which was also noted on a sheet of paper during testing. The choices were logged and noted as points for each room, where zero points for an altruistic choice and one point for a selfish choice was given. In addition, each participant's playthrough was screen recorded as well as recorded in real life.

To analyse the results, various comparison between the means of the noted points across all of the four treatments was made. The Student's T-Test was used to compare the means to tell whether there is a difference in the mean and to tell how significant the difference is. For all of the comparisons the null and alternative hypothesis will be as follows:

H0: The means are the same.

HA: There is a difference in the means.

A two-tail test will be used, since the alternative hypothesis suggests that there is a difference in the means and not to which direction (higher or lower), with a significance level of 0.05.

4.2 Participants

A total of 72 participants participated in the evaluation. Out of those, 58 were male and 14 were female. The age ranged between 20 and 37 with and average of 24 (SD=2.49). In the demographics questionnaire the participants were asked about their first language, resulting in: Danish (63), Arabic (1), Czech (2), German (2), Hungarian (1), Polish (1), Romanian (3), Ukrainian (1). Participants were also asked about their average time playing video games, resulting in: 52.8% every day, 30.6% a few times a week, 9.7% a few times a month, 1.4% less than a few times a month and 5.6% never. Additionally, they were asked about how many times they approximately spent in VR, resulting in a range from 0-100 hours with an average of 20 hours (SD=30.31).

4.3 Procedure

The participants were first asked to sign a consent form, which would allow for recording during testing, followed by a demographics questionnaire that they were asked to fill out. Once everything was filled out the participant was informed about the experiment and how to navigate in either the VR or PC version. Once the participant went through one of the treatments they were asked to fill out a questionnaire regarding what decisions they made, how difficult they found the decision and why and how they made the decision.

The setup of the evaluation can be seen in Figure 5 and Figure 6.

Figure 5: The room in which the evaluation took place. The participant filled out questionnaires on the right-most laptop and then played either the PC version on the left-most laptop or the VR version on the empty space to the left.

Figure 6: Participant playing the PC version while being recorded.

4.4 Results

As previously mentioned, various comparisons across the four treatments will be made. Each comparison is analysed in the following subsections. These results will be further discussed in section 5.

4.4.1 PC vs. VR

When comparing the mean values of the points from the PC treatment (0.5) against the VR treatment (0.69) there seems to be a difference (see Figure 7). However, when using a Student's t-test, it becomes evident from the comparison of the t-stat (-1.24) and t-critical value (1.99) that, although there is a difference between the means, this difference is not significant. Furthermore, the P-value (0.21) indicates that these results could have been obtained by chance and is therefore not reliable enough to make a final conclusion on whether the increase in SoE from PC to VR changes the players tendency to make a selfish choices over an altruistic one.

	PC	VR
Mean	0.5	0.69444
Variance	0.48571	0.38968
Observations	36	36
t-Stat	-1.24694	
P(T<=t) two-tail	0.21664	
t-critical two-tail	1.99495	

Figure 7: A Student's t-test run on the comparison of PC and VR.

4.4.2 Low narrativity vs. High narrativity

The same method for analysing the results of the low narrativity treatment against the high narrativity treatment was used, and the results mirrors what was found in the analysis of the PC versus VR treatment. That is to say, the means are different, but this difference was not found to be significant nor are the results reliable enough to reach a conclusion on whether the low or high narrativity changes the players tendency to make a selfish choices over an altruistic one (see Figure 8).

	Low	High
Mean	0.666667	0.52778
Variance	0.457143	0.42778
Observations	36	36
t-Stat	0.885863	
P(T<=t) two-tail	0.378724	
t-critical two-tail	1.994437	

Figure 8: A Student's t-test run on the comparison of Low narrativity and High narrativity.

4.4.3 Further comparisons

Although it was found that there is no significant difference between the systems (PC and VR) and the levels of narrativity (Low- and High narrativity), it would be interesting to narrow the comparison further to see whether there is a difference in:

- PC - Low narrativity vs. VR - Low narrativity
- PC - High narrativity vs. VR - High narrativity
- PC - Low narrativity vs. PC - High narrativity
- VR - Low narrativity vs. VR - High narrativity

Each of the four comparison shows a difference in means that are not significant and the P-values also indicates that

the results could be obtained by chance, rendering them unreliable (see figure 9).

	PC - Low	VR - Low
Mean	0.61111	0.72222
Variance	0.60458	0.33007
Observations	18	18
t-Stat	-0.48761	
P(T<=t) two-tail	0.62926	
t-critical two-tail	2.03951	

	PC - High	VR - High
Mean	0.388889	0.66667
Variance	0.369281	0.47059
Observations	18	18
t-Stat	-1.28596	
P(T<=t) two-tail	0.207146	
t-critical two-tail	2.032245	

	PC - Low	PC - High
Mean	0.61111	0.38889
Variance	0.60458	0.36928
Observations	18	18
t-Stat	0.95538	
P(T<=t) two-tail	0.34655	
t-critical two-tail	2.03693	

	VR - Low	VR -High
Mean	0.722222	0.66667
Variance	0.330065	0.47059
Observations	18	18
t-Stat	0.263416	
P(T<=t) two-tail	0.793868	
t-critical two-tail	2.034515	

Figure 9: A Student's t-test run on the comparison of the system (PC and VR) and the level of narrativity (Low- and High narrativity)

5. DISCUSSION

In the following sections the results, evaluation method and design and implementation will be discussed, as well as ideas for future work.

5.1 Discussion of results

From the results of the experiment it is not possible to say whether the difference in SoE or narrativity had any impact on a participant's decision between a selfish and altruistic choice. However, in the post experiment questionnaire, the participants were asked to rate the difficulty of the choice in each room on a scale from 1 (very easy) to 5 (very hard). The general trend found here when observing the means of the difficulty across the different treatments, is that the treatments involving VR were found more difficult than the treatments involving PC (see figure 10 & 11 & 12).

Dog Room	PC	VR
Mean	1.638888889	2.527777778
Variance	0.694444444	2.027777778
Observations	36	36
t-stat	-3.23248814	
P(T<=t) two-tail	0.002058422	
t-critical two-tail	2.003240719	

Figure 10: A Student's t-test run on the comparison between VR and PC on how difficult it was to make the decision in the dog room.

Underwater Room	PC	VR
Mean	1.944444444	2.305555556
Variance	1.025396825	1.475396825
Observations	36	36
t-stat	-1.37010286	
P(T<=t) two-tail	0.175161566	
t-critical two-tail	1.995468931	

Figure 11: A Student's t-test run on the comparison between VR and PC on how difficult it was to make the decision in the underwater room.

Blender Room	PC	VR
Mean	2.027777778	2.722222222
Variance	1.684920635	2.034920635
Observations	36	36
t-stat	-2.16036212	
P(T<=t) two-tail	0.034220193	
t-critical two-tail	1.994945415	

Figure 12: A Student's t-test run on the comparison between VR and PC on how difficult it was to make the decision in the blender room.

These differences are found to be significant in regards to the dog room and blender room, but not for the underwater room. However, when comparing the low narrativity treatments against the high narrativity treatments for the underwater room, it is found that the choice was more difficult in the low narrativity treatments (mean = 2.388) than the high narrativity treatments (mean = 1.861). When comparing the means using a Student's t-test, the difference is found to be both reliable and significant (see figure 13). Since this difference is only seen for the underwater room, it is speculated that the story for this room might have been more effective in promoting empathy for the NPC than the other two stories. Additionally the story for the underwater room presents the NPC as capable of saving many other people, which is an incentive that the stories in the other two room does not give the player. This could further explain why a significant difference was found in difficulty between platforms for the dog and blender room, but not the underwater room. A full overview of all comparisons can be found in appendix B.

Underwater Room	Low	High
Mean	2.388888889	1.861111111
Variance	1.273015873	1.151587302
Observations	36	36
t-stat	2.033677182	
P(T<=t) two-tail	0.045776216	
t-critical two-tail	1.994437112	

Figure 13: A Student's t-test run on the comparison between low and high narrativity in regards to how difficult it was to make the decision in the underwater room.

The participants were asked to wear an Empatica E4 wristband for the purpose of collecting physiological measurements during the playthrough. Technical difficulties however prevented proper data from being collected consistently and so these measurements have been excluded from the project.

It is imagined that this data would have given a better understanding of the results of the experiment, as there could have been a correlation between the physiological responses and choices or narrativity. It is therefore recommended that any future experiments aiming to get a better understanding of SoE and its impact on decision making should consider different ways of obtaining such data.

5.2 Discussion of evaluation method

Participants for this experiment was gathered from around the Create building at Rendsburggade 14 9000 Aalborg Denmark. This location is primarily allocated for students studying at Aalborg University. As is evident from the results of the demographics questionnaire, this approach to gathering participants resulted in a very unequal distribution of participants who play video games daily versus participants who played less frequently. Since many participants answered the post questionnaire with statements such as "it is only a game", it raises the question of whether participants who play video games daily viewed the game experience differently, e.g. by finding it easier to separate the game from reality compared to the other participants. Besides the frequency of which the participants play video games, there is also a large discrepancy in the amount of time each participant had previously spent in VR.

These factors could have had an effect on their decisions during the experiment, and it is therefore recommended to narrow down the sampling frame, i.e. ensure that all participants have roughly the same experience playing video games, the same amount of time spent in VR and all participants having the same first language.

Besides the design and implementation of the game itself, there is also the question of how the context in which the participants played the game might have had an effect on their choices. The presence of a camera and the two facilitators might have had an impact on their behaviour in the game. If they felt like they were being judge by their decisions, a participant might have chosen the altruistic choice out of fear of being judged by the facilitator as an immoral person. A way of avoiding this possible influence, one could ensure the participants that there is no right choice as well as inform them that the facilitators will leave the room during the session for total privacy.

5.3 Discussion of design and implementation

A reason why the majority made altruistic choices could be due to the lack of consequences, as argued as being one of the four components that makes a choice meaningful. For example, when a participant would first go through the room in which they had to sacrifice their hand to save a man and decided to do so, they realized that the in-game model of the hand was still present and unharmed. This could have led them to believe that putting yourself through danger and discomfort had no further consequences. Participant would directly state, in their elaboration on why and how they made their decision, that "because the hand didnt disapear, i didnt really feel any impact" and "it was only a computer simulation, i didn't count in real harm to myself." Another reason for why mainly altruistic choices were made could be due to having no incentive for making a selfish choice. Participants would state in their elaborations that "I know there is no real damage done to me, and i was curious how/if the game would change" and "For, fun, waned to see how the game interacted with my motion". These statements suggests that participants curiosity was a dominant factor in their decision-making. By adding consequences to the game, such as actually losing your simulated hand to the blender, or a reward for making selfish choices, such as points, could add incentive to make a selfish decision. However, the game was designed in such a way that the context of the altruistic choice was presented as uncomfortable or dangerous, e.g. being underwater and close to a hungry shark, and the incentive for the selfish choice therefore lied in avoiding this discomfort.

Looking through the responses on why and how participants made their decision, a large amount of the responses states that it was the right thing to do, i.e. due to being morally correct. An equally large amount of the responses relates to the fact that it was "only a game" and "not real". These responses suggests, alongside the fact that the vast majority made altruistic choices, that the game is not realistic enough. To make the game seem more realistic, especially for the VR implementation, one could utilize newer technology such as Valve's Knuckles [2]. Knuckles are controllers that supports finger tracking, which arguably can increase the sense of agency and sense of body ownership. Another way to increase the realism could be to implement visuotactile feedback, such as vibration in the controllers when a participant sticks their hand in the blender. This would increase the sense of body ownership. To add further realism, one could implement a virtual body, which arguably could further enhance the sense of self-location, due to the visual illusion of being inside a body. This could, however, not be implemented due to limitations of the study and the pricing of current solutions for a fully functional VR body. As mentioned in section 3.2.3, it could also result in a mismatch between the real and the virtual body which, in turn, lowers the sense of body ownership. Though there are several ways to reach for more realism, one can speculate whether VR can ever become "real enough" or if a person will always be consciously aware of being inside a simulation.

5.4 Future works

To obtain more reliable results in future studies on SoE regarding decision-making, it is adviced to consider previously mentioned changes such as properly obtaining physiological measurements, let participants play in privacy, let choices have consequences if applicable and, lastly, further enhance the SoE.

Even though many games introduce moral dilemmas that often presents options of selfish and altruistic nature, many other types of choices are made in video games, such as what playstyle to use e.g. melee or ranged, or even more trivial decisions such as choosing between walking down a dimly lit hallway versus a brightly lit hallway. It would therefore also be interesting to see if such choices in regards to gameplay are affected by the SoE. However, before this can be done, proper methods for evaluating such questions need to be explored.

6. CONCLUSION

To better understand if playing a video game using a VR device instead of a standard PC setup could have an affect on decision making in video games, one of the properties closely related to VR, namely the sense of embodiment, was investigated to answer the following research question:

How does an enhanced sense of embodiment affect decision-making in video games?

In an attempt to answer this, two versions of a game were created. One with a low SoE played on a standard PC setup and one with a heightened SoE played using a VR setup. Both of these games had two versions, one with low- and one with high narrativity. To tell whether SoE has an effect on decision-making, participants were presented with two choices, one being altruistic but requiring the participant to engage with an uncomfortable or potentially dangerous scenario and a selfish choice which allowed the participants to avoid said discomfort. With a total of 72 participants across all treatments no significant difference were found in the participants' decisions between selfish and altruistic choices, with the majority making altruistic choices. The only significant difference found was in regards to how difficult it was to make a choice in the dog and blender room between the two mediums, as well as the difficulty in the underwater room between the two levels of narrativity.

Based on the findings, an enhanced SoE does not affect decision-making in video games. However, these findings lack the necessary reliability in its current state and further investigation therefore needs to be undertaken to properly answer this question.

An important point to add is that the behaviour of the participants did not align with their feelings for each of the choices. Several participants explained in the post experiment questionnaire that they would never make the altruistic choice in real life even though they did make that choice in the game. This could be caused by the fact that the participants were playing a game and therefore many adopted an exploratory approach to the experiment, i.e. trying every interaction and testing the limitations of the game. The realism of the graphics and entity responses could be a contributing factor, but it seems very likely that knowing it is a game alters their behaviour in a way that minimizes the impact an increased sense of embodiment would otherwise have on decision-making. However, seeing as participants found the decision to be harder in VR for two of the three rooms, it would indicate that the sense of embodiment does make a difference in the individuals emotional responses, but not to an extend that alters their behaviour.

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APPENDIX

A. NARRATION SCRIPTS

A.1 Script for high narrativity version

A.1.1 Intro/Tutorial

After baseline measurment
clears throat "I'm glad to see you are finally awake. I hope you slept well.. even though that blow to your head might have been.. uhm *clears throat again* too rough. In any case, this research is very important. So, why don't we start with seeing if your cognitive abilities are still intact!"

Walking:
"Now, let's see if you can still, erh, walk. Just try and walk around a bit."

Door + lift:
"Good. You need a code to unlock the door. You can find the code upstairs. Take the lift to get upstairs"

Unlock door:
"Very good. See the code? Now get back down and use the code to unlock the door"

After unlocking:
"Fantastic. Seems like everything is intact. Let the experiments begin!"

A.1.2 Dog

"I would like to tell you a little story about Fluffy. Fluffy was born in a shelter. One day Fluffy was adopted by Billy and Fluffy was very excited to see his new home. Fluffy loved his new life. He got to walk every day. Eat his favorite food every day. Play with his favorite toys every day. But as time went by, Fluffy's life seemed to go downhill. Billy started spending each night away from Fluffy. Oftentimes Billy would get home drunk and yell at Fluffy. Fluffy didn't know what was happening, but tried his very best to help Billy. But Billy didn't seem to care. He would hit Fluffy. And Fluffy had no idea why... Finally, one day Billy seemed to appreciate Fluffy's help. So much, in fact, that Billy would feed Fluffy his favorite food. Yummy! Unfortunately, Fluffy did not feel so well after eating all of his food. In fact, Fluffy got really really sick. And as it turns out, Billy had poisoned the food and Fluffy.. could not.. be saved"

Projector turns off, lights turn on

"And nooow Fluffy is here. Look at him.. Poor Fluffy. Now, I know this is all veery sad. But you, my friend, is now left with two choices. You can either leave Fluffy be and let him die slowly and painfully by exiting this room through that door.. or, you can pick up this knife and end his suffering quickly. Either way, Fluffy is going to die. But how? The decision is yours."

" *cough cough* Kill Fluffy or exit the room"

A.1.3 Underwater

"This is Jane, Jane is an only child who grew up with two loving parents Tom and Judy. For the most of her younger years she was the center of attention and she loved her parents very much.

On the day of Jane's 18th birthday her parents Tom and Judy had planned to surprise her with a very large birthday cake from the cake palace. The cake was indeed so large that it would take both Tom and Judy to carry it. Unfortunately on their way back from the cake palace an elderly driver had in a moment of confusion started driving against the flow of traffic. The elderly driver crashed straight into Tom and Judy's car. Tom lost his life and Judy was in a coma for 3 years before her heart gave in.

Jane was utterly crushed by the loss of her parents. She wished that she could have somehow rescued them. That's when she decided to pursue a medical education to help others, and now 20 years later, she is the world's leading brain surgeon. She has saved many lives and has the potential to save many more."

Projector turns off and lights turn on

"aaand..right now Jane is located in a cage at the bottom of the pool in front of you. She only has enough air for 10 minutes, after which she will drown. The code to unlock the cage is at the bottom of the pool. You could of course also just leave through the exit. I mean, you have no personal connection to this woman nor does she have any friends or family left."

when player walks

“Oh and should you choose to save her then.. *giggles/laughs* look out for the shark, it hasn’t eaten in quite while.”

“ *cough cough* Get into the water and save her or exit the room”

A.1.4 Blender

“Here you see John. John is a loving father who lives at home with his wife and their two kids. Every morning, John drives his kids to school. Every evening, he cooks for them and come night time, he tucks them in and tells them a bedtime story of their choosing. Sadly, everything isn’t purely sunshine and rainbows, Johns wife is very ill and she is in no condition to take care of the kids by herself.”

projector turns off and lights turn on

“As you can see John is trapped in the glass box in front of you. I bet you want to save him and be the hero that reunites him with his family, huh?? but how far are you willing to go to save him? You see, the way this little contraption works is that the glass box and blender is connected, and only by filling the blender with blood will the box be lifted. So to free John you have to make a sacrifice. You must stick your hand in the blender so that the blood from your injury can fill it. If all of that is a bit too much for you.. I know it would for me.. you could of course just take the exit and leave him behind, in which case the box will fill with deadly gas. The choice is yoOOURrs!“

“*cough cough* Hand in the blender or exit the room”

A.1.5 Ending

“Thank you very much for participating! What a ride, huh? To ease your mind you should know that no one was actually hurt. This was all a simulation! *laughs* But how fun was that. I mean, you should have seen your face. *wraah* Oh well, uhm. That was all. You can go now. Bye bye.”

A.2 Script for low narrativity version

A.2.1 Tutorial

“Thank you for waiting. Welcome to the tutorial”

Walking:
“Please try and walk around a bit”

Door + lift:
“To unlock the door you need a code. The code is upstairs. Use the lift to get upstairs”

Unlock door:
“Unlock the door by entering the code from upstairs. The code was 123”

After unlocking:
“Now enter the room. The tutorial is now over.”

A.2.2 Dog

“Kill the dog using the knife or proceed to the next room”

A.2.3 Underwater

“Save the woman from the shark in the pool or proceed to the next room”

A.2.4 Blender

“Blend your hand and save the man or proceed to the next room”

A.2.5 Ending

“Thank you for participating in this virtual simulation. Please take off your headset”

B. RESULTS

This appendix contains all comparisons made for all versions e.g. amount of selfish choices made and the difficulty of individual rooms across different versions.

B.1 Amount of selfish choices

	PC	VR
Mean	0.5	0.69444
Variance	0.48571	0.38968
Observations	36	36
t-Stat	-1.24694	
P(T<=t) two-tail	0.21664	
t-critical two-tail	1.99495	

	Low	High
Mean	0.666667	0.52778
Variance	0.457143	0.42778
Observations	36	36
t-Stat	0.885863	
P(T<=t) two-tail	0.378724	
t-critical two-tail	1.994437	

	PC - Low	VR - Low
Mean	0.61111	0.72222
Variance	0.60458	0.33007
Observations	18	18
t-Stat	-0.48761	
P(T<=t) two-tail	0.62926	
t-critical two-tail	2.03951	

	PC - High	VR - High
Mean	0.388889	0.66667
Variance	0.369281	0.47059
Observations	18	18
t-Stat	-1.28596	
P(T<=t) two-tail	0.207146	
t-critical two-tail	2.032245	

	PC - Low	PC - High
Mean	0.61111	0.38889
Variance	0.60458	0.36928
Observations	18	18
t-Stat	0.95538	
P(T<=t) two-tail	0.34655	
t-critical two-tail	2.03693	

	VR - Low	VR -High
Mean	0.722222	0.66667
Variance	0.330065	0.47059
Observations	18	18
t-Stat	0.263416	
P(T<=t) two-tail	0.793868	
t-critical two-tail	2.034515	

Figure 14: Results of several Student's t-tests used on the amount of selfish choices players made.

B.2 Difficulty of decision in dog room

	PC	VR
Mean	1.638888889	2.527777778
Variance	0.694444444	2.027777778
Observations	36	36
t-stat	-3.23248814	
P(T<=t) two-tail	0.002058422	
t-critical two-tail	2.003240719	

	Low	High
Mean	2.138888889	2.027777778
Variance	1.551587302	1.570634921
Observations	36	36
t-stat	0.377291339	
P(T<=t) two-tail	0.707098576	
t-critical two-tail	1.994437112	

	PC - Low	VR - Low
Mean	1.666666667	2.611111111
Variance	0.705882353	2.016339869
Observations	18	18
t-stat	-2.42857143	
P(T<=t) two-tail	0.021833285	
t-critical two-tail	2.048407142	

	PC - High	VR - High
Mean	1.611111111	2.444444444
Variance	0.722222222	2.14379085
Observations	18	18
t-stat	-2.088410764	
P(T<=t) two-tail	0.046322585	
t-critical two-tail	2.051830516	

	PC - Low	PC - High
Mean	1.666666667	1.611111111
Variance	0.705882353	0.722222222
Observations	18	18
t-stat	0.19723489	
P(T<=t) two-tail	0.844818113	
t-critical two-tail	2.032244509	

	VR - Low	VR - High
Mean	2.611111111	2.444444444
Variance	2.016339869	2.14379085
Observations	18	18
t-stat	0.346682176	
P(T<=t) two-tail	0.730966648	
t-critical two-tail	2.032244509	

Figure 15: Results of several Student's t-tests run on the results from all participants' responses to the difficulty of the dog room.

B.3 Difficulty of decision in underwater room

	PC	VR
Mean	1.944444444	2.305555556
Variance	1.025396825	1.475396825
Observations	36	36
t-stat	-1.37010286	
P(T<=t) two-tail	0.175161566	
t-critical two-tail	1.995468931	

	Low	High
Mean	2.388888889	1.861111111
Variance	1.273015873	1.151587302
Observations	36	36
t-stat	2.033677182	
P(T<=t) two-tail	0.045776216	
t-critical two-tail	1.994437112	

	PC - Low	VR - Low
Mean	2.111111111	2.666666667
Variance	1.163398693	1.294117647
Observations	18	18
t-stat	-1.50354192	
P(T<=t) two-tail	0.141932242	
t-critical two-tail	2.032244509	

	PC - High	VR - High
Mean	1.777777778	1.944444444
Variance	0.888888889	1.467320261
Observations	18	18
t-stat	-0.460657433	
P(T<=t) two-tail	0.648159818	
t-critical two-tail	2.036933343	

	PC - Low	PC - High
Mean	2.111111111	1.777777778
Variance	1.163398693	0.888888889
Observations	18	18
t-stat	0.987178957	
P(T<=t) two-tail	0.330738117	
t-critical two-tail	2.034515297	

	VR - Low	VR - High
Mean	2.666666667	1.944444444
Variance	1.294117647	1.467320261
Observations	18	18
t-stat	1.843908891	
P(T<=t) two-tail	0.073925924	
t-critical two-tail	2.032244509	

Figure 16: Results of several Student's t-tests run on the results from all participants' responses to the difficulty of the underwater room.

B.4 Difficulty of decision in blender Room

	PC	VR
Mean	2.027777778	2.722222222
Variance	1.684920635	2.034920635
Observations	36	36
t-stat	-2.16036212	
P(T<=t) two-tail	0.034220193	
t-critical two-tail	1.994945415	

	Low	High
Mean	2.194444444	2.555555556
Variance	1.418253968	2.482539683
Observations	36	36
t-stat	-1.097022698	
P(T<=t) two-tail	0.276679031	
t-critical two-tail	1.997137908	

	PC - Low	VR - Low
Mean	1.666666667	2.722222222
Variance	1.176470588	1.153594771
Observations	18	18
t-stat	-2.93381886	
P(T<=t) two-tail	0.005958748	
t-critical two-tail	2.032244509	

	PC - High	VR - High
Mean	2.388888889	2.722222222
Variance	2.016339869	3.035947712
Observations	18	18
t-stat	-0.629174288	
P(T<=t) two-tail	0.533566633	
t-critical two-tail	2.034515297	

	PC - Low	PC - High
Mean	1.666666667	2.388888889
Variance	1.176470588	2.016339869
Observations	18	18
t-stat	-1.71482786	
P(T<=t) two-tail	0.096047405	
t-critical two-tail	2.036933343	

	VR - Low	VR - High
Mean	2.722222222	2.722222222
Variance	1.153594771	3.035947712
Observations	18	18
t-stat	0	
P(T<=t) two-tail	1	
t-critical two-tail	2.048407142	

Figure 17: Results of several Student's t-tests run on the results from all participants' responses to the difficulty of the blender room.

C. QUESTIONNAIRES

The following pages contains a printed version of the online questionnaires used before and after the experiment.

C.1 Demographics

Demographics

* Required

1. **Age** *

2. **Gender** *
   Mark only one oval.
   - ◯ Male
   - ◯ Female
   - ◯ Other

3. **First Language**

4. **How often du you play video games?** *
   Mark only one oval.
   - ◯ Every day
   - ◯ A few times a week
   - ◯ A few times a month
   - ◯ Less than a few times a month
   - ◯ Never

5. **Hours spent in virtual reality (approximately)** *

6. **If applicable, specify which virtual reality device(s) you have used**

Thank you!

Please notify the facilitator that you are done.

C.2 Post Experiment Questionnaire

Questionnaire

We would now like to ask some follow up questions regarding the decisions you made in the game. Please remember that there is no right or wrong answers, so please be as honest and elaborate as possible.

Dog scene

What choice did you make? *
Mark only one oval.

- I left the dog
- I killed the dog

How difficult did you find the decision? *
Mark only one oval.

	1	2	3	4	5	
Very Easy						Very Hard

Please elaborate on why and how you made that decision

Underwater/shark scene

What choice did you make? *
Mark only one oval.

- I left the woman
- I saved the woman

How difficult did you find the decision? *
Mark only one oval.

	1	2	3	4	5	
Very Easy						Very Hard

Please elaborate on why and how you made that decision

Blender scene

What choice did you make? *

Mark only one oval.

- ◯ I left the man
- ◯ I saved the man

How difficult did you find the decision? *

Mark only one oval.

	1	2	3	4	5	
Very Easy	◯	◯	◯	◯	◯	Very Hard

Please elaborate on why and how you made that decision