Does body movement engage you more in digital game play? And Why?

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Abstract. In past years, computer game designers have tried to increase player engagement by improving the believability of characters and environment. Today, the focus is shifting toward improving the game controller. This study seeks to understand engagement on the basis of the body movements of the player. Initial results from two case-studies suggest that an increase in body movement imposed, or allowed, by the game controller results in an increase in the player's engagement level. Furthermore, they lead us to hypothesize that an increased involvement of the body can afford the player a stronger affective experience. We propose that the contribution of full-body experience is three-fold: (a) it facilitates the feeling of presence in the digital environment (fantasy); (b) it enables the affective aspects of human-human interaction (communication); and (c) it unleashes the regulatory properties of emotion (affect).

Keywords: Engagement, body movement, gaming, affective states.

1 Introduction

The new generation of games starts to offer control devices that allow for a more natural type of interaction. For example, Guitar Hero, introduced by RedOctane for the Playstation, comes with a guitar-shaped device with tilt-in sensors that require guitar-player-like movements for controlling the game. "Wii" controller, introduced by Nintendo, is equipped with a motion capture and gyroscopic device. Instead of using cursor keys and buttons to hit a tennis ball, the Wii remote will allow players to act as if they were actually handling a tennis racket. Similarly, Sony has introduced a new Dual Shock controller for their PlayStation 3, which also includes a gyroscopic device. The aim of these devices is to allow the player to control the game through natural movements. These new games, or rather, these new types of devices, not only have the ability to capture the interest of a larger audience (as they may allow for a faster learning curve), they could also facilitate the engagement of the player along all the 4 factors proposed by Lazzaro [14].

Whilst this recent trend suggests that game designers expect these new consoles to result in more intuitive and natural games, engagement is still a novel area in game research, and the relationship between engagement and body movement has not been studied. Recent studies in cognitive and affective sciences have shown the important role played by the body over the mind: "*thought grows from action and that activity is* *the engine of change*" [35]. On this view, the way our body interacts with the environment is affecting the way we perceive the environment.

This study, therefore, seeks to further our understanding of the relationship between body movement and the engagement experience in computer games, by testing the hypothesis that an increase in body movement imposed, or allowed, by the game controller can result in an increase of the player's engagement level. But first, let us briefly review the literature on engagement in game and engagement in general.

2 Engagement

The degree of involvement in technology is currently described using a variety of terms: immersion, engagement, presence or fun, to name just a few. The concept of presence or immersion, and their measurement, has mostly been studied in the context of virtual environments (e.g., [1-5]). In the context of games, however, the definition of engagement, and its related terms, is still unclear.

According to Malone [6], the qualitative factors for engaging game play are challenge, curiosity, fantasy and flow. Csikszentmihalyi's [7] theory of "flow" depicts a state of mind in which a person feels so engaged by an activity that his/her actions and awareness merge. Also known as optimal experience, this phenomenon is closely linked with motivation and attention, and is essential in games. An optimal level of challenge is necessary to maintain motivation in game players. When skills improve, a new level of challenge is required for challenge to meet the improved skill level [8]. Douglas and Hargadon [9] mentioned that flow is involved in both immersion and engagement.

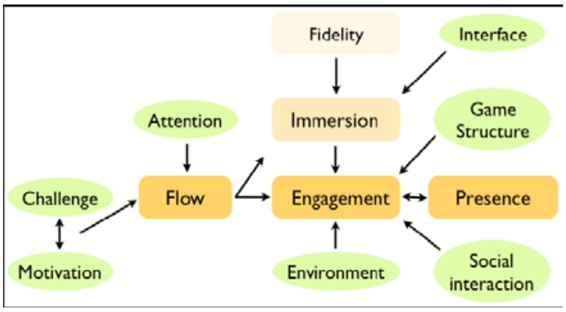

Fig. 1. Engagement model summarizing the various theories. The figure is modified from Chen et al. [11]'s figure, which focused mainly on game usability.

While Brown and Cairns [10] defined the relationship of engagement as the first step in immersion then to engrossment and then to full immersion, Chen et al. [11] used fidelity, immersion, and engagement. While these cannot be compared directly, both introduce three steps in a person's level of involvement. Brown and Cairns suggested that control of the game is a barrier in their definition of engagement to move to the next level, and game structure is a barrier for engrossment. Chen et al. [11] also consider similar aspects of the aural and visual interface to influence fidelity and game structure to influence immersion. Then, Brown and Cairns claimed that "full immersion is presence", with Smith et al. [4] adding that environmental factors affect this relationship.

Finally, engagement was also described in terms of three categories: participation, narration and co-presence of others, thus stating the social aspect of engagement [12]. Figure 1 depicts a schematic representation of the various theories linked to engagement. Although the specifics of the figure could be argued, what we would like to stress is the fact that most theories of engagement have focused purely on its mental aspects. Tellingly, Koster [13] defined "fun" as the act of mastering the game mentally. One aim of this paper is to suggest that body movements should play an important role in engagement.

2 Social and Regulatory properties of Body Movement

In a qualitative study, Lazzaro [14] used facial expressions and surveys of players to identify four factors characterizing fun: hard fun (similar to the challenge factor of Malone), easy fun (similar to the curiosity factor of Malone), altered states (closely related to Malone's fantasy factor) and socialization (the people factor). The significance of this study is that it associated bodily expressions of affects to engagement. The choice of facial expressions to characterize engagement was not surprising given the traditional view that facial expression is the most powerful modality for expressing affective states. With their 7-38-55 rule, for example, the oft-quoted Mehrabian and Friar [15] stressed how important the non-verbal component (55% for facial expression and 38% for voice tone) of communication was in communicating affect when compared to the purely verbal component (7%).

In recent years, however, this idea has been questioned by psychology studies showing body posture to be a very good indicator for certain categories of emotions, see [16-19]) for examples. And accordingly, recent studies (see [20-25] for some examples) have set to establish a framework for grounding the recognition of affective states into body postures. Our own studies, in particular, have proposed a general description of posture based on angles and distances between body joints and used it to create an affective posture recognition system that maps the set of postural descriptors into affective categories. In addition to classification rates that favourably compared with those obtained using facial expressions, we also showed how posture could provide for the discrimination of affective categories across cultures [26], thus showing posture as a very powerful communicative modality.

But interestingly, another line of work suggests another important role of body posture. And that is that changes in posture can induce changes in affective states or have a feedback role affecting motivation and emotion. A study by Riskind and Gotay [27], for example, revealed how "*subjects who had been temporarily placed in a slumped, depressed physical posture later appeared to develop helplessness more readily, as assessed by their lack of persistence in a standard learned helplessness task, than did subjects who had been placed in an expansive, upright posture*." Furthermore, it was shown that posture had also an effect on verbally reported self-perceptions. This is not surprising, as others have reported similar regulatory properties with other forms of non-verbal expressions of affects. Richards and Gross [28], for example, showed that simply keeping a stiff upper lip during an emotional event had effect on the memory of the event, and generally, exacted a cognitive toll as great as intentional cognitive avoidance. As a result, the field of pain management, for example, is becoming increasingly interested in the relation between pain and emotion [29], as various studies suggest that problems in regulating and expressing emotions are linked to increased pain and distress.

3 Body Movement and Engagement

These two facets of bodily activity in general (posture, movement) provide the theoretical justification for our hypothesis on the existence of a (possibly bilateral) relationship between engagement and body movement. The question we specifically address here is whether an increase in task-related body movement imposed, or allowed, by the game controller will result in an increase of the player's engagement level. To address this question, we conducted two separate experiments. In the first experiment the participants played a same computer game using two different controllers that imposed different amount of task-related movement. To rule out the possibility that the shape of the controllers itself may be a confounding factor, a second experiment was performed in which the participants used the same controller with the difference that the amount of body motion imposed in the two conditions depended upon how the controller was used.

3.1 Experiment 1

Method

Fourteen participants (aged 25±4.4) were asked to play Guitar Hero, a music game for PlayStation. This game sees the player "play" the song by pressing a number of colour-coded buttons in sequence. The timeliness of each input contributes to the score of the player. Each participant was asked to play the game in two conditions. In the "pad" condition, the player was given a standard PlayStation DualShock controller, which only involved button pressing. In the "guitar" condition, the player was given a guitar-shaped controller that featured not only five fret buttons but also a strut bar and a whammy bar so that the device feels like, and plays like, a real guitar. With this controller, raising the guitar upward increases the player's "star power", which further encourages him/her to use full-body movements.

All participants were beginners and had no prior exposure to any such game. Before playing the game, the tendency of the participant to get immersed -- a potential predictor of engagement [10] -- was assessed using a revised version (GITQ)[1] of the Immersive Tendency Questionnaire (ITQ) proposed by Witmer and Singer [5]. This questionnaire was used with the assumption that engagement is the first step towards immersion. After filling the questionnaire, the participants were let to familiarize themselves with the game and the game controllers for a period of 5 minutes. The participants were fitted with a lightweight (6kgs) exoskeleton -- GIPSY by Animazoo (UK) -- on their upper body, arms and head, so as to provide angular measurements

[1] http://www.cs.ucl.ac.uk/staff/n.berthouze/Questionnaire/GITQ-RevFromWitmer98.pdf

for each of the upper-body joints. In addition, a video camera was placed in front of the participant to record his/her body movements during play.

Each participant was asked to play for 20 minutes in each condition, with each condition played over two different days. The order in which each participant played each condition was counterbalanced. After each condition, the engagement level of the participant was assessed using a revised version [2] of the Gaming Engagement Questionnaire (GEQ) by Chen et al. [11].

Results

Since both GEQ and GITQ are based on the theoretical work by Sheridan [1] who suggested that the factors that underline the concept of presence could be grouped into 4 categories (Control, Sensory, Distraction and Realism), it is reasonable to think of the tendency to get immersed as a predictor for engagement. To investigate how individual differences in immersive tendency actually related to the degree of engagement experienced, three correlation coefficients were calculated: (a) the Pearson's coefficient for the "dual-pad" condition (condition D thereafter), (b) the Pearson's coefficient for the "guitar" condition (condition G thereafter) and (c) the Pearson's coefficient when both conditions were pooled (condition D+G thereafter).

In the pooled condition, a significant correlation of $r=.610$ ($p<.01$) was obtained, thus justifying our prediction. When considering each condition separately, however, we found that this correlation was mostly accounted for by a significant correlation obtained in the G condition, $r=.810$ ($p<.01$) since the D condition showed a non-significant correlation of $r=.426$ ($p=.146$). The significance of this finding will be discussed later in the section.

To investigate the role played by the game controller in the engagement level of the participant, we performed a paired t-test on the engagement scores of the participants in each condition. The test revealed that players in the G condition returned significantly higher engagement scores ($t=3.659$, $p<.001$). This finding is corroborated by an analysis of the video recordings of the players. Such analysis showed a higher incidence of task related movements (such as keeping the beat using head and body) in the G condition that, at least qualitatively, correlates with a higher engagement. This analysis is discussed in section 4.

The amount of body movements in each condition was quantified by a measure (denoted Gypsy score thereafter) computed as the normalized sum of the total angular movement over the entire duration of the song. Concretely, a sum of angular differences between each consecutive frame was computed, summed up over all frames (60 frames per second), and normalized by the number of frames in a song to account for differences in song duration.

Prior to looking into any correlations between movement and engagement, a comparison of means between conditions D and G was done on the GITQ, GEQ and Gypsy scores. Since these scores have interpersonal differences, using absolute values might not be appropriate [30]. To standardize the scores, the Gipsy score X_n was z-transformed, i.e., demeaned and divided by the standard deviation σ: $Z_n=(X_n-\mu)\div\sigma$. Significant differences were obtained in both GEQ scores ($t=-3.659$, $p<.001$) and

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[2] Items that did not relate to gaming and engagement were excluded and some of the terminology was modified to suit measuring people playing games. http://www.cs.ucl.ac.uk/staff/n.berthouze/Questionnaire/GEQ-RevFromChen2005.pdf

Gypsy scores (t=-3.264, p=.002), both obtaining higher values in the G condition. A similar significant difference was not found in GITQ scores (t=-.768, p=.444). This lack of significance in the GITQ scores was reasonable since the participant's tendency to immersion should not be affected by any of the variables, including the change in game controller. Thus, these findings demonstrate significant differences between conditions.

In light of those findings, the correlations obtained earlier between the two questionnaires become significant. They suggest that providing the participants with either a more natural game controller, or affording them more movement facilitates this relationship. Given a similar GITQ score and the fact that engagement is considered the first step in immersion [10], the higher correlation obtained in the G condition demonstrates that the guitar-shaped controller enhanced the level of engagement the participants experienced.

3.2 Experiment 2

Method

To remove the possibility that the shape of the controller (and hence its novelty), rather than the movements it afforded and elicited, could be a factor in the increased engagement level, we carried out a similar experiment with the main difference that only the guitar-shaped controlled was used. In one condition (here again called D for consistency), the guitar-shaped controller was used as a dual-pad controller, i.e., the participants were taught all of those features that are controlled solely with the hands (i.e., fret buttons, strut bar and whammy bar). In the second condition (here again called G for consistency), instead, the participants were also informed about the tilt sensor in the neck of the guitar to acquire "star power". Eighteen participants (mean age of 20 and standard deviation of 0.77) took part in the experiment. All participants were beginner. Each group of 9 participants was asked to play one condition only since using the guitar knowing about the tilt-sensor feature but not being allowed to use it would have been too unnatural. Each participant was asked to play for 10 minutes after which his/her engagement level was assessed using the same revised version of the Gaming Engagement Questionnaire (GEQ) as mentioned earlier.

Results

After confirming that the GEQ score were normally distributed, they were analysed using a t-test. The test revealed that players in the G condition returned significantly higher engagement scores (t=5.123, p<.001) supporting the finding of the previous experiment, i.e., that the body movement imposed in the G condition appears to affect the engagement level.

To better understand how the conditions affected the engagement level, we measured the amount of motion of the players in two different ways. The first measures were computed using the data collected with the motion capture system. For the second type of measurements, we asked 3 observers (students from the Psychology department) to rate the amount of movement of each player over a 7-degree scale (10 minutes of video for each player). The observers were informed of the two experiment conditions and instructed not to consider in their evaluation the interval in which the players are raising their arms to get "star power". To examine the validity of these two types of measures, the average of the observers' scores was computed and correlated with the motion capture scores. A strong correlation was found between the two types of measurements (Pearson = 0.858, $p < 0.001$).

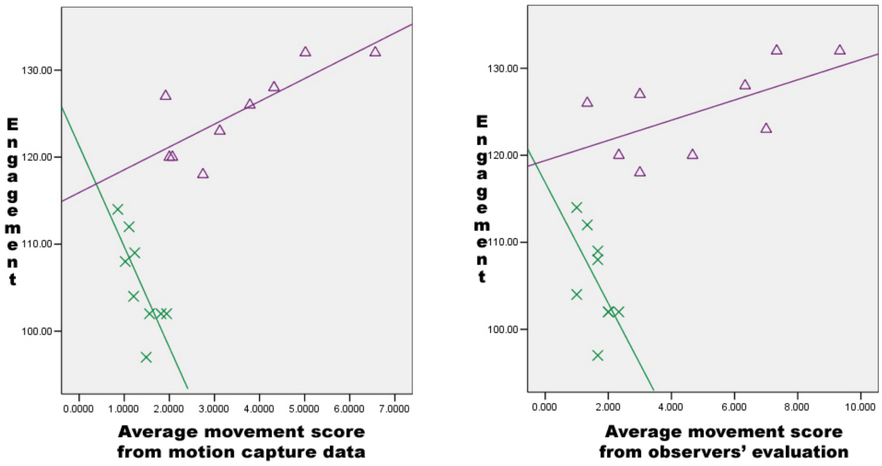

Fig. 3. Movement vs. engagement score. On the left, the amount of movement is computed on the data collected with the motion capture. On the right, it is computed as the average of the scores of 3 observers. We can observe a positive correlation for the G condition (Δ), and a negative correlation for the D condition (X).

We then computed the correlation between amount of movement and engagement scores. The left panel in Figure 3 shows the relation between amount of movement computed on the motion capture data and the engagement score, whereas the right panel depicts the relation between engagement score and movement as evaluated by the 3 observers. Both graphs reveal a positive trend in the G condition and a negative one in the D condition. The trend in the D condition (Pearson's coefficient = - .766, $p = .016$ for the left panel) seems to confirm the results of other studies that showed that attention in computer games is correlated with a decrease of body motion [36, 37].

In contrast, the trend in the G condition (Pearson's coefficient = .799, $p = .01$ for the left panel) appears to contradict such result as the amount of motion is positively correlated to the level of engagement in the player. We would like to suggest that conditions D and G simply involve two different levels and types of engagement. In condition D, players may be driven by a desire to win the game (hard fun), leading to an increased focus on the display. In condition G, instead, engagement may also derive from the feeling of becoming a guitar player (fantasy) and from the higher level of arousal and positive experience that it generates.

4 Affective experience

To confirm the hypothesis that this increased involvement of body movement affects the fantasy and the affective experience of the player, we selected from the videos collected in experiment 1, the clips that showed body movement that could either be related to affective expressions (see Figure 4) or be task-related movements (excluding the movement of raising the neck of the guitar). Twenty seven video clips, portraying 12 of the 14 participants, were obtained. As expected from the previous section, the number of clips that could be extracted from the G condition was much higher than in the D condition. Each clip included 2 seconds prior to the main motion and 2 seconds afterwards so as to provide some context. In total, the clips lasted about 5 to 8 seconds, depending on how long the expressional movements or gestures were (1 to 4 seconds). To provide a reference for the type of affective experience that may occur in non-computer games, ten clips of affective body movements from players playing a social board game were added to this pool.

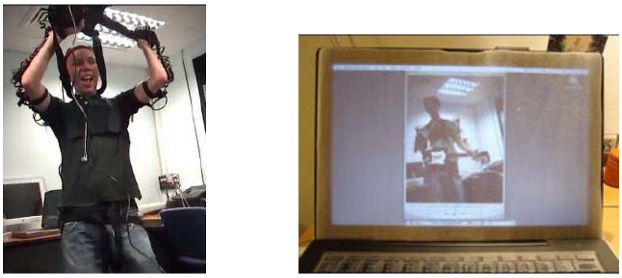

Fig. 4. Left: Example of body movement in the selected clips. Right: Experimental setting. A semi-transparent sheet was used to blur any facial information.

6 observers (students from the Psychology department) were asked to rate the body movements displayed in the video clips according to three affective dimensions (valence, arousal and power of control) on an 11-point scale. They were also asked to select, within a list of 22 affective words, the word that they felt best described the subject's emotions. The design of this list (excited, aroused, happy, content, relaxed, satisfied, bored, depressed, sad, miserable, frustrated, annoyed, angry, alarmed, surprised, frightened, disgusted, hateful, amused, disappointed, calm, joyful) was made on the basis of the Circumplex model of affect by Russell [31], a list of words proposed by Bowen [32] and by Peter and Herbon [30], and from a pilot study we conducted. In addition, the observers were also encouraged to select their own word if they could find a more appropriate one. The observers were allowed no more than 4 viewings of each clip and each session took approximately 30 to 40 minutes.

The randomized 37 clips were shown to the 6 observers using an Apple MacBook 2.0Ghz laptop computer with a 13.3" wide-screen display. To remove any possible confounds of sound and facial expressions, the clips were shown in mute and with a semitransparent sheet covering the display. The relatively low resolution of the clips (320x240 pixels) and the relative opaqueness of the material resulted in clearly visible body movements but blurred facial expressions (see Figure 4, right).

4.2 Results

Means and standard deviations were calculated for each clip's dimensions of arousal, valence and control. The scores were in the range [-5,5]. Mean scores were used to minimize individual differences and investigate the general consensus as a whole. It showed arousal, valence and control/power mean values to range from approximately - 2.5 to 3. All clips had a standard deviation of less than 2.5, except for five clips. The third dimension was found to essentially correlate with arousal (possibly because of a misunderstanding by the observers) and was therefore discarded.

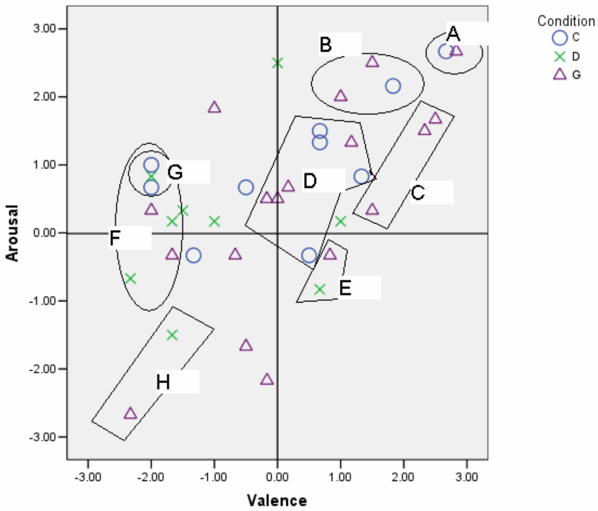

Fig. 5. Projection of the clips into the arousal and valence space and their clustering according to body gestures. O = social board game, X = D condition and Δ = G condition. Each cluster is denoted by a letter. The descriptions of the gestures in each cluster are in Table 1.

Table 1. Typical body movements observed in the clips corresponding to the clusters depicted in Figure 5 and the emotion labels used by the observers.

Cluster	Body gestures	Affective Labels
A	Raising arms up to mid air	Excited, joyful, happy
B	Shaking body in a rhythmic fashion (dancing)	Excited, content, aroused
C	Thumbs-up and arm bent	Happy, satisfied, joyful
D	Leaning back and shaking body	Amused, excited, happy, content, surprised, satisfied
E	Shaking head	Relaxed, content satisfied
F	Dropping arms	Disappointed, frustrated, calm
G	Shaking/shivering body while leaning back	Disappointed, frustrated
H	Very little movement	Bored, disappointed

Figure 5 shows the projection of the clips in the arousal/valence space. We analyzed that data in terms of whether adjacent clips in that coordinate system would show similarities in the associated body movements. Our analysis revealed 8 clusters, as shown in Table 1. Looking at the type of movement associated to each cluster, we can see that the high-arousal/high-valence quadrant contains movements that are related to positive emotions and to music-player movements. The opposite quadrant instead contains movements that can be related to negative emotion expressed possibly when the player made mistakes. What is interesting to notice here is that most of the clips for the D condition fall in the low-valence quadrants (predominantly around low/neutral levels of arousal). The clips from the G conditions fall mainly in the high-valence/high-arousal quadrant but still have a good representation in the low-valence/low-arousal quadrant. This supports our hypothesis that in the G condition, the affective experience is not only related to the performance in the game, but also to the enjoyment derived from the music-player role assumed by the player.

To rule out the possibility that the extraction of the clips could be biased, we repeated the experiment by asking 3 new observers to rate the complete videos of 6 participants (3 videos for each condition) randomly selected. The observers were asked to indicate the starting time and ending time of each negative or positive affective expressions or task-related movement (e.g., dancing, keeping the rhythm). The results showed a significant difference with a larger presence of positive affective expressions ($p < 0.0001$) as well as rhythmic movements such as dancing ($p < 0.005$) in the G condition.

5 Discussion

The significance of the findings reported in this paper must be qualified by the rather small size of the pool of subjects. Nevertheless, our studies indicate statistically significant relations between body movement and engagement which raise interesting questions.

Our main finding is that body movements appear not only to increase the players' level of engagement but also to modify the way they get engaged. The combined results demonstrate in fact that the controller itself plays a critical role in creating a more complete experience. By inducing body movement, the device resulted in a higher sense of engagement in the players and mediated a feeling of presence in the digital world. The players appeared to quickly enter in the role suggested by the game, here, a musician, and started to perform task related motions that were not required by the game itself. Gaming was no longer only a question of challenge; it was the experience itself that rewarded the players. A further analysis of the game scores of the participants could shed more light on the different type of engagement in the two conditions. Nonetheless, this is an important finding that supports the factor of fantasy of Malone [6] and Lazzaro [14] in their description of engagement. It also comes in contrast with the predominant view that the feeling of presence can only be induced by virtual reality environment. Another important observation is that the involvement of body movements appeared to address another of Malone's factor, i.e., the affective aspect of the game. As discussed in our section on the regulatory properties of body movements, the body movements also appeared to play a role in determining the players' affective state and hence in increasing the players' level of engagement.

In the G condition, task-related body movements (i.e., raising the guitar upward) resulted in the player displaying more excitement. It must be noted, however, that the resulting increased "star power" could also be a contributing factor. However, even within the same G condition, the engagement scores were positively correlated with the amount of movement of the player, thus supporting our hypothesis.

Describing the effect of interface on emotion and engagement, Brown and Cairns [10] claimed that there needs to be an invisibility of controls for total immersion to take place. With respect to human-machine interaction, this study opens the door to the development of systems, which, by involving bodily activity, can induce specific affective states and therefore improve user engagement. By looking at the relationship between engagement, behaviour and affective states in game play, we will be able to ground their relationship in a gaming context and be able to suggest a model for application in future games. By increasing the non-verbal response of the player, we are providing the game designer with a huge amount of information that could allow the creation of more social and entertaining games. Indeed, the experience of the player itself could be used as an input to the game. The impact of such approach could extend beyond the realm of gaming. Edutainment, for example, stands to benefit from methods aiming to support and facilitate task related movements in the user. Recent studies have shown that the use of body motion during cognitive processes supports these cognitive processes [38] even if the gestures performed are not necessary to the accomplishment of the task [33, 34].

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