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Exploring Players' Perceptions of the Haptic Feedback in Haptic Digital Games

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Abstract
This study explores the added value of haptic digital games as a novel and innovative form of human-computer interaction that complements and enriches traditional forms of visual and auditory communication. In light of the limited number of empirical studies in this area, the statement above becomes more significant. The use of haptic digital games becomes especially important when we consider that these games are not just passive digital applications where users do not act and passively receive information on their skin. Haptic interaction is an active form of communication in which the user receives information through vibrations, rumbles, pulses or thermal feedback on their body. Users intentionally choose their actions when exploring and manipulating an object or situation. These actions provide information about the properties of objects and thus give the player helpful feedback that affects the game experience. The main objectives of this qualitative study was to examine and clarify the features of haptic digital games that (a) increase player immersion and player engagement in the game, (b) make the game experience more realistic and compelling, and (c) distract or disengage them.

Keywords *Haptic technology, digital games, players' experience, haptic experience*

1. Introduction

Humans use their hands to explore and understand the world by perceiving the material, texture and shape of any object (Classen, 2020; Van Beek, 2017). Through the sense of touch, which provides information about the hardness, softness, elasticity and stiffness of an object, they also learn to recognise the effort required to handle these objects (van Beek, 2017; Hayward et al., 2004; Srinivasan & Basdogan, 1994). The importance of the sense of touch is obvious, as it has a great influence on people's attitudes, feelings and attitudes towards other objects (Racat & Capelli, 2020).

Haptics is defined as technology that stimulates the user's sense of touch (Andrews et al, 2006) and experiences and creates touch sensations in human operators (Hannaford & Okamura, 2016, p. 1064). This interaction is achieved through the use of haptic devices that transmit thermal, vibrating and pulsating information to the user, greatly enhancing the experience (Sathiyamurthy et al., 2021). There are also environments where communication via robotic systems is preferable, more practical or safer, such as when entering a nuclear plant to perform device maintenance (van Beek, 2017).

Thus the idea of haptic interaction emerged in the early 20th century and became known as haptic user interface. In the 1970s and 1980s, a lot of research was done in robotics. It turned out that developing robotic hands with haptic capabilities was much more difficult than originally thought. However, as the field of haptic interaction is a predominantly interdisciplinary field, it has been

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influenced by various disciplines, e.g. computer science, human-computer interaction (HCI) science, computer design, medicine, industrial design, architecture, etc. (Kumar, 2021; Sathiyamurthy et al., 2021). Thus, the term haptic user interface has been replaced by the term haptic interaction, which is considered more comprehensive as it encompasses all modern concepts and gives priority to design principles (touch and material, physical integration, physical interaction) over the visible interface (Hornecker & Buur, 2006).

A simple haptic system consists of a haptic device that is operated by the user and transmits information in both directions, from the user to a virtual environment and from the virtual environment to the user, creating a highly interactive environment. Information is conveyed to the user in different ways (Camacho et al., 2019). Haptics stimulate sensors (a) on the surface of the skin (tactile information), which inform the user about the nature of objects, shape, size, temperature, orientation, pressure, curvature, etc. (Hayward et al., 2004), and (b) through force feedback, which applies vibrations or pulsating movements to human limbs and joints, providing information about the mass, weight, hardness and strength of objects (Avouris et al., 2015). Tactile or kinesthetic information is sometimes used simply to enhance the user experience, sometimes to provide feedback to the user to improve performance, and sometimes to replace the lack of vision (Deng, 2013).

While in the early 2000s, designing and developing haptic games required expensive and complex software and hardware, today their development is inexpensive (Dalton & Musetti, 2018; Kazanidis et al., 2018) and more accessible even to primary school students (Chen et al., 2019), using low-cost hardware such as the Arduino open hardware development board (https://www.arduino.cc/), Makey-Makey (https://makeymakey.com/), Espressif (https://www.espressif.com/), Osmo (https://www.playosmo.com/en/), TopCode (http://users.eecs.northwestern.edu/~mhorn/topcodes/).

Today, haptics are being integrated into a variety of products, including smartphones (Bermejo & Hui, 2021; Verona et al., 2021), smartwatches (Graham-Knight, et al., 2020; Group, 2017) and robotic surgery (Schleer et al., 2019; Giannini et al., 2019). Haptic applications are a modern and interesting area of research in human-computer interaction that is developing rapidly and excitingly, offering opportunities for the development of new haptic digital games that combine visual, auditory and haptic information and can significantly influence human-computer interaction. The main objectives of this qualitative study was to examine and clarify the features of haptic digital games that (a) increase player immersion and player engagement in the game, (b) make the game experience more realistic and compelling, and (c) distract or disengage them.

2. Haptic technology in digital games

In the digital games industry, designers have deliberately incorporated the sense of touch to enhance the game experience and increase player engagement, in contrast to conventional digital games that only provide players with visual or auditory feedback (MacLean et al., 2017). Since the 1970s, arcade game developers have been thinking about how to make existing games more immersive. More specifically, Sega's Fonz in 1976 was the first arcade game to feature haptic feedback. In this game, a rider had to drive his motorbike along a road. To complete the route as

quickly as possible, the player had to dodge motorbikes from the opposite direction that were approaching at high speed. When the player's motorbike collided with another motorbike, he felt a vibration and rumble in his steering wheel. This was a novelty, as haptic feedback had never been offered to players before. This innovation seems to have led to great success in the USA and Japan, as the Fonz game was one of the ten best-selling games in Japan.

The success of Sega's Fonz prompted other digital game developers to create games with similar haptic effects. For example, in October 1983 Tatsumi Electronics developed TX -1, a racing simulation game that was later sold to Namco (https://bandainamco-am.co.jp/) and then to Atari Inc (https://atari.com/). Three screens on the TX -1 gave a three-dimensional feel. By pressing a pedal, the player could change his speed. Like Fonz, TX -1 was one of the best-selling games in Japan and one of the best arcade games. The haptic feedback that TX -1 offered set it apart from other racing simulation games. Every time the players braked or slowed down, spun at high speed or went off the track, they felt vibrations, pulses and rumbles on the game's steering wheel, which gave a more realistic driving experience compared to conventional, non-haptic digital games.

In 1989, Williams Electronics released Earthshaker! As the name suggests, it was a pinball machine inspired by earthquakes, so that the player experienced temporary vibrations as haptic feedback with every action in the game. Not surprisingly, the game was released with the slogan "It's a Moving Experience!".

In the 1990s, companies stopped developing arcade games, mainly because of the advent of consoles such as the Microsoft Xbox (https://www.xbox.com), Sony PlayStation (https://www.playstation.com) and Nintendo (https://www.nintendo.com/), which shifted gamers' entertainment from the familiar "arcades" to home entertainment. Microsoft Xbox, Sony PlayStation and Nintendo sought to incorporate haptic feedback into their original consoles, which they had been developing since 1995, to make the gaming experience more exciting and interesting. This happened in 1997 with the development of game controllers with built-in haptic feedback, such as the Sidewinder Force Feedback Pro from Microsoft or the N64 Rumble Pak from Nintendo and the DualShock from Sony. In recent years, game manufacturers have developed several different versions of these controllers, all designed to enhance the gaming experience
A system called PHANToM (Personal HAptic Interface Mechanism) was developed in 1995 (Massie & Salisbury, 1996). The arms of this robot were equipped with socket-shaped sockets that were connected to computers. This allowed a person's finger to be inserted into the socket and feel objects on the screen.

In the 2000s, things started to change. After realising the added value of haptic feedback, various companies tried to develop new devices that offered better haptic feedback. For example, TNGames (https://tngames.com/) introduced its ForceWear Vest at the San Francisco Game Developer's Conference in March 2007. The vest was renamed the 3RD Space Vest in November 2007 and was available for purchase for the first time. The 3RD Space Vest can be used in 50 different first-person shooter games (FPS). Using air pressure actuators, it simulates the impact of bullets or other explosive devices in eight different areas of the body, four on the front and four on the back.

Depending on the range and strength of the incoming bullet or weapon, the player receives different feedback.

Palan et al. (2010) have developed a new haptic vest. In addition to simulating bullets and other objects, this device can simulate flowing blood on the player's body, punches or kicks to the body, and fluctuations in ambient temperature. This feedback greatly increases the player's immersion in first-person shooter and third-person shooter games. According to Palan et al, 2010, the device can also be used for training military teams and makes video games even more realistic. In recent years, several devices have been developed to facilitate haptic interaction between humans and machines. These include controllers (Oculus, Windows Mixed Reality, Steam VR, Pico), hand tracking (Ultraleap Gemini, Leap Motion, Oculus Quest 2, Microsoft HoloLens 2), haptic gloves and exoskeletons (Senseglove, Manus, BeBop Sensors) and wearable devices (Woojer, Audio haptic devices). The combination of these devices and advances in digital game development have allowed us to create high-quality haptic games that immerse players in a virtual environment (Hou et al., 2014) and let them feel the game (Soderstrom et al., 2022).

As mentioned earlier, research needs to be done to gain insights into players' perceptions and ideas. In order to design games that make the best use of haptics, we need to find out what features of haptic games players like or dislike, that keep them engaged and immersed, or that irritate and distract them. The following chapters of this paper present a qualitative research study that attempts to achieve the above goals.

3. Research method

3.1. Research focus and questions

The main objectives of this qualitative study was to examine and clarify the features of haptic digital games that (a) increase player immersion and player engagement in the game, (b) make the game experience more realistic and compelling, and (c) distract or disengage them. This research aims to answer the following research questions based on the above objectives:

Research Question 1: What are the primary features of haptic digital games that lead to greater immersion and player engagement with the game?

Research Question 2: What are the primary features of haptic digital games that make the game experience more realistic and compelling?

Research Question 3: What are the primary features of haptic digital games that disengage or distract players?

3.2. Design of the research process

The aim of this study was to examine and clarify the primary haptic technology features of digital games that determine whether the gaming experience is positive or negative. For this qualitative study, three digital games were selected to be played by participants on three different digital media:

"Forza Horizon" was played on the Xbox console, "Angry Birds Friends" was played on a tablet and "Clouds and Sheep" was played on a smartphone.

A total of 10 children aged 9-12 years participated in the study in three phases. In the first phase, an interview was conducted to establish participants' demographic data and prior knowledge of haptic digital games and haptic feedback. In the second phase, participants were asked to play with 3 haptic games for 15 minutes each. In the third phase, the researcher asked participants six open-ended questions to gain a deeper understanding of their perceptions and attitudes towards haptic feedback. The whole process lasted 50-60 minutes per participant. In all interviews, the researcher acted as both interviewer and recorder. Recording was supported by the use of an audio recorder, which recorded both the participant and the researcher throughout the interaction with the participant's consent.

3.3. Participants

A combination of two methods was used to select the research sample. The first approach was the self-selection sampling method, followed by the convenience sampling method (Saunders et al., 2012). In the self-selection sampling method, participants are selected to participate who consider the research valuable to them, which increases their response rate and willingness to provide information (Thornhill et al., 1997). In contrast, the convenience sampling method selects participants based on their availability and ease of participation (Saunders et al., 2012). When exploring a new phenomenon such as haptic technology and haptic feedback, both self-selection and convenience sampling are considered the most appropriate methods because participants either know little about the topic or are unsure (Saunders et al., 2012).

While Moran (2019) suggests involving five subjects in similar qualitative research to uncover the most common problems with a product, this study involved 10 subjects to collect data. The participants were between 10 and 13 years old. The parents and guardians of the children were sent a letter informing them of all aspects of the research project and asking for their parental consent. The parents and guardians were informed that they had the right to withdraw their consent if they no longer wanted their child to participate in the study. It was made clear to them that the children's personal information and research data would only be used for the needs of this research project and would not be shared with third parties. Before the research began, a discussion session was held with the children so that they could receive the necessary information about the purpose and process of the research project, ask questions and understand their participation. It was explained to them that they could withdraw their consent if they changed their mind at any stage of the experiment and no longer wished to participate in the research.

3.4 Data collection instruments

Data collection was based on semi-structured interviews. A literature review on haptic technologies in digital games served as a guide for the design of the interviews. The context of the interview included introductory remarks to explain the purpose of the interview and to create an environment for

meaningful discussion between the researcher and the participants. At this stage, each participant completed a questionnaire to collect demographic information.

The semi-structured interview covered six topics, including the following questions: (a) Does haptic technology give you realistic and convincing feedback? (b) Do you feel more immersed and engaged in the game when you receive haptic feedback? (c) Do you sometimes find haptic feedback distracting or disengaging? (d) Are there features of haptic games that you particularly like? (e) What features of haptic games do you dislike? (f) How would you like to see haptic technology used in digital games?

4. Results

This chapter describes the participants' perceptions and ideas about haptic feedback according to different topics.

Topic 1: Does haptic technology give you realistic and convincing feedback?

- Seven out of ten participants reported that haptic digital games are more convincing and realistic than conventional digital games because they feel the haptic feedback with their hands, which makes the experience more vivid and closer to their real lives.

> ... when I drive the car in Forza Horizon and take a turn, the vibration I feel in my hands makes the game more realistic.
>
> ... when I change gear in the car, the controller vibrates and that makes driving more believable.
>
> ... the haptic feedback lets me know that I have done something, that I have chosen something. It confirms to me that I have done something right or wrong without seeing it with my own eyes.

- Two participants stated that the feedback in haptic digital games is realistic because they feel with their body what is happening in the game, or they feel the different force they have to exert on different bodies, which is not possible in conventional digital games.

> … For me it is important that I can feel with my hands what is happening in the game.

- One participant explained that haptic digital games are more realistic than conventional digital games, although there are sometimes problems that reduce the realism of the experience.

> ...while in reality the gun does not work if it falls into the water, in games this does not happen. In this case, I would like to get feedback that the weapon does not work.

Topic 2: Do you feel more immersed and engaged in the game when you receive haptic feedback?

- Eight out of ten participants reported that haptic feedback is engaging.

  ... it excites me and makes me want to play on.

  ... the haptic feedback makes it easier for me to concentrate on the game.

  ... I want to play because it makes me feel more involved in the game.

- Some participants felt that interaction could be improved if the device gave different feedback

  ... It would be nice if there were different feedback for different game events.

- One participant stated that the haptic feedback does not make the game more interesting.

  … sometimes the vibration bothers me.

Topic 3: Do you sometimes find haptic feedback distracting or disengaging?

- The majority of participants said that haptic feedback does not distract or disengage them. One of the participants said that haptic feedback can sometimes be distracting if it is given for no particular reason

  … the controller sometimes vibrates for no reason, which bothers me.

Topic 4: Are there features of haptic games that you particularly like?

- Many participants indicated that they liked haptic feedback when it worked together with visual and auditory feedback. Combining haptic and visual feedback in a game was felt to be more useful. Most participants feel that haptic feedback can replace auditory feedback, but not visual feedback completely. The latter is only possible during certain game events. In these events, the player may not be able to rely on the game graphics, either because he has poor vision or because he needs to use his vision for some other reason. In these cases, haptic feedback could serve as a substitute for vision.

  .. I like to focus on the road, see the road, and at the same time play the game with the haptic feedback informing me of something else, like that I am in danger of going off the road.

  … there are times when I am warned about something I can not see, and I like that.

- Others said they enjoy feeling things that happen in the game with their hands.

  …I like the vibration in shooting games.

  …I like the vibration in racing and car games.

  …I like the feeling when a bullet comes out of a gun.

Topic 5: What features of haptic games do you dislike?

- Almost all participants felt that there was nothing they disliked or found annoying about haptic games. One participant reported that haptic feedback is sometimes annoying when it has no meaning.

> … I do not like it when the controller vibrates so much that sometimes I feel like it's going to slip out of my hand.
>
> … sometimes it bothers me when the controller vibrates for no particular reason.

Topic 6: How would you like to see haptic technology used in digital games?

- The majority of participants stated that in haptic games they want feel with their hands what is happening in the game, feel the vibrations of weapons or the steering wheel of a car, to feel the temperature of the environment or objects they are interacting with and feel their weight.

> … I want to feel what is happening in the game.
> … I want to feel the vibration when the car crashes.
>
> … in Call of Duty, sometimes the player splashes. I do not just want to hear the sound of the splash, I want to hear the controller vibrate so I can understand it better.
> … I want to feel the heat when the car catches fire.
>
> … I wish there was haptic feedback in horror games. It's night and dark and suddenly something vibrates in your hands and you get scared, otherwise it's not like that
> ... I want to feel the coldness of the environment
>
> … I want to feel when I can escape from a building when I am in danger.
> scary.
> … in Roblox, when you open a car door to steal it, when you crash, when you speed up, you feel the vibration.

- Most participants stated that haptic feedback should be given as a reaction of the game to certain actions of the player.

> ...I would like to get haptic feedback as a reaction to what I am doing.

- Some participants would like haptic feedback to be given when the player needs confirmation of something they have done, or a warning of something that might happen to them, or information about how close or how far they are from reaching a goal.

> ... it would be very useful if it could warn me about something or let me know how close I am to something

- Participants also agreed that haptic feedback should only be used when needed and that players should be able to turn it off or on.

> ... it would be very helpful if I had the feedback when I needed it and if I did not have it when I did not need it

- Many participants agreed that haptic feedback can replace sound as feedback in environments with loud outside noise where the game sound cannot be heard, or in very quiet environments where the game sound might disturb other people. Many participants argued that haptics would help the games industry to develop games for the hearing impaired.

5. Discussion

The purpose of this chapter is to categorise players' ideas and perceptions of haptic feedback in digital games and to explain why players have positive or negative feelings about it.

5.1. Increasing the realism of games

Realism is an important factor in the gaming experience. In recent years the quality of graphics has been improved, resulting in more realism and better performance, thus improving the overall gaming experience (Kappers, 2011). For example, in modern digital games, the racing cars are more similar to real racing cars, their engine sounds are more similar to the engine sounds of real racing cars and their driving behaviour is more similar to real cars. Furthermore, in modern digital games, players can not only shoot or blow up their virtual opponents, but they can also perform these actions on various objects in the game, such as doors, windows, walls and anything else in the virtual world of the game, shooting deadly shards depending on what they are made of. However, things are not always perfect .

Realism is a concept that is not easy to define. Often game designers and developers overdo it in their efforts to create realistic gameplay. What is considered realistic in a digital game may not be so in real life. In a racing game, for example, a car can run off the road, hit a wall and continue as if nothing had happened, even though in real life this action would have destroyed the car and seriously injured the driver. Similarly, in a fighting game, a player can submerge his weapons in the water of a lake, a river or the sea, and although the weapons are wet, they can still function normally. These are all problems that affect the realism of games.

In spite of the above problematic situations on the subject of realism, it must be emphasised that game graphics are not sufficient to make us feel that the game world is real. We can only perceive the virtual game world as real if the virtual world reacts realistically to us. Anything that does not respond to the player's actions is an unrealistic object. Dealing with digital games raises the question of disembodiment. It seems that playing digital games is an activity detached from reality and disembodied. The game console is located far away from the computer or television screen on which all gameplay takes place, and the only interface between the player and the game is the use of keyboard, mouse or controller (Low, 2001). At this point, haptic digital games offer the solution to the

problem of disembodiment. Touch activates the player's body, which increases the realism of the games and enhances the perception of reality. Touch reduces the distance between the player and the screen. The player feels in his hands, body and feet the interaction with the virtual world of the game. He not only sees and hears the result of the interaction between user and computer, but also feels it in his own body. He feels the vibrations caused by hitting an object or the warmth of a radiator. Adding more stimuli makes the game seem more realistic as users interact with the game through these additional senses (Lee et al., 2013). Several studies have shown that games that use multiple senses provide a more positive experience compared to unimodal games (García-valle et al., 2017; Moll, et al., 2010; Sigrist et al., 2013) and significantly improve realism (Lee et al., 2013).

5.2. Increasing immersion, presence and emotional engagement

Immersion and presence are concepts that are very important for the digital games industry as they are responsible for the positive emotions that come from games and the pleasure that players experience. When players enter a state of immersion, they become more focused on the game, become completely absorbed in it and lose sense of time and place (Brown and Cairns, 2004). According to Brown and Cairns (2004), three levels of immersion can be distinguished in digital games: engagement, the first level of immersion, which refers to the player's lowest level of involvement in the game; engrossment, the second level of immersion, which refers to the player's higher level of involvement and devotion to the game; and total Immersion, where the player is cut off from reality and so absorbed that the game is the only thing that interests them. Since total immersion is not always possible and can only occur under certain conditions, the model of an average immersive and a highly immersive experience in digital games can be limited to the degree of engagement or engrossment.

On the other hand, presence in games is the situation in which a person's cognitive and perceptual systems make them believe that they are in a place other than their physical location (Patrick et al., 2000), that they are in the game world (Brockmyer et al., 2009). It is common to consider the concepts of immersion and presence as a single, identical concept (McMahan, 2003). Patrick et al. (2000) and Brown and Cairns (2004), for example, equate the concept of total immersion described above with the concept of presence. According to these researchers, engagement and engrossment are the precursors of the experience of total immersion and presence, even if players never reach this higher psychological state. Based on this, modern conventional digital games that use the technology of 3D images, stunning graphics and effects, and stereo sound largely succeed in engaging and absorbing players in their virtual worlds, evoking positive emotions and providing pleasure.

However, of the five human senses, traditional digital games only use two: sight through stunning graphics and hearing through sound effects. However, in haptic digital games, players can also use the sense of touch to feel some of the objects that make up the digital world (e.g. to feel the resistance or weight of an object) or to feel the texture of objects to gain more information about them. By using haptic digital games, the player is offered activities that engage the three basic senses and it is easier and more efficient to achieve what the games industry calls total immersion and presence. Just imagine how much more immersive and enjoyable the experience of playing a video game for

consoles and computers can be through the use of the Feelbelt haptic belt (https://www.kickstarter.com/projects/1267629547/feelbelt-strap-it-feel-it-love-it), which gives the player a thrilling experience of driving a race car. Due to the haptic technology, the player can feel the forces acting on the body of a racing car during cornering or sudden acceleration, or the vibrations when the wheels of the car leave the track. Combined with the beautiful graphics and impressive sound effects, the player can immerse himself in what we call total immersion or presence, which makes the gaming experience very enjoyable.

Another important factor of a digital game is the level of user's emotional engagement with its content. Emotional engagement refers to the user's effort, attention and perseverance in starting and completing an activity (Skinner et al., 2008). Emotional engagement includes the user's excitement, interest and enjoyment (Meyer & Turner, 2006). In the body of the literature, emotional engagement is considered a strong predictor of user performance (Skinner et al., 2008), i.e. the stronger a user's emotional engagement, the more likely they are to successfully complete the activities they are engaged in. In the field of haptic digital games, significant efforts have been made in recent years to achieve uesr' emotional engagement in games. Special haptic devices have been developed, such as iFeel_ IM! The iFeel_ IM! (Tsetserukou and Neviarouskaya, 2020) is a wearable system that transmits haptic feedback to different parts of the human body, such as the heart, arms, stomach and ribs. The haptic device visualises emotions through the avatar in a virtual world, enhances and improves the user's emotional state and reproduces the so-called social touch through haptic stimulation in the real world. The player feels the emotional state of his avatar in the game through the wearable haptic device by understanding the intense beating of his heart, the fluttering of the butterfly in his stomach or the embrace of his teammates.

5.3. More effective interaction and communication

Most modern digital games require complex actions from players. For example, a player can run, jump, shoot and protect himself from the opponent's shots at the same time. For this reason, game controllers have been developed in modern gaming devices such as the Xbox or PlayStation to help players perform several similarly complex actions. Haptic digital games can provide more effective interaction and communication by allowing players to interact with the virtual environment in a much more natural way, using one of the most important human senses, the sense of touch. Haptic technology adds what is known in haptics as "biohaptics", where the player's hands or body receive the haptic feedback from the game. Imagine how much better our interaction and communication with the smartphone or smartwatch is when we can feel the vibration triggered by pressing a virtual button. The confidence we have gained comes from the feeling of that vibration. Or even more, how much the player's communication with the game can be improved when, while busy with many different actions at the same time, they can feel the press of a certain button through the vibration without necessarily having to control it with their own eyes. When haptic feedback is given in different forms for different actions of the player, this can be a much more positive experience as players know what action they are getting feedback on without having to take their eyes off the game screen. Players' interaction

with the game via the sense of touch not only affects their immersion and sense of presence, as described above, but also the accuracy of their movements (Vosinakis & Koutsabasis, 2018).

According to the research, user-computer interaction can be more effective whwn a game offers vibrations, shocks or pulses for a reason. Furthermore, haptic feedback should be designed in such a way that it does not surprise or distract the player. In many cases, haptic feedback can lead to negative results if it is transmitted for no particular reason. Haptic feedback should generally be avoided if it is extensive or repetitive. It is better to give players a small amount of meaningful, consistent haptic feedback than a large amount of trivial feedback.

6. Conclusion and proposals

From the research findings, we can conclude that the features of haptic digital games and the haptic feedback they provide to users significantly enhance the player's immersion and presence in the game world, increase the realism of the games, improve the effectiveness of player-game interaction, increase the player's embodied learning and emotional engagement with the game. Haptic features make digital games more realistic and enhance the gaming experience.

To conclude this study, we present some suggestions for optimising the game experience and human-computer interaction:

(a) Simple haptic effects are often most effective

Paraphrasing the saying of brothers Julius Charles and Augustus William Hare "the best truths are the simplest" (Hare and Hare, 1848, p. 304), we would say that "the best haptic feedback is the simplest". The feedback that haptic digital games provide does not need to be complex and complicated. What a player needs when playing a game is to perceive what is happening in the game world through touch. The simpler the haptic feedback, the more useful it is.

(b) Haptic effects combined with visual and sound effects enhance the overall experience

Haptic feedback cannot bring the interaction between player and game to an optimal level. A combination of haptic feedback with other types of feedback, such as visual or auditory, is essential. The inclusion of other human senses besides touch creates a multi-sensory digital environment where players receive information through multiple sensory channels, making the game an immersive experience.

(c) Haptic effects must not disturb, confuse or overwhelm the player

It is certainly very nice when the player feels the touch of a virtual button with his hand. But the frequent use of haptic feedback can lead to what is called haptic overload. It is used so frequently that it confuses players. This is evident in the case of Jane Manchun Wong, who announced on Twitter that Instagram plans to introduce haptic feedback for Likes. From the comments that followed this post, it appears that users are concerned about this idea. In addition, Apple's developer guide (Playing haptics, for example) suggests that haptic feedback should be used with caution, as trying to add something innovative can lead to negative results. It is a good idea to provide haptic feedback on

a small number of meaningful, consequential haptic interactions rather than a large number of trivial haptic interactions, as this can overwhelm players. In general, extensive or repetitive haptic feedback should be avoided. Often the best haptic experience is one that players do not notice, but miss when it is turned off.

d) It is good to allow the player to choose the type of feedback effect they want

A crucial factor in the playability of a game is the type of feedback the player can receive depending on the context in which the game is played. To make the above argument more understandable: If players are playing the game in a computer lab at school or on a crowded public transport, it is important that they can turn it down or turn it off completely so that other students or passengers are not disturbed. If at any point in the game the player feels that the haptic feedback is distracting, confusing or just plain annoying, it is a good idea to have the option to turn it off.

In summary, haptic technology has significantly changed the way games are played and experienced. Of course, we cannot estimate what will happen in the future and how much haptic technology and haptic games will evolve. But since an important success factor of digital games is the degree of player engagement with the game, it is certain that the future of haptic games is promising. The big question is whether the game designers will be able to achieve the emotional involvement of the players that will drive the success of the games up.

It is important to mention that the research conducted so far faced a number of limitations: (a) the focus groups were conducted with children only, without teachers or parents present; (b) the research focused mainly on primary school children; and (c) the aim of this study was not to determine whether or not haptic digital games provide better or worse experiences for children than traditional digital games. Therefore, no control group of children was recruited to be interviewed about their experiences with conventional digital games to gather their own opinions.

Last but not least, further research aims to:

(a) developing of a haptic digital game based on children's perceptions of haptic technology as captured in the present research. This haptic game will be tested and evaluated with children to determine the meaningfulness, usefulness and reliability of the findings of the present research, and,

(b) exloring whether the immersive and challenging environment of haptic technology, combined with the highly influential environment of a digital game, can lead to over-stimulation and addiction in children and negative effects on their development and mental health.

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