Game experience when controlling a weak avatar in full-body enaction

Roberto Pugliese, Klaus Förger, and Tapio Takala

Department of Computer Science, Aalto University,
Otaniementie 17 / PO Box 15500, 02150 Espoo, Finland
`{roberto.pugliese,klaus.forger,tapio.takala}@aalto.fi`
`https://mediatech.aalto.fi/`

Abstract. In this paper we describe a motion-controlled game based on a paradigm of a player enacting the character, rather than a character mimicking the player's action. Our hypothesis is that a controlling scheme based on the adaptation of a player to the way the avatar is able to perform actions, can result in a stronger presence and psychological bond to the character. The approach is based on previous studies showing that features, attitudes and behaviors of the digital representation of players in a virtual reality setting, alter the players self-perception in the virtual environment (Proteus effect). The interaction mechanism is inspired by enactive approach to cognition and embodied action. In a mini-game we explore effects of controlling a weak character on self-presence and identification with the avatar. We show that increasing degrees of effort in the controlled bodies resulted in different impressions of the physical state of the character. Additionally, we provide our interpretation of relation between game experience and the kinetic parameters and adaptation indicators extracted from the motion of the player and avatar. Finally, we address scenarios where this enaction-based approach to motion controlled avatar can find application.

Keywords: motion-controlled games, embodied interaction, game experience, self presence, proteus effect

1 Introduction

Controlling an avatar using full-body interaction is not anymore exclusive of Virtual Reality research but is also available at consumer level. Motion controllers in video-games allow a more direct link between player's action and the avatar they are impersonating than mouse and keyboard or joypad based interfaces. As shown in a previous study [3], a motion-based controller (a controller that affords more movement) can enhance the level of engagement the participants experienced in the case of music and simulation games. Motion-controlled games have been studied also for other scenarios like gamification of trampoline jumping [17]. These scenarios are augmentation and simulation of physical activity where the player is brought one-to-one into the game world without the mediation of an avatar.

While in sport simulation a perfect mirroring or even an exaggerated version of players' movement is desirable, a controller scheme where the avatar copies the action of the player might not be suitable. In narrative games situations might arise when the character is not capable of executing the same action of the player e.g. character is wounded, affected by spells or needs to interact with objects of a certain weight. All these cases introduce a motion decoupling between player and game character. This has been acceptable in joypad-controlled games, either by displaying non-interactive sequences to the player or partially altering the controller mechanism (the same input on the gamepad produces an exaggerated or dampened output). Nevertheless, consistent natural interaction throughout the game might result in a more engaging experience.

The need of simulating a different body can also come from the opportunity of increasing sympathy and wish to help others by the use of a Virtual Environment (VE). For instance, Head Mounted Display has been used to reproduce visual impairment, e.g. color blindness and studies [1] have shown that participants of the study manifested an increased attitude to help others also after the experiment.

In this study we explore the possibilities of providing a self-representation of the player which is different not in terms of appearance but rather in the way it moves in the VE. We will portray an increasingly tired character that cannot follow the movement of the player perfectly. We examine the effect of this mediating body in a game and its impact on the game experience.

2 Related Works

Impersonating a character in a virtual environment (VE) can have profound effect on one's action in that environment. Studies show that people's behaviors can conform to their digital self-representation, the avatar. This phenomena renamed as Proteus effect might occur when the user's virtual self-representation is dissimilar to the physical self [26], for instance a more or less attractive version of one-self, a thinner or overweight, a taller or smaller. The Proteus effect has been explored for the potential of inducing virtuous behavior in the player ([12], [13]). The effects of self-representation can extend outside the virtual environment and promote for instance more healthy eating behavior and positive effect on exercising. In the case of occupying a fictional super-hero with super-powers, a sense of empowerment and tendency towards pro-social behaviors can be found among players [24].

2.1 Self-presence, Identification and the body

A key concept under which identification and Proteus effect fall into is self-presence, or the experience of feeling one's self within a virtual environment ([18],[16],[21]). Adopting self-perception theory [2] to the avatar case, people might observe their virtual self behavior and infer from that their own features, affecting their self-image and also attitudes and future behaviors [11].

Another key-concept underlying the relation and bonding between the person and the avatar is identification. According to Klimmt et al. [8], "from the perspective of social psychology, identification is defined as a temporary alteration of media users' self-concept through adoption of perceived characteristics of a media person". The authors claim that compared to other media, due to the interactive setting of video games the player does not perceive the game character as an entity completely separate from themselves but rather a merging of their own self and the protagonist of the game. To identify with the media character is actually to perceive or be the media character.

Putting ourselves in someone else's shoes lets us understand other's feeling by simulating them ourselves. We understand another person's actions by reenacting those actions using our own motor system, for instance judging the weight of an object by watching how a person lifts a heavy object [7]. For the Proteus effect, embodiment produces significantly larger behavioral changes than mere observation of the same visual stimuli [27].

Overall, the process of identification and self-presence are responsible for the actual transfer of attitudes, behavior and emotional response between the player and its digital representation.

But if the mechanisms to understand somebody else's behaviors and feeling are based on internal simulation of those behaviors and feelings, what would be the consequence of physically enacting that behavior ? Can we expect a stronger self-presence in the VE ? Does adapting to another body and becoming in control of it affect our feeling and behaviors inferred from the movement capabilities of the new body?

The paradigm of enaction ([23], [10]) provides an account of social understanding based on embodied action, or in other words, the importance of the body in cognition and sense-making as an action-perception loop. In the case of a motion-controlled avatar, when a player needs to adapt to the avatar to achieve a goal she gets enclosed in a perceptually guided action loop where a dynamical coupling exists among the two. Only by enacting the body of the avatar the goal can be achieved, and through enaction the player understands the avatar she embodies. It is important that the relation between player and avatar is disrupted every time the player acts regardless of the avatar response perceived. Coordination needs to be maintained over time by a continuous negotiation among the parties. We will take into account these design criteria in the user study.

2.2 Game experience

Many factors contribute to engagement in game experience and different models are have been provided to illustrate their relationship. For instance the framework of [5] models the relation between motion and engagement. This approach helps us understanding how the game experience can be modulated via sensory experience due to different quality of player's motion when using motion-based controllers.

We focus here on one of the main contributors towards engagement: flow. Flow theory [9] has been widely adopted in research on computer games [25]. Flow is a state of optimal experience, the product of the balance between challenge offered and skill required to accomplish a task. Higher states of flow go hand-in-hand with an enjoyable experience. Due to this absorption in the activities performed, flow has been also associated with immersion, or the degree of involvement with a computer game [15]. Similar features are shared among flow and immersion: lack of awareness of time, loss of awareness of the real world and and involvement and a sense of being in the task environment. Immersion is less radical than a perfect flow state, with a remaining awareness of the surrounding and it does not correspond to a pleasant experience of clear and reachable goals at all times. In this paper we refer to flow in this less radical "immersion-like" formulation. It is not our direct goal to provide an enjoyable experience but rather a strong embodied experience of identification and presence with the avatar. Nevertheless a minimum amount of flow might be necessary to reach a control of the avatar that guarantees a sense of attachment and dynamic coupling with movement of the avatar. In other words, without a certain amount of flow, impersonating the digital representation of our self becomes more difficult and also self-presence can be reduced. We will test this hypothesis in our study.

Other factors related to the response of the character to the player's input play a role in the game experience. The impact of lag in a platform game has been investigated by [20], studying independently the contribution of two aspects of lag: latency (constant delay) and jitter (varying delay). The results showed the negative effect of latency especially due to jitter on players' game experience, in terms of performance, satisfaction, ease of control, and sometimes how favorably players view the avatar.

3 Avatar implementation and research questions

We describe here the implementation of a character controlled by the movement of a player. The character follows the movement of the player more or less closely, being as fast or slower than the player, it can fall down and might need the player to modify their own movement in order to keep control of the character. The character is intended to show weakness and tiredness while still being capable of moving where the player wants.

3.1 Research questions

In the exploratory study presented in this paper we want to investigate the relationship between the body-controller mechanism implemented and the game experience. More specifically we are after the hypothesis that controlling a character which exhibits a behavior that can be countered only through a deliberate effort of the player towards adaptation can have an effect on identification, self-presence and game experience.

For the game experience we are interested in the impact of controlling the weak characters on flow and challenge and their relation with emotional response.

We also want to investigate if any relation exist between the motion of the player, the game experience and the recognition of particular features of the character they are controlling.

3.2 Controller-mechanism

The implementation is based on commercially available tracking technology like Microsoft Kinect 2. The player is shown as a green stick-figure with 14 joints. The tracking mechanism introduces a latency of 50 ms with good accuracy and responsiveness.

Since we want to understand how impersonating a character who presents motion features different from the player's affects the player's experience in the game, we created a physics-based modification of the original avatar. The visual appearance of this character is the same stick-figure but the movement is modified by applying custom forces to the individual joints. Three forces are applied at each joint. The first is an attraction force that pulls the joint to the original position.

The second force called *Potential Force* is also an attraction force pulling the joint to the original position but only within a certain distance from the original position. The *Potential Force* acts on the joint to make its trajectory over time follow the original one but it decreases linearly with the distance. When the avatar is displayed in front of the player, the avatar follows the movement of the player as long as the player waits for the avatar to follow the movement. The player needs to imitate at first the posture of the avatar if different from his own and then move smoothly enough not to "lose grip" of the avatar. Conversely, the faster and more independently from the avatar the player moves the less the player is in control of the avatar.

The third force is a force pushing down that is used to change the posture of the character to make it look tired or weak. The influence of posture on attitude and behavior has been studied by [22] and more recently in the game context by [4]. The three forces can be scaled independently for each joint.

When all the forces are applied, the player has more control the more she adapts their movements to the one of the character by matching the posture. Nevertheless letting the character lag behind can result not just in the need of slowing down but also going all the way to a crouched posture before being able to control the character again (Figure 1). This process stimulates the adaptation of the player to the pace of the avatar in a continuous feedback of push-pulling the avatar.

We expect those traits of the avatar to transfer to the player because the digital representation appears and behaves (it needs to be controlled) differently from the mirrored representation (Proteus effect). Additionally, the embodied experience of that behavior (I am controlling/adapting to the movement of my digital representation) will promote identification with the avatar and modified

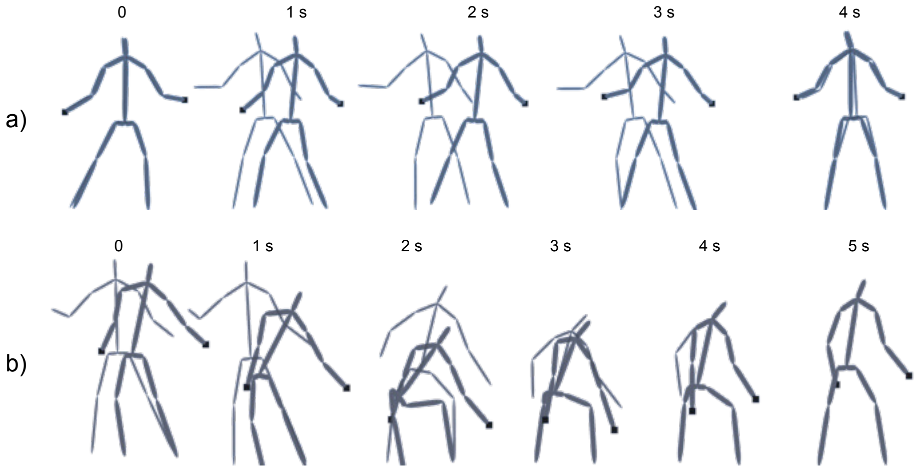

Fig. 1. Original (thin limbs) and avatar (tick): in a) the control of the avatar is partially lost due to a lateral fast movement. The player needs to wait for the avatar. In b) the avatar starts falling down and the player needs to adapt to the crouched posture.

self-presence. Furthermore, the posture regulated by the controller mechanism will act as a regulator for emotion [4].

4 Method

A motion-controlled mini-game was designed where a character on the screen needs to pop soap bubbles as fast as possible using its hands only. A new bubble appears every 7 seconds or 1 second after it has been popped. All the interaction happens on the same depth plane so that depth perception does not influence game play. Scores and a timer is shown on top of the game (Figure 2).

Fig. 2. Subject playing the bubble-popping mini-game (left) and screen-grab from gameplay (right).

The conditions were designed to discover differences of movements and game experiences against the mirroring condition when posture and movement between player and controlled character differs. The dimensions we explore are the posture of the avatar and the avatar's response to the player's movement (Table 1).

Avatar movement	**Avatar Posture**	
	Mirror	Crouched
Avatar follows player movement	Condition 1	Condition 4
Avatar moves as the player only if the player matches its pose (with higher tolerance)	Condition 2	Condition 5
Avatar moves as the player only if the player matches its pose (with lower tolerance)	Condition 3	Condition 6

Table 1. Dimensions explored in the user study and designed conditions

The resulting conditions can be grouped in characters that move similarly as the player but differ in posture (condition 4), characters that move as the player only if the player is close enough to their pose (condition 2 and 3) and conditions where the player needs to exert a continuos effort of adaptation if she wants to maintain control and not lose the "grip" of the character (condition 5 and 6) that otherwise falls down into a crouched posture.

On the screen (see Figure 2) 2 stick figures are displayed, the original body (thin stick figure) and the transformed body (thicker limbs figure). In this way the player has a visual feedback of the difference between the pose and movement of the controlled and transformed avatar. This helps the process of matching his own pose with the one of the transformed avatar and being in control of it. When the distance of the corresponding body parts is small, the thinner limbs disappear inside the ticker one of the transformed characters, thus visually confirming the successful bonding of original and transformed character. As an exception, in the conditions where the character has tired posture and mirrored movement, the display shows only the the transformed character. An accompanying video showing the different conditions in actions is available at:

`https://vimeo.com/robertopugliese/enactingtheavatar`.

4.1 Procedure

A within-subject design for the experiment was used. 11 participants were recruited among colleagues and were promised that the best players of the user study will receive a movie ticket. The sample consisted of 7 men and 4 women who ranged in age from 24 to 61 (MV = 32.5, SD = 11.17). The experiment was conducted in an office room. The game was displayed on a 54" screen with participants playing from c.a. 2 meters distance.

A training session preceded the actual experiment. During this phase the participant went through all the conditions for 30 seconds each one receiving an explanation about how the transformed body was intended to be controlled. Then, 12 2-minutes trials were presented consisting of the 6 conditions repeated twice in randomized counterbalanced order.

4.2 Measures

Quantitative study The motion tracking data for the players and character were recorded every trial. With this data we calculated the average pose distance between player and character, the average speed of the player and an adaptation percentage. The adaptation refers to the percentage of frames when the player can see a target bubble, but moves away from it instead of trying to actively pop it, therefore likely trying to adapt to the behavior of the avatar.

Subjective evaluation study We designed a questionnaire to be filled in after each trial. The items comprised questions that address Identification and Self-presence (see Appendix), emotional response with the Self-assessment manikin [6] and game experience using the Game Experience Questionnaire [14]. The GEQ (in-game) components can assess experiential constructs of immersion, tension, competence, flow, negative affect, positive affect and challenge.

A further question included in the questionnaire addressed the features or characteristic the player saw in the avatar: "Which of the following best describes your impression of the avatar? (weak, strong, angry, sad, happy, other)".

5 Results

We considered all the measures of section 4.2 as dependent variables and conducted a 2-way within-subjects ANOVA considering the conditions and the repetitions as factors. In the case of the calculation of the Pose Distance we limited the analysis to the Condition 2-3-5-6 because only in these conditions the player can affect the variable with their movement, while in condition 1 the pose distance is 0 by definition and condition 4 is an off-set resulting from the gravity force applied. Post-hoc threshold of significance was corrected using Bonferroni adjustment for multiple comparisons among conditions.

In Figure 3 the calculated motion data are shown. The **Pose Distance** (F(3,30) = 12.318, $\eta_p^2 = 0.552$, $p < .0001$) clearly shows that in condition 6 participants found themselves more often far from the character than in other conditions. Pairwise comparison showed differences between Condition 2 ($MV = 0.316$) and Condition 6 ($MV = 0.832$, $MD = -.516$, $p < .05$), and between Condition 5 ($MV = 0.338$) and Condition 6 ($MD = -.494$, $p < .05$).

As a consequence players need to adapt their movements more and not go directly towards the bubble to pop, as it can be seen from the **Adaptation movements** (F(5,50) = 7.849, $\eta_p^2 = 0.44$, $p < .0001$). Pairwise comparison showed differences between Condition 2 ($MV = 14$ %) and Condition 3 ($MV = 18.5$ %, $MD = .045$, $p < .05$), and between Condition 2 and Condition 6 ($MV = 21.7$ %, $MD = .077$, $p < .05$), between Condition 3 and Condition 4 ($MV =$

10.4 %, MD = -.081, $p <$ .05), between Condition 4 and Condition 6 (MD = .113, $p <$ .05) and between Condition 5 (MV = 15.3 %) and Condition 6 (MD = .064, $p <$ .05).

Speed (F(5,50) = 83.866, η_p^2 = 0.893, $p <$ .0001) greatly varied among conditions as a result of the different adaptation required with Condition 2 and 3 showing similar mean values as 5 and 6. Pairwise comparison showed significant differences of Condition 1 with Condition 2 (MD = .073, $p <$ .001), with Condition 3 (MD = .084, $p <$ .001), with Condition 5 (MD = .073, $p <$ .001), and Condition 6 (MD = .077, $p <$ .001). Condition 2 was found different from Condition 3 (MD = .011, $p <$ .001). Also differences were found among Condition 3 and Condition 4 (MD = -.063, $p <$ .001), Condition 5 (MD = -.011, $p <$ .001) and Condition 6 (MD = -.007, $p <$ .01). Non surprisingly, scores (F(5,50) = 169.668, η_p^2 = 0.944, $p <$ .0001) followed the same trend of the speed.

As it can be observed from the **Vertical Center of Mass** F(5,50) = 76.565, η_p^2 = 0.884, $p <$ .0001, players spent more time couched in condition 5 and 6 for the need of picking up the character when falling. Pairwise comparisons among conditions showed strong significant differences ($p <$ .001) between the Conditions 1-2-3-4 and Condition 5 and 6.

In Figure 4, statistically significant results for the subjective evaluation aggregated according to the questionnaire instruction are presented. We found significant differences for **Presence** (F(5,50) = 9.077, η_p^2 = 0.476, $p <$ .0001). Pairwise comparison showed higher values for condition 1 (MV = 18.318) over Condition 2 (MV = 13.727, MD = 4.591, $p <$ .05), Condition 3 (MV = 12.727, MD = 5.591, $p <$ .01), Condition 4 (MV = 16.182, MD = 2.136, $p <$ .05) and Condition 5 (MV = 13.773, MD = 4.545, $p <$ .05)). Also Condition 2 and 4 were found different (MD = -2.455, $p <$ .05)

No significant differences among conditions were found for the variable **Identification**, with mean values between 8.8 (Condition 3) and 9.1 (Condition 1).

Significant differences among conditions were found also for **Flow** (F(5,50) = 2.808, η_p^2 = 0.219, $p <$ .05). Pairwise comparison showed significant differences among condition 1 (MV = 6.955) and Condition 2 (MV = 5.682, MD = 1.273, $p <$ .05), and Condition 2 with Condition 5 (MV = 6.5, MD = -.818, $p <$ .05).

For **Challenge** we found statistically significant differences among conditions (F(5,50) = 9.468, η_p^2 = 0.486, $p <$ .0001). Pairwise comparison showed significant differences among condition 1 (MV = 5.364) and Condition 3 (MV = 7.591, MD = -2.227, $p <$ .05), and Condition 1 with Condition 6 (MV = 7.727, MD = -2.364, $p <$ .01), and also for Condition 4 (MV = 5.773, MD = -1.955, $p <$ .05) with Condition 6.

Significant differences among conditions were found also for **Dominance** (F(5,50) = 34.507, η_p^2 = 0.775, $p <$ .0001). Pairwise comparison showed significant differences among condition 1 (MV = 6.955) and Condition 2 (MV = 5.682, MD = 1.273, $p <$ .05), and Condition 2 with Condition 5 (MV = 6.5, MD = -.818, $p <$ .05).

Additionally, we found significant differences for the **Negative affect** (F(5,50) = 3.229, η_p^2 = 0.244, $p <$ .05). Pairwise comparison showed higher values for condition 4 ($MV = 4.864$) compared to Condition 1 ($MV = 3.727$, $MD = -1.136$, $p < .05$).

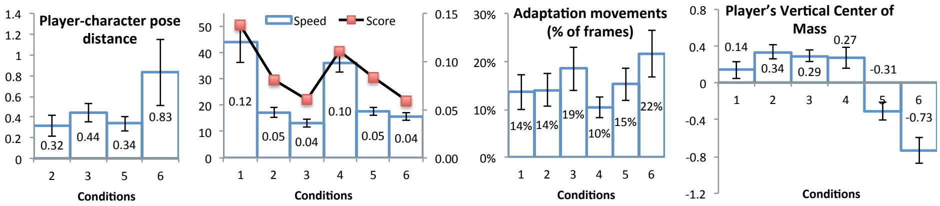

Fig. 3. Statistically significant results from the motion data analysis. Error bars show 95% confidence intervals.

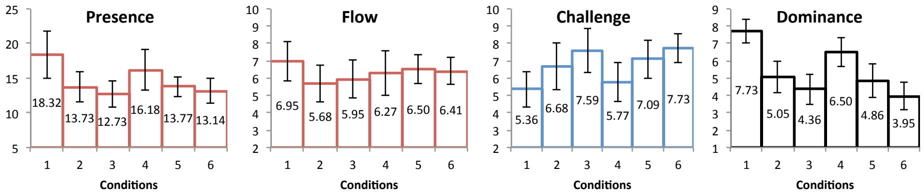

Fig. 4. Statistically significant results from subjective evaluation. Error bars show 95% confidence intervals.

Figure 5 reports the impression participant got of the character they controlled. From an initial list of 49 adjectives, we operated a reduction by grouping common concepts reaching a total of 17.

6 Discussion

As expected the different conditions offered a different degree of challenge and a similar trend could be seen in the dominance measure. This is due to the fact that the mechanics of the game stayed the same among conditions and the main factor affecting the challenge is different degree and autonomy of control of the character. Interestingly, flow did not score that differently between the mirror condition and the conditions with the falling character (conditions 5 and 6). This could be attributed to the fact players can reach a level of expertise in a short time that let them be in a good flow state and shows that the controller mechanism proved successful in bringing a good trade-off between challenge and ease-of-use.

Self-presence was lower in conditions where the motion of the character was modified. Looking into the individual items of the questionnaire, the sense of embodying the character is higher when the motion follows directly the players movement (Condition 1 and 4). This could be due to the representation of the character as a separate entity causing the player to see both themselves and the character as separate. Moreover, as it can seen from the question "To what extent did the avatar seem real?", conditions 2-3-5-6 portrayed a less realistic and believable character. The character exhibited less realistic behavior not obeying natural physical constraints of the human body (legs crossed in a cartoonish style) and not falling according to real gravity.

Conditions	weak	slow	tired	sad	dead	apathetic	clumsy	stiff	disobeying	confused	lazy	neutral	strong	fast	ready	happy	other
1	1	0	0	0	0	0	0	0	0	0	0	7	7	2	2	2	1
2	9	6	0	1	0	1	1	0	0	0	3	0	0	0	0	1	0
3	7	4	1	1	1	1	0	1	1	1	1	0	0	0	0	1	2
4	4	3	5	2	0	0	1	1	0	0	0	2	0	0	2	0	2
5	11	5	0	1	1	0	1	0	1	0	1	0	0	0	0	1	0
6	12	1	0	2	1	1	0	0	2	1	1	0	0	0	0	1	0

Fig. 5. Frequency table of the impressions players had of the character.

From Figure 5 we can notice Condition 6 being associated more often to a weak character rather than a slow one, suggesting that the intended design of portraying weakness through the effort needed to control the character succeeded. The most tired character was found in Condition 4, impression that could be explained considering the posture of the character in conjunction with the ability to move unconstrained and let the player achieve the second higher score among conditions. We can speculate that being in a tired position (Condition 6) rather than observing a tired representation (Condition 4) shifts the experience of the player from seeing tiredness to feeling the weakness of the avatar.

Other adjectives mentioned by the participants belong semantically to the dissatisfaction of their expectations in controlling the character (*apathetic*, *boring*, *lazy*,...). A lack of context and motivation for the behavior of the character probably puts emphasis on pure performance task and it makes the avatar feel non-cooperative to reach the player's goal. Indeed the condition 6 is the one where players spent more time searching for control (Player-character pose distance) and the highest effort in adaptation was necessary (Adaptation Movements in Figure 3).

We could not find statistically significant differences in arousal and valence. As witnessed during the test and from the answers, individual preferences emerged about the conditions players liked the most. This study does not aim at showing the best condition but rather the suitability of the conditions for specific game play context and applications.

While there was no difference among condition for identification, the mean value were high in all the conditions maybe indicating on one hand a better metric for this aspect should be used but also a richer game scenario should be designed.

7 Conclusion and future works

We have presented an implementation of a motion-controlled avatar that shows different responses to the player movement and needs to be controlled through the player adaptation to it. Those features aimed at portraying a weak character in both posture and effort in movement. We found that when the player needs not just to adapt to the pose of the character but also to go into a crouched position to retain control of the avatar (enaction) elicits in the player the impression of controlling a weak character. We showed that the loss of control does not excessively compromise a state of flow during game play. We showed that posture alone creates the impression of controlling a tired character, offers equivalent flow state as the enaction case but less challenge. The observed drop of self-presence could be overcome by using a more realistically moving avatar. As potential scenario for the deployment of this character, we want to point at the simulation of motor skills disorder in order to foster empathy towards people with motor difficulties. Also, we suggest a variety of game scenarios where this enactment could take place and enrich the game experience like dramatic storytelling and role-playing game in which the state of the character is altered due to the enfolding of the story.

We can hypothesize that context and pre-story would augment the impact of adopting this kind of enactment and its effect on the identification and self-presence, extending the player's impression of the avatar to an effective transfer of the avatar's features to the player.

From a methodological point of view, in future study we could use a post-game self-identification task as proposed by [19]. This could overcome a difficulty in measuring through questionnaire the physical identification the player with the impersonated character. It would help in understanding how the movements resulting from the attempted adaptation to a different body are internalized in the memory of the player.

References

1. Ahn, S.J.G., Le, A.M.T., Bailenson, J.: The Effect of Embodied Experiences on Self-Other Merging, Attitude, and Helping Behavior. Media Psychology 16(1), 7–38 (Jan 2013)
2. Bem, D.J.: Self-perception theory. Advances in experimental social psychology 6, 1–62 (1972)
3. Bianchi-Berthouze, N.: Understanding the role of body movement in player engagement. Human–Computer Interaction 28(1), 40–75 (2013)
4. Bianchi-Berthouze, N., Cairns, P., Cox, A., Jennett, C., Kim, W.W.: On posture as a modality for expressing and recognizing emotions. In: Emotion and HCI workshop at BCS HCI London (2006)
5. Bianchi-Berthouze, N., Kim, W.W., Patel, D.: Does body movement engage you more in digital game play? and why? In: Affective Computing and Intelligent Interaction, pp. 102–113. Springer (2007)

6. Bradley, M.M., Lang, P.J.: Measuring emotion: the self-assessment manikin and the semantic differential. Journal of behavior therapy and experimental psychiatry 25(1), 49–59 (1994)
7. Chandrasekharan, S., Mazalek, A., Nitsche, M., Chen, Y., Ranjan, A.: Ideomotor design: using common coding theory to derive novel video game interactions. Pragmatics & Cognition 18(2), 313–339 (2010)
8. Christoph, K., Dorothée, H., Peter, V.: The video game experience as "true" identification: A theory of enjoyable alterations of players' self-perception. Communication Theory 19(4), 351–373 (2009)
9. Csikszentmihalyi, M.: The psychology of optimal experience new york (1990)
10. De Jaegher, H., Di Paolo, E.: Participatory sense-making. Phenomenology and the cognitive sciences 6(4), 485–507 (2007)
11. Fox, J.: The use of virtual self models to promote self-efficacy and physical activity performance. Ph.D. thesis, Stanford University (2010)
12. Fox, J., Bailenson, J., Binney, J.: Virtual Experiences, Physical Behaviors: The Effect of Presence on Imitation of an Eating Avatar. Presence: Teleoperators and Virtual Environments 18(4), 294–303 (Aug 2009)
13. Fox, J., Bailenson, J.N.: Virtual self-modeling: The effects of vicarious reinforcement and identification on exercise behaviors. Media Psychology 12(1), 1–25 (2009)
14. IJsselsteijn, W., De Kort, Y., Poels, K.: {The Game Experience Questionnaire: Development of a self-report measure to assess the psychological impact of digital games. Manuscript in Preparation} (2013)
15. Jennett, C., Cox, A.L., Cairns, P., Dhoparee, S., Epps, A., Tijs, T., Walton, A.: Measuring and defining the experience of immersion in games. International journal of human-computer studies 66(9), 641–661 (2008)
16. Jin, S.A.A., Park, N.: Parasocial interaction with my avatar: Effects of interdependent self-construal and the mediating role of self-presence in an avatar-based console game, wii. CyberPsychology & Behavior 12(6), 723–727 (2009)
17. Kajastila, R., Holsti, L., Hämäläinen, P.: Empowering the exercise: a body-controlled trampoline training game. International Journal of Computer Science in Sport (2014)
18. Lee, K.M.: Presence, explicated. Communication theory 14(1), 27–50 (2004)
19. Mazalek, A., Nitsche, M., Chandrasekharan, S., Welsh, T., Clifton, P., Quitmeyer, A., Peer, F., Kirschner, F.: Recognising your self in virtual avatars. International Journal of Arts and Technology 6(1), 83–105 (2012)
20. Normoyle, A., Guerrero, G., Jörg, S.: Player perception of delays and jitter in character responsiveness. In: Proceedings of the ACM Symposium on Applied Perception. pp. 117–124. ACM (2014)
21. Ratan, R., Santa Cruz, M., Vorderer, P.: Multitasking, presence, and self-presence on the wii. In: Proceedings of the 10th Annual International Workshop on Presence. pp. 167–190 (2007)
22. Riskind, J.H., Gotay, C.C.: Physical posture: Could it have regulatory or feedback effects on motivation and emotion? Motivation and Emotion 6(3), 273–298 (1982)
23. Rosch, E., Thompson, E., Varela, F.J.: The embodied mind: Cognitive science and human experience. MIT press (1992)
24. Rosenberg, R.S., Baughman, S.L., Bailenson, J.N.: Virtual superheroes: Using superpowers in virtual reality to encourage prosocial behavior. PloS one 8(1), e55003 (2013)
25. Sweetser, P., Wyeth, P.: Gameflow: A model for evaluating player enjoyment in games. Comput. Entertain. 3(3), 3–3 (Jul 2005)

26. Yee, N., Bailenson, J.: The proteus effect: The effect of transformed self-representation on behavior. Human communication research 33(3), 271–290 (2007)
27. Yee, N., Bailenson, J.N.: The difference between being and seeing: The relative contribution of self-perception and priming to behavioral changes via digital self-representation. Media Psychology 12(2), 195–209 (2009)

Appendix

Identification

The questionnaire was adapted from APPENDIX A: STUDY 1 [11].

(1 = Strongly disagree; 2 = Somewhat disagree; 3 = Neither disagree nor agree; 4 = Somewhat agree; 5 = Strongly agree)

- While playing the game, I wanted the avatar to succeed by popping as many bubbles as possible.
- While playing the game, I did NOT want the avatar to give up and miss bubbles.

Presence

The questionnaire was adapted from APPENDIX A: STUDY 1 [11].

(1 = Not at all; 2 = Slightly; 3 = Moderately; 4 = Very much; 5 = Extremely)

- To what extent to do you feel the avatar is an extension of yourself?
- To what extent do you feel that if something happens to the avatar, it feels like it is happening to you?
- To what extent do you feel you embodied the avatar you controlled?
- To what extent did you feel you were in the same room with the avatar?
- To what extent did the avatar seem real?
- To what extent were you involved in the game world?

GEQ In-Game version as in [14].

Please indicate how you felt while playing the game for each of the items, on the following scale:

(1 = not at all; 2 = Slightly; 3 = Moderately; 4 = Fairly; 5 = Extremely)

Questions	Measure
2 - I felt successful 9 - I felt skillful	Competence
1 - I was interested in the game's story 4 - I found it impressive	Sensory and imaginative immersion
5 - I forgot everything around me 10 - I felt completely absorbed	Flow
6 - I felt frustrated 8 - I felt irritable	Tension
12 - I felt challenged 13 - I had to put a lot of effort into it	Challenge
3 - I felt bored 7 - I found it tiresome	Negative affect
11 - I felt content 14 - I felt good	Positive affect