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How the position and behavior of a video game's health meter affect the player's behavior and his/her understanding of the game?

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Preface

This paper is the result of two years of work to graduate Communication at the UCLouvain FUCaM in Mons. It will study how the position and behavior of a video game health meter affect the player's understanding and behavior of the game. Being myself a gamer since my childhood, I always knew I would eventually work on video games. The idea of this paper came to me after doing a work on user experience focusing on the game digital distribution platform *Steam* for the Media Literacy course.

More and more development studios start to use UX Design to improve the gameplay or the user interface. The interface is the most efficient way to communicate with players. If it is poorly designed, they might find the game frustrating or unfair because of the lack of crucial information at the right time. However, a game user interface consists of many elements (health meter, ammunition, mini-map…) that's why I decided to focus on the most important one for me: the health meter.

The purpose of this paper is to be able to come up with recommendations to help development studios design better, more efficient, more understandable health meters and therefore, design better, more user-centered designed video games.

Writing this paper has not been easy. Indeed, there are not a lot of relevant articles concerning my researches's very topic unfortunately. This new industry is not well established in Belgium yet, so it was rather hard to find Belgian players's data. Moreover, even if I have never had difficulties with this language, it was a real challenge to write the entirety of this paper in English, but it was more relevant considering its final purpose. I'm glad I was able to make it.

Acknowledgments

Cette partie spécifique du mémoire sera la seule rédigée en français, je veux être certain de me faire comprendre par toutes les personnes citées.

Tout d'abord, je souhaiterais remercier Mme Suzanne Kieffer, professeure à l'Université Catholique de Louvain. En tant que promotrice, elle m'a guidé pendant toute la réalisation de ce travail en me conseillant et me recadrant lorsque cela fût nécessaire. Son intérêt pour le thème de ma recherche a été une source de motivation constante pour moi.

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Je désire remercier également les personnes ayant accepté de participer à mon expérimentation pour le temps qu'ils ont consacré à ma recherche et leur sérieux durant les expériences.

Finalement, je souhaiterais remercier ma mère sans qui il m'aurait été impossible de réaliser ce master en communication et ce mémoire. Je remercie, elle ainsi que toute ma famille proche, pour le soutien et la compréhension dont ils ont pu faire preuve pendant toute la durée de la rédaction de ce mémoire.

Je souhaite remercier spécialement ma compagne, Marie, pour sa patience, sa bienveillance et son soutien lors des moments de doutes, de frustrations et de stress qui ont ponctué le processus de rédaction de ce mémoire. Ce mémoire ne serait pas ce qu'il est maintenant sans elle.

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I. Glossary

- Head-Up Display (HUD): “any transparent display that presents data without requiring the user to look away from his or her usual viewpoint.”[1] It is “*the method by which information is visually conveyed to the player whilst a game is in progress.*”[2]

- POV (Point of view): in video games, it defines the angle of the camera which can be first-person (FPP), third person (TPP), Top-down (a view from above) or a mix of several views.

- First-person perspective (FPP): a camera angle that let us see through the eyes of the character.

- Third-person perspective (TPP): a camera angle that shows us the character from behind or by side and that follows him/her/it through his/her/its actions.

- Top-down: a camera angle that shows us the character and the world from above like in a helicopter.

- Mixed: a mix of several camera angles (FPP, TPP, Top-down). Games with a mixed POV either let the player decide the view he/she prefers or impose a specific POV for a certain gameplay phase.

- Gameplay: “*Term used to define the way players interact with a certain video or computer game. It is further characterized as the way the game is played, including the rules, the plot, the objectives and how to conquer them, as well as a player's overall experience.*”[3]

- Adventure game: “*Games which are set in a "world" usually made up of multiple, connected rooms or screens, involving an objective which is more complex than simply catching, shooting, capturing, or*

[1]Fagerholt, E., Lorentzon, M., & Björk, S. (209apr. J.-C.). *Beyond The HUD: User Interfaces for Increased Player Immersion in FPS Games*. 124.
[2]Ibid.
[3]Techopedia, *Gameplay*, (Page visited on 23 October 2018), [webpage], https://www.techopedia.com/definition/1911/gameplay

escaping, although completion of the objective may involve several or all of these."[4]

- Fighting game: "*Games involving characters who usually fight hand-to-hand, in one-to-one combat situations without the use of firearms or projectiles.*"[5]
- Hack'n Slash game: Type of game where the player fights against several enemies and tries to get the best score possible.
- Platformer game: "*Games in which the primary objective requires movement through a series of levels, by way of running, climbing, jumping, and other means of locomotion. Characters and settings are seen in side view as opposed to the top view, thus creating a graphical sense of "up" and "down" as is implied in "Platform.*"'[6]
- Puzzle game: "*Games in which the primary conflict is not so much between the player character and other characters, but rather the figuring out of a solution, which often involves solving enigmas, navigation, learning how to use different tools, and the manipulating or reconfiguring of objects.*"[7]
- Racing game: "*Games based primarily on driving skills, such as steering, maneuverability, speed control, and fuel conservation. It can also describe Games in which the objective involves the winning of a race, or the covering of more ground than an opponent*"[8]
- Role-Playing game (RPG): "*Games in which players create or take on a character represented by various statistics, which may even include a developed persona. The character's description may include specifics such as species, race, gender, and occupation, and*

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[4]Wolf, M. J. P. (2002). *Genre and the Video Game. In the Medium of the Video Game* (University of Texas Press).
[5]Ibid.
[6]Wolf, M. J. P. (2002). *Genre and the Video Game. In the Medium of the Video Game* (University of Texas Press).
[7]Ibid.
[8]Ibid.

may also include various abilities, such as strength and dexterity, to limited degrees usually represented numerically."[9]

- Rhythm game: "*Games in which gameplay requires players to keep time with a musical rhythm.*"[10]
- Sandbox game: "*A game in which the player has been freed from traditional video game structure and direction, and instead chooses what, when, and how they want to approach the available content.*"[11]
- Shooter game: "*subgenre of action game, which often test the player's speed and reaction time. It includes many subgenres that have the commonality of focusing on the actions of the avatar using some sort of weapons. Usually this weapon is a gun or some other long-range weapon.*"[12]
- Simulation game: "*Games or programs which attempt to simulate a realistic situation, for the purpose of training, and usually the development of some physical skill such as steering (as in driving and flight simulators).*"[13]
- Strategy game: "*Games emphasizing the use of strategy as opposed to fast action or the use of quick reflexes, which are usually not necessary for success in these games.*"[14]
- Survival game: "*Subgenre of action video games set in a hostile, intense, open-world environment, where players generally begin with minimal equipment and are required to collect resources, craft tools, weapons, and shelter, and survive as long as possible.*"[15]

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[9]Ibid.
[10]Ibid.
[11]Wikipédia, *Glossary of video game terms*, (Page visited on 23 October 2018), [webpage], https://en.wikipedia.org/wiki/Glossary_of_video_game_terms#Sandbox_game
[12]Wikipédia, *Shooter game*, (Page visited on 23 October 2018), [webpage], https://en.wikipedia.org/wiki/Shooter_game
[13]Wolf, M. J. P. (2002). *Genre and the Video Game. In the Medium of the Video Game* (University of Texas Press).
[14]Ibid.
[15]Wikipédia, *Survival game*, (Page visited on 23 October 2018), [webpage], https://en.wikipedia.org/wiki/Survival_game

II. Introduction

Current standards of video games graphic design are not well documented in scientific literature and remain virtually nonexistent within development studios. For example, the position and the behavior of basic elements (health meter, experience bar, map, inventory, etc.) are different from a game to another and vary over the years mainly due to hardware limitations. Because of that, players, beginners or confirmed, can encounter problems of comprehension, location or usage of those basic elements in particular when they discover the game for the first time. All those problems can harm the user experience.

This paper focuses on the health meter within video games for the following reasons:

Firstly, the state of the health meter defines if the game continues, stops or starts over. It is a major element in most video games opposed to others such as experience bar, inventory, map, compass, etc.; making this element an object of analysis simultaneously representative of the problem and relevant for the research.

Secondly, with more than 7000 new video games coming out every year on online platforms (for example. Steam, Origin or Uplay), the analysis of all previously mentioned elements is a problem too wide to be studied in the context of this paper.

The main goal of this paper is to come up with recommendations concerning health meters for the attention of the video game industry and the scientific world in the field of video games. The goals are:

- Describe potential patterns of health meter position or behavior;
- Analyze the influence of those patterns on the behavior and user experience of players. The paper is divided in two successive analysis stages, each corresponding to a goal cited above.

III. Theoretical Framework

For this research, we decided to search information and theories for key elements. Those elements include:

- Health meters
- Human-Computer Interactions / User-centered Design
- User Experience Design
- Eye tracking in video games

Those theories helped us to better understand the importance of health meters, how a player can interact with a system, the current state of UX Design in video games and the current state of eye-tracking technology in the video game industry.

A. Health meters

Since the first gaming console was released in 1975, every new generation has been more powerful than the one before. Game designers are less and less restricted by hardware limitations which allows them to design better games where health meters are not always compulsory. Before home console, video games didn't need health meters as they were only available on arcade systems designed to make money. The more a player lost, the more he spent in the machine. Health meters systems first appeared in *Dungeons & Dragons* paper game as it was fairer for players to be able to take damage rather than risking dying anytime[16]. It was then adopted in video games with upcoming genres such as Fighting[17] or Platformer[18] and became common in home consoles games.

As far as I can remember, I always encountered some kind of health meters in every game I played. May it be a bar, points counter, both or something completely different, most video games use a health meter as a game-state feedback between the user and the game itself. The goal of a game-state

[16]Moore, M. (2011). *Basics of Game Design.* A K Peters/CRC Press.
[17]See glossary for more information
[18]Ibid.

feedback system is to "*inform the player about the current state of the game*"[19] and a health meter is only one type among many others.

However, a health meter is not enough to fully grasp what is happening in the game as *"it is part of a complex network of signs"*[20]. It is only one of the many ways available for the game to communicate with the user, but it is not enough in itself. The interpretation of the health meter state within a game can depend on several variables: are there enemies around? How low is their health? Do I have anything to regain health?[21] All those variables have an influence on the strategy of the user to win, will he play safe or take a risk? The health meter is therefore only a sign that needs to be put with others to be fully understood.

The health meter within a game is most of the time part of a layer, called the Head-Up Display (HUD)[22], between the user's and the game's reality which generally presents "*system information on a separate layer allows designers to give players an insight into the intricate inner machinations of more complex systems and virtual worlds*"[23]. HUD elements can be diegetic (they exist inside the game's world) or non-diegetic (they are only available for the user)[24]. The health meter is therefore not only a game-state feedback but can also be part of the game story and can enhance immersion. For example, in the game *Dead Space*, the health meter is displayed on the spine of the main character suit and the ammunition on the gun itself. This was a decision from the studios as they supposed that diegetic HUD elements will increase the player's involvement in the game[25]. This was partially confirmed by Iacovides, I and al. saying that "*diegetic interface may*

[19]Fagerholt, E., Lorentzon, M., & Björk, S. (2009). *Beyond The HUD: User Interfaces for Increased Player Immersion in FPS Games*. 124.
[20]Tekinbaş, K. S., & Zimmerman, E. (2003). *Rules of play: game design fundamentals*. Cambridge, Mass: MIT Press.
[21]Ibidem
[22]See glossary for more information
[23]Llanos, S. C. (s. d.). *What Does the HUD Tell Us?: The Heads Up Display as a Meta-communication in Videogames*. 5.
[24]Iacovides, I., Cox, A., Kennedy, R., Cairns, P., & Jennett, C. (2015). *Removing the HUD: The Impact of Non-Diegetic Game Elements and Expertise on Player Involvement*. Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play - CHI PLAY '15, 13-22. https://doi.org/10.1145/2793107.2793120
[25]Ibidem

increase higher levels of involvement, such as immersion, through increasing challenge and requiring greater player attention"[26].

A well-thought health meter could, therefore, influence the performance and immersion of the player who could reach a state of flow: "*a highly immersed experience when a person is engaged in a mental and/or physical activity to a level where this person loses track of time and the outside world and when performance in this activity is optimal*"[27].

Another study by Fragoso S. suggests that "*elements that are always on the screen tend to disappear from view*"[28] which can only enhance the immersion of the user.

It is great for a game to display a health meter but how to make the user look at it? Nowadays, in addition to a health meter, it is common for game designers to use flashes on the screen or sounds to alert the user that damage has been taken. The most important is that "*the player should clearly know when they are getting hurt and losing health*"[29] whether with a visual effect, a hit sound or a cry of pain from the game character.

However, more and more games can use a HUD-less health system by displaying visual effects that gets more present as more damage is taken[30]. This integration of health within the game's world can have a positive or negative influence on the immersion, it varies from player to player[31] but according to Hodent C., deleting the HUD could provoke less immersion for

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[26]Ibidem

[27]Kickmeier-Rust, M. D., Hillemann, E., & Albert, D. (2011). *Tracking the UFO's Paths: Using Eye-Tracking for the Evaluation of Serious Games*. In R. Shumaker (Éd.), Virtual and Mixed Reality - New Trends (Vol. 6773, p. 315-324). https://doi.org/10.1007/978-3-642-22021-0_35

[28]Fragoso, S. (2014*). Interface Design Strategies and Disruptions of Gameplay: Notes from a Qualitative Study with First-Person Gamers*. In M. Kurosu (Éd.), Human-Computer Interaction. Applications and Services (Vol. 8512, p. 593-603). https://doi.org/10.1007/978-3-319-07227-2_56

[29]Rogers, S. (2014). *Level Up: The Guide to Great Video Games Design*. Hoboken: Willey.

[30]Ibidem

[31]Fragoso, S. (2014). *Interface Design Strategies and Disruptions of Gameplay: Notes from a Qualitative Study with First-Person Gamers*. In M. Kurosu (Éd.), Human-Computer Interaction. Applications and Services (Vol. 8512, p. 593-603). https://doi.org/10.1007/978-3-319-07227-2_56

players as they will have to look elsewhere to find the information that could be displayed in a HUD[32].

A health meter, no matter its shape or behavior, is the first step to ensure a good understanding of the game by the user. However, it must be used and interpreted with other elements (sounds, visual effects…) to be relevant and useful for the user. It is crucial for the game playability that "*players experience the user interface/HUD as a part of the game*"[33].

B. Human-Computer Interactions / User-Centered Design

Computer technology has been around for about 75 years. Nowadays, we use computers virtually every day to do more and more tasks. At first, computer technology was only accessible to a few people: scientists, heads of the army and colleges. This changed with the arrival of the Personal Computer (PC), anybody could own a computer at home and the world saw the emerging of Human-Computer Interactions (HCI) study.

HCI is "*the study of the way in which computer technology influences human work and activities*"[34]. HCI goes along *User-Centered Design* which is a way to design computer technology, so it is easier to use and understand.[35] The key point of this design technique is what is called *Usability* which focuses on the efficiency and effectiveness of the system but also on the satisfaction of the user.[36] Every user interacts with a computer through an interface. The communication between the user and the machine cannot be optimal if the interface is not well thought and tested ahead; this would be like two people talking to each other in two different languages.

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[32]Hodent, C. (2018). *The Gamer's Brain: How Neuroscience and UX can Impact Video Game Design*. https://doi.org/10.1201/9781315154725
[33]Desurvire, H., & Wiberg, C. (2009). *Game Usability Heuristics (PLAY) for Evaluating and Designing Better Games: The Next Iteration*. In A. A. Ozok & P. Zaphiris (Éd.), Online Communities and Social Computing (Vol. 5621, p. 557-566). https://doi.org/10.1007/978-3-642-02774-1_60
[34]Dix, A. (2009). *Human-Computer Interaction*. In L. LIU & M. T. ÖZSU (Éd.), Encyclopedia of Database Systems (p. 1327-1331). https://doi.org/10.1007/978-0-387-39940-9_192
[35]Ibidem
[36]Ibidem

According to Cai X., a game is nothing more than a cycle of HCI: "*computer presents the virtual game environment to the players through images, sound or other manners of perception (game output step). Based on the received information and referring to the rules of the game, players make action decision (player-processing step). Players express their intentions through operating the hardware input devices (players' input step). In accordance with the rules of the game, computer calculates the corresponding scores of players' action (computer's processing step). After this step it will return to Step one and enter into the next round of HCI cycle*"[37]. Therefore, HCI is crucial in a video game and allow other game elements to work together[38].

Two laws of HCI are mainly used in video game design: the Fitt's law and the Hick-Hayman Law.[39] The Fitt's law allows designers to "*predict the time required for a human to point to a target, either by touching it or pointing at it with a cursor, depending on the distance to*

the target and the size of the target"[40]. This prevents designers to put buttons or elements of the interface too close to each other or too small. This law also explains why interface elements are most of the time in a corner of the screen as it is easier to point something there.

The Hick-Hayman law says that "*the user's reaction time to make a decision will logarithmically increase with the number of options displayed*"[41]. This prevents designers to overload the user's attention with useless information on the game interface. This was confirmed by a study led by Dyck and al. about the interface of contemporary games which has

[37]Cai, X. (2009). *Principles of Human-Computer Interaction in Game Design*. 2009 Second International Symposium on Computational Intelligence and Design, 92-95. https://doi.org/10.1109/ISCID.2009.171
[38]Ibidem
[39]Hodent, C. (2018). *The Gamer's Brain: How Neuroscience and UX can Impact Video Game Design*. https://doi.org/10.1201/9781315154725
[40]Ibidem
[41]Ibidem

shown that "*games communicate information to users in ways that do not demand the users' attention and do not interrupt the flow of work*"[42].

However, according to Barr P., Noble J. and Biddle R., HCI evaluation in video games should not use the same technique as HCI evaluation of other computer technology as the purpose of the game system is not to facilitate a user-defined task but to give the user a difficult task to accomplish[43] creating a sense of fun and entertainment. They think that video games interfaces "*can be strongly anchored in an understanding of values and value systems and the ways they relate to gameplay*"[44]. To understand the difference between video games and more traditional computer technologies, we need to define what is a video game.

According to Juul J., a video game is "*a rule-based formal system with a variable and quantifiable outcome, where different outcomes are assigned different values, the player exerts effort in order to influence the outcome, the player feels attached to the outcome, and the consequences of the activity are optional and negotiable*"[45]. The user of a video game will understand the system and interact with it based on different values displayed. It is not only the gameplay that dictates the behavior of the user but also the interpretation of different values (for example health, stamina, ammunition…) that the user has. Therefore, the interface is central in video games as "*it not only represents desirable values to players, but also mediates the value-driven conduct of the player*"[46]. The user's behavior and understanding in the game are not influenced by the interface itself but by the data it displays.

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[42]Jørgensen, A. H. (s. d.). *Marrying HCI/Usability and Computer Games: A Preliminary Look*. 4.
[43]Barr, P., Noble, J., & Biddle, R. (2007). *Video game values: Human–computer interaction and games*. Interacting with Computers, 19(2), 180-195. https://doi.org/10.1016/j.intcom.2006.08.008
[44]Ibidem
[45]Juul, J. (2003). *The game, the player, the world: Looking for a heart of gameness*. In: Copier, M., Raessens, J. (Eds.), Level up: Digital Games Research Conference Proceedings. Universiteit Utrecht, pp. 30–45.
[46]Barr, P., Noble, J., & Biddle, R. (2007). *Video game values: Human–computer interaction and games*. Interacting with Computers, 19(2), 180-195. https://doi.org/10.1016/j.intcom.2006.08.008

C. User Experience Design

User Experience Design (UX Design) is the field of study aiming to make users feel good when using an interactive system. We could define UX Design as a part of HCI which focuses mainly on making the system simple and easy to understand for the user. A broader definition could be: "*the creation and synchronization of the elements that affect users' experience with a particular company, with the intent of influencing their perceptions and behavior"*[47]. Another definition could be:" *a person's perceptions and responses that result from the use or anticipated use of a product, system or service"*[48].

In the video game industry, ten years have been enough to give UX Design a place of choice within game development studios. UX Design in video games is "*how players perceive and understand a game, how they interact with it, and the emotions and engagement elicited via this interaction*"[49]. We saw earlier that the interface of a game is the communication canal between the user and the system. The goal of UX Design in games is to keep the user engaged in the system and satisfied as long as possible through the use of interfaces among other things. This is confirmed by Dickey M. D. saying: "*strategies for engagement include player positioning or POV, narrative arc, and interactive choice*"[50].

Moreover, the emotional part is important in video games because its the first goal is to provide entertainment, thus fun, thus a feel-good feeling and "*when users feel good about something, they will have the tendency to*

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[47]Unger, R., & Chandler, C. (2009). *A Project Guide to UX Design: For user experience designers in the field or in the making (2nd Edition)*. New Riders Publishing Thousand Oaks.
[48]Schrepp, M., Hinderks, A., & Thomaschewski, J. (2014). *Applying the User Experience Questionnaire (UEQ) in Different Evaluation Scenarios*. In A. Marcus (Éd.), Design, User Experience, and Usability. Theories, Methods, and Tools for Designing the User Experience (Vol. 8517, p. 383-392). https://doi.org/10.1007/978-3-319-07668-3_37
[49]Hodent, C. (2018). *The Gamer's Brain: How Neuroscience and UX can Impact Video Game Design*. https://doi.org/10.1201/9781315154725
[50]Dickey, M. D. (2005). *Engaging by design: How engagement strategies in popular computer and video games can inform instructional design*. Educational Technology Research and Development, 53(2), 67-83. https://doi.org/10.1007/BF02504866

overlook its design faults"[51]. However, if the game is poorly designed, it will have the opposite effect on the user. This explains why UX Design is so important in contemporary video games: users hardly ever notice a well-designed interface that gives them the information they want at the right moment, but they won't miss a poorly designed one (difficult to use, too much or not enough information…).

There are different methods to assess user experience. The one used in this paper is the User Experience Questionnaire (UEQ) designed by Martin Schrepp, Andreas Hinderks and Jörg Thomaschewski.[52]. This questionnaire consists of choosing one of two opposite adjectives to define the experience with the system on a scale from 1 to 7 (4 being neutral). The goal is to measure 6 different characteristics of the system:

- Attractiveness: do the user like it or not?
- Perspicuity: is it easily understandable?
- Efficiency: can the user use it without efforts?
- Dependability: does the user feel in control of the interaction?
- Stimulation: is the system motivating or exciting?
- Novelty: is it innovative?

A system, such as a video game, needs its user experience to be regularly assessed before being released. Tools like the UEQ can help drastically developers to improve the UX of their systems as it is easy to use and can be done quickly. A fully automated Excel file is available online, free of charge, to encode data collected and have results right away.

[51]Ng, Y. Y., Khong, C. W., & Thwaites, H. (2012). *A Review of Affective Design towards Video Games*. Procedia - Social and Behavioral Sciences, 51, 687-691. https://doi.org/10.1016/j.sbspro.2012.08.225
[52]Schrepp, M., Hinderks, A., & Thomaschewski, J. (2014). *Applying the User Experience Questionnaire (UEQ) in Different Evaluation Scenarios*. In A. Marcus (Éd.), Design, User Experience, and Usability. Theories, Methods, and Tools for Designing the User Experience (Vol. 8517, p. 383-392). https://doi.org/10.1007/978-3-319-07668-3_37

D. *Eye Tracking in Video Games*

Being an interactive media, video games require an intensive use of the sense of sight. Even if, most game controllers nowadays have a built-in rumble pack that allows developers to make it vibrate during key moments, and even if developers can trigger specific sounds at key moments, visual cues remain the most important elements to communicate something to the user within the game. A way for developers to check if those visual cues work and are interpreted correctly is to use an eye-tracker device during play tests of the game.

The technique of eye tracking is to "*record eye movement while the user is looking at a stimulus*"[53]. The importance of this technique has grown quickly in the UX Design Field (web, applications…) but is not commonly used in the video game industry even if it "*provides an objective measurement of participants' visual patterns that allows us to determine what aspects of designs draw attention first and most*"[54].

Eye-tracking data are split in two categories[55]:

- Saccades: rapid eye movements to go from a point to another. It can be voluntary or triggered by a visual stimulus
- Fixations: when the eye stabilizes on an element on screen or in a region of interest

Those two categories are interpreted together to define visual patterns. Those patterns allow researchers to see where users look at first and what path their eyes are following. Knowing visual patterns of users in a specific situation is important for game developers as they "*generally reflects the observer's thought processes, indicating to some degree the goals of the*

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[53]Mat Zain, N. H., Abdul Razak, F. H., Jaafar, A., & Zulkipli, M. F. (2011). *Eye Tracking in Educational Games Environment: Evaluating User Interface Design through Eye Tracking Patterns*. In H. B. Zaman, P. Robinson, M. Petrou, P. Olivier, T. K. Shih, S. Velastin, & I. Nyström (Éd.), Visual Informatics: Sustaining Research and Innovations (Vol. 7067, p. 64-73). https://doi.org/10.1007/978-3-642-25200-6_7
[54]Worcester Polytechnic Institute, & Djamasbi, S. (2014). *Eye Tracking and Web Experience*. AIS Transactions on Human-Computer Interaction, 6(2), 37-54. https://doi.org/10.17705/1thci.00060
[55]Duchowski, A. T. (2017). *Eye Tracking Methodology (Third Edition)*. New York, NY: Springer Berlin Heidelberg.

observer and perhaps even the main areas of interest"[56]. This can allow them to design high-quality HUDs and interfaces.

However, this technique has its limitations as it allows researchers to see users' gaze but not what they are paying attention to[57]. For example, a user's gaze might be on the health meter (fixation) but in fact, he is paying attention to the enemy behind it.

Moreover, the analysis of all data that an eye-tracking device can provide is too time-consuming for it to be used regularly within game development studios[58].

Those two points might explain why the technique is having a hard time settling as common in the video game industry.

[56]Duchowski, A. T. (2017). *Eye Tracking Methodology (Third Edition)*. New York, NY: Springer Berlin Heidelberg.
[57]Hodent, C. (2018). *The Gamer's Brain: How Neuroscience and UX can Impact Video Game Design*. https://doi.org/10.1201/9781315154725
[58]Ibid.

IV. Exploratory research - Methodology:

The goal of the exploratory research is to answer the following question: "What are the position and behavior pattern of a health meter within a video game?"

To answer this question, we undertook an exploratory approach to create a classification that could describe the health meter of a game depending on key variables. The key variables we decided to use include the year of release of the game, its development studio, the type of game, the average score given by players and the press (both on the website Metacritic, a critic aggregator website), the health meter's position, the health meter's appearance (shape and color), the health meter's behavior and the player's POV (first-person or FPP, third-person or TPP, Top-down or Mixed). The method used is the classification of a video game selection in the topology followed by the identification of potential relationship of dependency between variables by analysis of hazard distribution frequency. Video games were selected in one of the following ways:

- 40 games per year: presence of a health meter + released between 2015 and 2017 + 10 best according to critics per POV;
- 120 games in total: presence of a health meter + released between 2015 and 2017 + 10 best according to critics per year per POV.

N.B.: DLC and episodic games were not taken into consideration.

V. Exploratory research – Analysis

To study patterns of health meter's positions and behaviors in video games, it was crucial to develop a chart gathering all informations needed.

A. Selecting games

The first phase of this exploratory research was to constitute the database of video games that will be studied. It was important to have enough games to study but not too many to keep the work smooth and relevant. Therefore, we decided to focus on video games released between 2015 and 2017 on the PC platform (further explanations will be given later). For each year, 40 games have been picked, 10 games for each POVs (FPP, TPP, Top-down, Mixed)[59] that we have considered important. All these games were picked considering their POV, the presence of a health meter and their place in their year ranking on the website Meta-Critic (which is a website that gathers critics from the press and from the users to give an average score for each game). This gave us 120 games to study, 40 per year, the 10 best games for each POV.

B. Constituting the Database

The second phase of this first analysis was to fill the chart with relevant informations for each game. The chart is split in 27 columns from left to right and can be found on the CD attached with this paper:

- **Year:** the year the game came out (2015, 2016, 2017)
- **POV:** the POV that the game uses (FPP, TPP, Top-down, Mixed)
- **# In ranking:** this column shows the position of the game in its year ranking on the website Meta-Critic. The closer to 1, the higher its critic and user's score.
- **Game:** the name of the game

[59]See glossary for more information

- **Genre:** The genre of the game. We considered 13 genres relevant for this analysis[60] : Adventure, Fighting, Hack 'n Slash, Platformer, Puzzle, Racing, Role-Playing Game (RPG), Rhythm, Sandbox, Shooter, Simulation, Strategy and Survival.
- **Release Date:** the precise date on which the game was released.
- **Development Studio:** the name of the studio/person that developed the game.
- **Critic score:** the average score given by critics on 100.
- **User score:** the average score given by users on 100.

This material was easy to find and mainly used to have a better idea on what game we are working on. The information in the following columns were gathered watching Let's play videos (commented or not) on YouTube and concern the health meter's position and behavior for each game:

- **Shape/Form:** this column concerns the shape or type of health meters used in the game. We have found 5 different types of health meters: Bar, Bar & Points, Points, State Icon and Timer.
- **1st position:** this column concerns the position of the health meter (or of the first one if there are more than one health meter) on the screen. There are 9 zones on the screen where you can find a health meter, going from 1 to 9, downwards from left to right: Top-left, Top-center, Top-right, Center-left, Center, Center-right, Bottom-left, Bottom-center and Bottom-right.
- **Characteristics of shape (1st position):** in this column we have described the look and design of the first health meter.
- **2nd position:** the position of the second health meter if there is one.
- **Characteristics of shape (2nd position):** Look and design of the second health meter if there is one.

[60]See glossary for more information

- **Diegetic or non-diegetic:** this column concerns if whether the health meter is part of the world of the game (diegetic) or if it is only a tool for the user and invisible in the world of the game (non-diegetic).[61]
- **Always on the screen:** Whether the health meter is always shown on screen or not.
- **If no, condition? :** If the health meter is not always shown on screen, under which circumstances does it appear?
- **Color (when full):** the color of the health meter when it is full.
- **Color gradient:** when the health meter decreases, does it go from a color to another?
- **Behavior 1st:** this column describes how does the first health meter function.
- **Behavior 2nd:** Same as above but with the second health meter if there is any.
- **Presence of shield:** does the game include a system of shield/armor/protection that will be consumed before the health meter when damage is taken?
- **Shield/armor icon:** if there is a system of shield/armor/protection, how is it shown on screen?
- **Healing process:** is it possible for the player to heal his/her character in-game and how?
- **When empty:** This column describes what happens when the health meter is empty.
- **Additional visual effects:** is there any visual effects on the screen when damage is taken/when the health meter decreases?
- **If mixed: Camera POV changes by the player or part of the gameplay?:** in games that use mixed POV (a combination of two or

[61]See glossary for more information

more POV), is the change of POV a part of the gameplay thought by the developer and therefore compulsory or is it a choice left to the player?

- **Source used for analysis:** the link of the YouTube video used to gather information for each game.

With all this data, we can do a primary analysis and approve or disapprove hypothesis.

N.B.: There are 120 games in the chart table but 121 lines because of the game "Evolve" which proposes two POVs depending on the character you're playing (FPP for hunter or TPP for monster). It was too difficult to keep the data on one line and we had to split it in two for clarity and ease of analysis.

C. *Primary analysis*

a. *What we are looking at*

The primary analysis consists of analyzing:

- The number of health meter per screen zone
- The number of games per genre
- The number of games per type of health meter
- The number of games in a game genre per POV.

Furthermore, we will be able to approve or disapprove the following hypothesis:

- H0: The position of the first health meter depends on the game genre
- H1: The position of the first health meter depends on the POV
- H2: The type of the health meter depends on the game genre
- H3: The type of the health meter depends on the POV
- H4: The behavior of the health meter depends on the game genre
- H5: The behavior of the health meter depends on the POV

b. *First analysis*

Health meter per screen zone (see annex n°1 – chart 1): we can see on the following chart that more than a half of games in our database (71 games or 59%) display their first health meter in the first screen zone (top-left) and in the seventh (bottom-left). And another 25% (31 games) display a first health meter in the eighth (bottom-center) and ninth (bottom-right) screen zone. The others use another screen zone or another way of display (other games below the chart).

Games per genre (see annex n°1 – chart 2): we can clearly see that most of the games (103 games or 85%) are split in four genres: Shooter (50 games), RPG (22 games), Strategy (19 games) and Platformer (12 games).

Games per type of health meter (see annex n°1 – chart 3): 50% of games (60 games) use a simple bar as health meter and 48% (57 games) use either a bar & points meter or a simple point meter. Only 3 games use a state icon and only one uses a timer meter.

Type of health meter per game genre (see annex n°1 – chart 4)

Game genre per POV: 28 games out of 30 are Shooter games in the FPP category. The other two games are one Puzzle game and one Survival game. *(see annex n°1 – chart 5)*

The TPP category is split between Platformer, RPG or Shooter games. *(see annex n°1 – chart 6)*

The Top-down category is split between RPG, Strategy or once again Shooter games. *(see annex n°1 – chart 7)*

Finally, the Mixed category is almost evenly split with a majority of Shooter and Strategy games (19 games out of 30) *(see annex n°1 – chart 8)* *c. First approval or disapproval of hypothesis*

- H0: The position of the first health meter depends on the game genre

In game genre with 2 games or less, we can see a draw between two zones or only one zone being used. In game genre with more than 2 games, we can see that there is a screen zone with more games than others.

  - First screen zone (top-left) with 8 games on 12 for the Platformer genre.
  - Seventh screen zone (bottom-left) with 2 games on 3 for the Racing genre.
  - Draw between the first and the seventh screen zone with 14 games on 22 for the RPG genre.
  - Seventh screen zone with 2 games on 4 for the Sandbox genre.
  - First, seventh and eighth (bottom-center) screen zones with 35 games on 50 for the Shooter genre.
  - Seventh screen zone with 8 games on 15 for the Strategy genre.

We can see that the first and seventh screen zones are used in multiple genres.

Therefore, the hypothesis is rejected.

- H1: The position of the first health meter depends on the POV

We can see that in every POV, every screen zone is used by at least one game, except for the sixth screen zone (center-right) which is never used. However only the TPP POV has more than 50% of its games (63%) using only one screen zone (first screen zone).

Therefore, the hypothesis can be accepted for TPP games but rejected for all other POV.

- H2: The type of the health meter depends on the game genre

We can see in the chart that bar, bar & points and points meters are used in most games. However, it is interesting to see that the Timer type is only used in Puzzle games and the State Icon type is mostly used in Survival games.

Game genre with more than 2 games also uses a main type of health meter (except Platformer and Racing genre).

RPG, Sandbox and Shooter games mainly use Bar type. Strategy and Platformer games are stuck between two types and Racing games between three.

Therefore, the hypothesis can be accepted for Puzzle games and Survival games but rejected for all other genres.

- H3: The type of the health meter depends on the POV

In three POVs, we can see a majority (more than 50% or very close) of health meter type.

FPP, TPP and Mixed POV games use mainly a Bar type meter.

Only the Top-down POV is stuck between the Bar type and the Points type meter.

Therefore, the hypothesis is rejected.

- H4: The behavior of the health meter depends on the game genre

Looking at the chart, we can see that health meters in 71% of games (85 games) mainly behave in four different ways:

Bar decreases from right to left (31,40%)

Bar decreases from right to left, points move towards 0 (19,83%)

Bar moves downwards (10,74%)

Points move towards 0 (9,09%)

However, it seems that no behavior is specific to a game genre except for unique behaviors only used in one game.

Therefore, the hypothesis is rejected.

- H5: The behavior of the health meter depends on the POV

Looking at the chart, we can draw the same conclusion as above: it seems that no behavior is specific to a POV.

Therefore, the hypothesis is rejected.

D. Focus on data

After doing this first analysis, we thought we could focus on Shooter, RPG, Strategy and Platformer games as they represent 85% of games in our chart. The data we have for those games is richer and the conclusion we will get out of it will be more relevant.

After deletion of non-relevant genre, we are left with 50 Shooter games, 22 RPG games, 19 Strategy games and 12 Platformer games. This gave us a total of 103 games.

Those games are still almost evenly distributed per POV: 28 FPP games, 25 TPP games, 29 Top-down games and 20 Mixed games.

We did a second analysis after the deletion of games with a genre other than Shooter, RPG, Strategy or Platformer.

E. Second analysis

Health meter per screen zone (see annex n°1 – chart 9): compared to the primary analysis we can see a drop of games displaying their first health bar in a screen zone in every zone except for the second, fourth, fifth, sixth and eighth which remain unchanged. The most used zones are still the first, seventh and eighth with 77 games or 75%.

Games per genre (see annex n°1 – chart 10): These numbers were given in point 4: Focus on data.

Games per type of health meter (see annex n°1 – chart 11): Once again, 50% of games (52 games) use a simple bar as health meter. The rest is split almost evenly between bar & points and points because the State Icon type and Timer type are not used anymore.

Type of health meter per game genre (see annex n°1 – chart 12)

Game genre per POV: Every game in the FPP category is a Shooter game. *(see annex n°1 – chart 13)*

The TPP category is split between the four genre we decided to keep with most Platformer games. *(see annex n°1 – chart 14)*

The Top-down category is split between RPG, Strategy or Shooter games. *(see annex n°1 – chart 15)*

Finally, the Mixed category is split between RPG, Strategy or Shooter games which represent the majority. *(see annex n°1 – chart 16)*

a. *Second approval or disapproval of hypothesis*

- H0: The position of the first health meter depends on the game genre

We can see that most games of the genre we decided to keep display their first health meter in the first and/or in the seventh screen zone.

Therefore, the hypothesis is again rejected.

- H1: The position of the first health meter depends on the POV

Compared to the first analysis, we can see that:

FPP games mainly display their first health meter on the bottom of the screen (7^{th}, 8^{th} and 9^{th} zone) with 71% of games.

TPP games mainly display their first health meter in the 1^{st} screen zone with 56% of games.

Top-down games mainly display their first health meter in the 7^{th} or 1^{st} screen zone with 62% of games.

Mixed games mainly display their first health meter in the 8^{th} or 7^{th} screen zone with 52% of games.

Therefore, the hypothesis is accepted but with caution for Mixed POV games.

- H2: The type of the health meter depends on the game genre

Most Shooter and RPG games use a bar type health meter. Strategy games are still stuck between bar and bar & points type. Platformer games are stuck between bar and points type.

No game genre uses exclusively a type of health meter therefore the hypothesis is rejected.

- H3: The type of the health meter depends on the POV

The conclusion remains the same as in the first analysis. We cannot see a particular trend of the type of the health meter depending on the POV.

Therefore, the hypothesis is rejected.

- H4: The behavior of the health meter depends on the game genre

The conclusion remains the same as in the first analysis. We cannot see a particular trend of the behavior of the health meter depending on the game genre.

Therefore, the hypothesis is rejected.

- H5: The behavior of the health meter depends on the POV

The conclusion remains the same as in the first analysis. We cannot see a particular trend of the behavior of the health meter depending on the POV.

Therefore, the hypothesis is rejected.

F. Conclusion and use of this exploratory research

We can clearly see that only one hypothesis can be accepted in the first analysis and one (but with caution) in the second analysis.

This can be possibly explained by the lack of guidelines in the video game industry. Each development studio does what it wants with the health meter but takes inspiration from hit games, games that were market successful.

This taxonomy was made to show the current state of video game industry and how studios think the health meter nowadays.

This taxonomy was also made to select games for the second part of our research which will focus on the game experience of the player depending on the health meter. This second part will help us understand how much the health meter influences the understanding and the behavior of the player in the game.

G. *Sum-up of hypothesis for exploratory research*

ID	Hypothesis	First analysis	Second analysis
HO	The position of the first health meter depends on the game genre	Rejected	Rejected
H1	The position of the first health meter depends on the POV	Accepted and rejected	Accepted
H2	The type of the health meter depends on the game genre	Accepted and rejected	Rejected
H3	The type of the health meter depends on the POV	Rejected	Rejected
H4	The behavior of the health meter depends on the game genre	Rejected	Rejected
H5	The behavior of the health meter depends on the POV	Rejected	Rejected

VI. Experimental research – Methodology

A. *Experimental design*

The goal of the experiment is to study how health meters affect the user's experience while playing a video game.

B. *Data collection methods*

We used an eye-tracking device to collect user data such as fixation, saccades and time until first fixation of a Region of Interest (ROI). We also collected the time to execute user tasks (by timing the performance) and self-reported satisfaction (with a questionnaire at the end of the session).

C. *User tasks*

The experiment involved the execution of three specific user tasks:

- Task 1: click on the health meter as fast as possible,
- Task 2: click where you would expect to find a health meter and explain the reason(s) why,
- Task 3: play the game.

D. *Participants*

We recruited six experimented gamers to be part of the study. We decided not to involve non-experimented gamers, as they might not be familiar with the use of a controller, hence compromising the reliability and the relevance of the data collected for Task 3. We recruited three males and three females, as 48% of players in France, UK, Germany and Spain were women in 2018[62]. We can assume that numbers in Belgium are relatively the same.

[62]Interactive Software Federation of Europe (2012). ISFE Key Facts 2018: https://www.isfe.eu/isfe-key-facts/

E. *Individual sessions*

Each individual session with the participants followed the same agenda:

- Signing of a consent form
- Directed interview (questionnaire-based) about the participant's age, gender, mean hours spent weekly playing video games, level of expertise/familiarity with a game controller, identification of the games they have played and liked over the past 3-6-12 months.
- Presentation of the instructions
- Execution of Task 1 with a selection of 12 games
- Execution of Task 2 with another selection of 12 games
- Execution of Task 3 with another selection of four games
- Completion of a questionnaire self-reported satisfaction (UEQ)

Each individual session lasted between 40 and 75 minutes depending on the participants' personality, game skills and will to talk.

F. *Game selection*

We extracted all games involved in Tasks 1, 2, 3 from the database constituted during the exploratory analysis.

The main selection criteria to include a game in the experiment was its critic rating. This allowed us to shape two different charts: one with the top-rated games *(see annex n°2 – chart 1)* and the other with the lower-rated games *(see annex n°2 – chart 2)*. The variables used in each chart include health meter behavior (the four most relevant), the POV and the year of release.

The next step was to select games from those charts for the experimentation. In some cases, games are present in both charts and will therefore not be used during task 1 and task 2. We also decided not to use mixed POV games for task 1 and task 2 as a single screenshot wouldn't be able to show those games' several POV.

If two or more games have the same critic rating and cannot be included all in the selection, user rating will be used to decide.

The first chart (top-rated games) was used for task 1 where participants were shown 12 screenshots of 12 video games and were asked to click, the fastest possible, on what they think is the health meter and explain why. We assumed that top-rated games are usually better designed and therefore present a more recognizable health meter. We decided to pick the 6 best games and the 6 "worst" games in this chart to establish a correlation between rating and time to execute the task.

Screenshots are taken from 12 video games each one selected by its rating, its health meter's behavior and POV category.

Games selected for task 1 are:

- *The Witcher 3: Wild Hunt* (TPP – "Bar from right to left" – 2015 – Rating: 93/100)
- *Overwatch* (FPP - "Bar from right to left & points towards 0" - 2016 – Rating: 91/100)
- *Stardew Valley* (Top-down – "Bar downwards" – 2016 – Rating: 89/100)
- *Dark Souls III* (TPP – "Bar from right to left" – 2016 – Rating: 89/100)
- *Hex: Shards of Fate* (Top-down – "point towards 0" – 2016 – Rating: 87/100)
- *Titanfall 2* (FPP – "Bar from right to left" – 2016 – Rating: 86/100)
- *Destiny 2* (FPP – "Bar from right to left" – 2017 – Rating: 83/100)
- *Helldivers* (Top-down – "Bar from right to left" – 2015 – Rating: 83/100)
- *Prey* (FPP – "Bar from right to left & points towards 0" – 2017 – Rating: 82/100)

- *Downwell* (TPP – "Bar from right to left & points towards 0" – 2015 – Rating: 81/100)
- *Tom Clancy's Rainbow Six: Siege* (FPP – "Points towards 0" – 2015 – Rating:79/100)
- *Dying Light* (FPP – "Bar from right to left & points towards 0" – 2015 – Rating: 75/100)

The second chart (lower-rated games) was used for task 2 where participants were shown 12 screenshots without HUD of 12 video games and were asked to click where they would put the health meter, how it would behave and explain why. Participants were also given the genre of the game and a bit of context to take their decision (which character they are on the screen, what are they doing, etc.).
The goal of this task is to establish a correlation between the genre of a game and the user's expectation of health meter position.
A reason that could explain the games's ratings in this chart might be their designs and we thought it would be interesting to be able to compare developers and players's ideas and conceptions of health meters.
Like the top-rated games chart, screenshots are taken from 12 video games each one selected by its rating (the 6 best ratings and 6 worst ratings again), its health meter's behavior and POV category.

Games selected for task 2 are:

- *Planescape: Torment – Enhanced Edition* (Top-down – "Bar from right to left" – 2017 – Rating: 85/100)
- *Shadow Tactics: Blades of the Shogun* (Top-down – "Bar downwards" behavior – 2016 – Rating: 85/100)
- *ICEY* (TPP – "Bar from right to left" – 2016 – Rating: 84/100)
- *BLEED 2* (TPP – "Bar from right to left" – 2017 – Rating: 83/100)
- *Duelyst* (Top-down – "Point towards 0" – 2016 – Rating: 82/100)
- *Shadowrun: Hong Kong* (Top-down – "Bar from right to left" – 2015 – Rating: 82/100)

- *Lawbreakers* (FPP – "Bar from right to left & points towards 0" – 2017 – Rating: 76/100)
- *Battlezone 98 Redux* (FPP – "Bar downwards" – 2015 – Rating: 75/100)
- *Far Cry Primal* (FPP – "Bar from right to left" – 2016 – Rating: 74/100)
- *Call of Duty: WWII* (FPP – "Bar from right to left" – 2017 – Rating: 73/100)
- *Battlefield: Hardline* (FPP – "Bar from right to left & points towards 0" – 2015 – Rating: 71/100)
- *Turok Remastered* (FPP – "Points towards 0" – 2015 – Rating:67/100)

Those first and second tasks will use a UX approach asking the participants to describe things as they do it.

Finally, task 3 will involve playing 4 different video games for a maximum of 5 minutes. The goal of this task is to analyze the behavior of the player when playing and when damage is taken in-game.

We selected games not involved in task 1 and task 2 using charts previously mentioned. To be fully relevant, we picked games that represent the different categories: there is at least one game for each year, for each health meter's behavior and for each POV. Games were also chosen based on their accessibility (controls easy to understand and playable with a controller), their pace (chosen games don't need an hour of playing before encountering enemies or challenge) and the possibility to play offline and alone. We also paid attention to their ratings thus we have a "good" game, a "worse" game and two games that are in both charts.

Those games include:

- *Furi* (Mixed – "Bar from right to left" – 2016 – Rating: 76/100) **the only game where the change of POV is part of gameplay and not controlled by the user**

- *Lovers in a Dangerous Spacetime* (TPP – “Bar downwards” – 2015 – Rating: 80/100)
- *Nuclear Throne* (Top-down – “Bar from right to left and points towards 0” – 2015 – Rating: 88/100)
- *Wolfenstein 2: The New Colossus* (FPP – “Points towards 0” – 2017 – Rating: 86/100)

After each gaming session, participants were asked to fill a self-reported satisfaction questionnaire (User Experience Questionnaire) to measure their overall feeling about the system.

Every experiment has been held in French and all documents related are also written in French to ensure a total understanding between us and participants. Those documents can be found on the CD attached with this paper.

VII. Experimental Research - Analysis

Experimentations were held on May 16th and May17th at the Social Media Lab of the Université Catholique de Louvain – FUCaM in Mons. The eye-tracking device used was the Tobii Pro X3-120 along with the Tobii Pro Studio software.

A. Participants Overview

We had six participants (3 males and 3 females) between 22 and 33 (mean age: 25) all playing video games at least once a week. A study of 2019 says that the average hours of playing per week is 7,11 hours[63].We determined that:

- The two participants playing less than 2 hours & between 4 and 6 hours per week are below than the average player
- The two participants playing between 6 and 8 hours per week are average player
- The two participants playing between 8 and 10 hours & more than 12 hours are above average player

We assumed players spending more time playing are more experienced than players spending less time.

Concerning the ease of use of a controller on a scale from 1 (weak) to 5 (strong), five participants self-evaluate their abilities at 4 and only one at 3 (the participant playing less than 2 hours per week).

Participants had on average 7 favorite genres of games out of the 13 we used during the exploratory research. Role-Playing Games were picked by every participant. The three other genres kept during the second analysis of the exploratory research (Platformer, Shooter and Strategy) were also picked by at least half of the participants. *(see annex n°3 – chart 1)*

[63]Market Research: The State of Online Gaming – Limelight Networks (2019): https://www.limelight.com/resources/white-paper/state-of-online-gaming-2019

Participants owned 5 different devices to play on average. The software Steam on PC and the smartphone being the most popular. *(see annex n°3 – chart 2)*

When asked what games they have played during the last 3 months, the last 6 months and the last 12 months, participants cited 49 games in total. The most cited is Riot Games' *League of Legends* (3 participants) followed by Epic Games' *Fortnite*, Ubisoft's *Assassin's Creed: Black Flag* and Activision's *Call of Duty: Black OPS 4* each cited by 2 participants. This reflects the taste of some participants for popular games such as *Fortnite* and *League of Legends* as well as for blockbuster games such as *Assassin's Creed: Black Flag* and *Call of Duty: Black OPS 4*. Other games were cited by only one participant and goes from little independent games to blockbuster games.

B. *Results for Task 1*

a. *What we are looking at*

During task 1, participants were shown 12 screenshots of 12 video games and were asked to click, the fastest possible, on what they think is the health indicator and explain why. We decided to pick the 6 best games and the 6 "worst" games in the chart at page … for this first task.

Data were collected during this first task using the eye-tracking device:

- Participants know the game on the screenshot (Y/N)
- Time before the first fixation on what the participant thinks is the game's health meter (in seconds)
- Time for the participant to click on what he/she thinks is the game's health meter after the first fixation on it (in seconds).
- Time total to execute the task (in seconds)
- Is the answer correct (Y/N)
- Explanation of his/her choice by the participant (not compulsory)

With those results, we can accept or reject the following hypothesis:

- H0: Mean time to click on the health meter depends on hours played (experience)
- H1: Mean time to click on the health meter depends on the number of favorite genres
- H2: Mean time to click on the health meter depends on the number of gaming devices owned
- H3: Number of right answers depends on hours played (experience)
- H4: Number of right answers depends on time to click on the health meter (more time = more right answers)
- H5: Mean time taken by a participant to click on what he/she thinks the game's health meter is after his/her first fixation on it depends on hours played (experience)
- H6: Right answers depend on the mean time taken by the participant to click on what he/she thinks the game's health meter is
- H7: Mean time to click on the health meter depends on the health meter's position on the screen
- H8: Mean time before the first fixation on what the participant thinks the game's health meter is depends on the health meter's position on the screen
- H9: Health meters of good rated games are seen, on average, quicker than those of lower-rated games

b. Analysis

Participants know the game on the screenshot (Y/N): We can see in this chart that 5 participants knew at least one game on screenshots. The most recognized was screenshot 4: *Overwatch* (4 participants) followed by screenshot 1: *Dark Souls 3* and screenshot 11: *The Witcher 3: Wild Hunt* (both recognized by 3 participants). Finally, screenshot 2: *Destiny 2* and screenshot 10: *Stardew Valley* were recognized by only one participant. The most recognized screenshots are among the six best-rated games in the top-rated games chart at page … *(see annex n°3 – chart 3)*

Time before the first fixation on what the participant thinks is the game's health meter (in seconds): in this chart, we can see that participants can take less than 1 second before the first fixation as well as 13 seconds depending on the participant and on the game. We also calculated the mean time before the first fixation for each participant. *(see annex n°3 – chart 4)*

Time for the participant to click on what he/she thinks is the game's health meter after the first fixation on it (in seconds): in this chart, we can see that participants need around one second to recognize or understand a health meter after the first fixation on it. Sometimes, participants seek something else that could be a health meter after the first fixation because what they saw didn't make sense to them. We also calculated the mean time for each participant. *(see annex n°3 – chart 5)*

Time total to execute the task (in seconds): in this chart, we can see that time to execute the task for each screenshot depends on the screenshot itself and on the participant. A health meter easy to spot for a participant isn't always easy to spot for another one. *(see annex n°3 – chart 6)*

Is the answer correct (Y/N): in this chart, we can see if the participant's choice during the task is in fact the health meter in the game. At least half of participants answered right on every screenshot except for screenshot 12: *Titanfall 2* where no one found the right answer. Although, this game can be found in the good-rated game chart at page … *(see annex n°3 – chart 7)*

Explanation of his/her choice by the participant (not compulsory): During task 1, participants were asked to describe what makes them think that the element on which they clicked on is indeed the health meter. As this part was not compulsory, not every participant explained their choice.

A word came up often during explanations: "Classic." This word means that participants based their choice on their experience, on what they have seen in other games even if their answer was false. It was mostly used on screenshots where the health was at the top-left or bottom-left corner.

On other screenshots, it was an icon or the number 100 that settles their choice because once again, they saw it in other games.

The choice was sometimes also based on color. Some participants associated red or green to a health meter even if their answer was false.

Finally, some participants made a choice on something random because they didn't find anything that makes think of a health meter. This is the main problem on screenshot 12: *Titanfall 2*. Other times, they made a choice but without being 100% sure.

c. *Acceptation or rejection of hypothesis for Task 1*

- H0: Mean time to click on the health meter depends on hours played (experience) *(see annex n°3 – chart 8)*

We decided to compare the mean time to click on the health meter with the experience for each participant. We can see in the chart that participants with less experience (in green in the chart) decided faster than more experienced players (average players in yellow and above average players in blue in the chart).

The hypothesis is therefore accepted.

- H1: Mean time to click on the health meter depends on the number of favorite genres *(see annex n°3 – chart 8)*

We used the same chart as above to compare the mean time to click on the health meter with the numbers of the favorite genre for each participant. We can see no correlations between those two elements.

The hypothesis is therefore rejected.

- H2: Mean time to click on the health meter depends on the number of gaming devices owned *(see annex n°3 – chart 8)*

We used, once again, the same chart as above to compare the mean time to click on the health meter and the numbers of gaming devices owned for each participant. We can see no correlations between those two elements.

The hypothesis is therefore rejected.

- H3: Number of right answers depends on hours played (experience) *(see annex n°3 – chart 9)*

We decided to compare the number of right answers (the participant chose the real health meter during the experimentation) with the experience for each participant. We can see that more experienced players have more right answers than those who play less but the progression is not linear.

Therefore, the hypothesis cannot be totally accepted or rejected.

- H4: Number of right answers depends on time to click on the health meter (more time = more right answers) *(see annex n°3 – chart 10)*

We decided to compare the number of right answers (the participant chose the real health meter during the experimentation) with the mean time to click on the health meter. We can see that participants who took more time to click have more right answers. However, the progression is, once again, not linear.

Therefore, the hypothesis cannot be totally accepted or rejected.

- H5: Mean time taken by a participant to click on what he/she thinks the game's health meter is after his/her first fixation on it depends on hours played (experience) *(see annex n°3 – chart 11)*

We decided to compare the mean time taken by a participant to click on what he/she thinks the game's health meter is after his/her first fixation on it with the experience for each participant. We can see in the chart that participants with less experience (in green in the chart) decided, once again, faster than more experienced players (average players in yellow and above average players in blue in the chart).

The hypothesis is therefore accepted.

- H6: Right answers depend on the mean time taken by the participant to click on what he/she thinks the game's health meter is *(see annex n°3 – chart 12)*

We decided to compare the number of right answers (the participant chose the real health meter during the experimentation) with the mean time taken by a participant to click on what he/she thinks the game's health meter is after his/her first fixation on it. We can see that participants with fewer right answers took less time between the first fixation and the click than players with more right answers. Although, the progression is, once again, not linear.

Therefore, the hypothesis cannot be totally accepted or rejected.

- H7: Mean time to click on the health meter depends on the health meter's position on the screen *(see annex n°3 – chart 13)*

We decided to compare the mean time to click on the health meter with the health meter's position on the screen for each screenshot. We saw earlier in this paper that the most used screen zones are the first and the seventh. Although, we can see in the chart that there is no correlations between the two elements of the hypothesis.

The hypothesis is therefore rejected.

- H8: Mean time before the first fixation on what the participant thinks the game's health meter is depends on the health meter's position on the screen *(see annex n°3 – chart 14)*

We decided to compare the mean time before the first fixation with the health meter's position on the screen for each screenshot. We saw earlier in this paper that the most used screen zones are the first and the seventh. Although, we can see in the chart that there are no correlations between the two elements of the hypothesis.

The hypothesis is therefore rejected.

- H9: Health meters of good rated games are seen, on average, quicker than those of lower-rated games *(see annex n°3 – chart 15)*

We decided to compare the place of each game in good rated games charts or lower-rated games charts with the mean time before the first fixation on where the participant thinks the health meter is. In the chart, "G" means the game is one of the best rated in the chart (blue) and “L” means the game is one of the lower-rated in the chart (yellow). We can see that participants took on average less than 1 second to spot the health meter in four games out of the six best-rated. We can also see that participants took always more than one second on average to spot the health meter in lower-rated games.

The hypothesis is therefore accepted.

d. Conclusion of Task 1

According to the results of this first task, we can see that the experience of participants (playing time in hours per week) has an influence on the time they took to spot the health meter and the time to click on it. We expected more experienced players to do the task quicker than less experienced players, but we observed the opposite. This could be explained by the fact that less experienced players have more confidence in their knowledge than more experienced players as in the Dunning-Kruger effect. This cognitive bias says that "*people with substantial deficits in their knowledge or expertise should not be able to recognize those deficits. Despite potentially making error after error, they should tend to think they are doing just fine.*"[64] This basically means that people with little to no knowledge in a field will usually feel more confident in their abilities and knowledge within that field than more experienced people.

We also observed that participants who took more time to execute the task usually answered better than faster participants. The explanation of this could be the same as above.

As we thought before the experimentation, the rating of a game may influence the time to spot its health meter. This could mean that best rated games have better designed health meters, easier to spot and/or to understand. Those games use colors (green or red) and/or common positions on the screen (zone 1 or 7) and/or an icon easy to recognize (a heart, the letter "E" …). Those elements might help players in their understandings of the health meter's behavior and position.

[64]Dunning, D. (2011). *The Dunning–Kruger Effect. In Advances in Experimental Social Psychology* (Vol. 44, p. 247-296). https://doi.org/10.1016/B978-0-12-385522-0.00005-6

e. Sum-up of hypothesis for Task 1

ID	Hypothesis	First analysis
HO	Mean time to click on the health meter depends on hours played (experience)	Accepted
H1	Mean time to click on the health meter depends on the number of favorite genres	Rejected
H2	Mean time to click on the health meter depends on the number of gaming devices owned	Rejected
H3	Number of right answers depends on hours played (experience)	Accepted and rejected
H4	Number of right answers depends on time to click on the health meter (more time = more right answers)	Accepted and rejected
H5	Mean time taken by the participant to click on what he/she thinks the game's health meter is after the first fixation on it depends on hours played (experience).	Accepted
H6	Right answers depend on the mean time taken by the participant to click on what he/she thinks the game's health meter is	Accepted and rejected
H7	Mean time to click on the health meter depends on the health meter's position on the screen	Rejected
H8	Mean time before the first fixation on what the participant thinks the game's health meter is depends on the health meter's position on the screen	Rejected
H9	Health meters of good rated games are seen, on average, quicker than those of lower-rated games	Accepted

C. *Results for Task 2*

a. *What we are looking at*

During task 2, participants were shown 12 screenshots without HUD from 12 video games and were asked to click where they would put the health indicator, how it would behave and explain why. Participants were also given the genre of the game and a bit of context to take their decision (which character they are on the screen, what they are doing, etc.). Screenshots are taken from 12 video games each one selected by its rating (the 6 best ratings and 6 worst ratings again) its health meter's behavior and POV category in the lower-rated games chart at page …

Data were collected during this second task using the eye-tracking device:

- Participants know the game on the screenshot (Y/N)
- The chosen screen zone where the participant would put a health meter
- The numbers of fixations in the chosen zone before choosing it
- Time to execute the task (in seconds)
- The answer given by the participant matches with reality
- Explanation of his/her choice by the participant

With those results, we can accept or reject the following hypothesis:

- H0: Mean time to execute the task depends on hours played (experience)
- H1: Mean time to click on the health meter depends on the number of favorite genres
- H2: Mean time to click on the health meter depends on the number of gaming devices owned
- H3: Number of answers matching reality depends on hours played (experience)
- H4: Number of answers matching reality depends on mean time to execute the task

- H5: Mean time to execute the task depends on the mean number of fixations in the chosen zone
- H6: Choices of screen zones are mostly based on comfort criteria
- H7: Most chosen screen zones will be the same as observed during the exploratory research
- H8: Most frequent chosen health meter type will be the same as observed during the exploratory research

b. *Analysis*

Participants know the game on the screenshot (Y/N): We can see in this chart that only two games were recognized by two participants. Game on screenshot 4: *Call of Duty WWII* and game on screenshot 8: *Lawbreakers*. *(see annex n°3 – chart 16)*

The chosen screen zone where the participant would put a health meter: we can see in this chart that zone 3, 5 and 6 were never chosen to display a health meter. The most chosen zones are the first (20) and the seventh (27) followed by a health meter following the character (9). One participant also said he would like to put the health meter in a menu which is something we have never encountered in our research. *(see annex n°3 – chart 17)*

The numbers of fixations in the chosen zone before choosing it: we can see in this chart that the number of fixations in the chosen zone depends mainly on the participant. *(see annex n°3 – chart 18)*

Time to execute the task (in seconds): We can see in this chart that the time needed to execute the task depends on the participant. We can also observe that participants took less time to execute the task on some screenshots (9 or 12 for example). *(see annex n°3 – chart 19)*

The answer given by the participant matches with reality: We can see that the higher rate of answers matching reality is 4. Only one participant never chose a screen zone matching with reality. The game with the higher matching rate is game on screenshot 4: *Call of Duty WWII* although being one of the worst-rated games in the lower-rated games chart. *(see annex n°3 – chart 20)*

Explanation of his/her choice by the participant: Participants were asked after choosing a screen zone why they made this choice and if possible describe the health meter they would like.

After reading all comments concerning choices of screen zone, we put them in four different categories : choices based on comfort criteria ("*I'd like it better if it was there*"), choices based on the field of view criteria ("*The game would be clearer if it was there*"), choices based on a comparison criteria ("*This other game does it like that so I'll do the same*") and choices based on habit criteria ("*I'm used to seeing a health meter there*").

After reading all comments concerning the behavior/type of health meter participants would put in the chosen screen zone, we put them in five different categories of behavior we used in the exploratory research: bar health meter, bar & point health meter, points health meter, vertical bar health meter and visual effects health meter.

We also counted the number of non-answers we had for both comments section. *(see annex n°3 – chart 21)*

c. *Acceptation or rejection of hypothesis for Task 2*

- H0: Mean time to execute the task depends on hours played (experience) *(see annex n°3 – chart 22)*

We decided to compare the mean time to execute the task with the experience for each participant. Unlike in task 1, it seems that the experience of the player has no influence on the mean time to execute the task.

The hypothesis is therefore rejected.

- H1: Mean time to click on the health meter depends on the number of favorite genres *(see annex n°3 – chart 22)*

We decided to compare the mean time to execute the task with the numbers of the favorite genre for each participant. Like in task 1, it seems that the number of favorite genres of a player has no influence on the mean time to execute the task.

The hypothesis is therefore rejected.

- H2: Mean time to click on the health meter depends on the number of gaming devices owned *(see annex n°3 – chart 22)*

We decided to compare the mean time to execute the task with the numbers of gaming devices owned for each participant. Like in task 1, it seems that the numbers of devices owned has no influence on the mean time to execute the task.

The hypothesis is therefore rejected.

- H3: Number of answers matching reality depends on hours played (experience) *(see annex n°3 – chart 23)*

We decided to compare the number of answers matching reality with the experience for each participant. We can see that less experienced participants had fewer answers matching with reality than more experienced participants. We could consider P4 being closer than 6 hours a week and P5 closer to 8 hours a week to explain the difference between them. However, P1 has 2 answers matching reality although he is playing less than P2 who has no answers matching reality. The number of answers might not depend only on the experience.

Therefore, the hypothesis cannot be totally accepted or rejected.

- H4: Number of answers matching reality depends on mean time to execute the task *(see annex n°3 – chart 24)*

We decided to compare the number of answers matching reality with the mean time to execute the task for each participant. P2 took on average 17 seconds to execute the task on each screenshot but has no answers matching reality while P6 took on average 8 seconds to execute the task on each screenshot and has 4 answers matching reality. There is no correlation between the two elements of the hypothesis.

The hypothesis is therefore rejected.

- H5: Mean time to execute the task depends on the mean number of fixations in the chosen zone *(see annex n°3 – chart 25)*

We decided to compare the mean time to execute the task with the mean numbers of fixations in the chosen zone. We supposed that the more fixations, the more time the participant would take to execute the task. We can see that P2, P3 and P5 have the highest mean times to execute the task and among the highest mean numbers of fixations. However, P4 took more time to execute the task, on average (9 seconds), with only an average of 6 fixations in the chosen zone per screenshot. Moreover, there is a difference of 6 seconds between P5 and P6 to execute the task, but the mean number of fixations is the same. The mean time to execute the task might not depend only on the mean number of fixations in the chosen zone.

Therefore, the hypothesis cannot be totally accepted or rejected.

- H6: Choices of screen zones are mostly based on comfort criteria

As seen in the last chart of the analysis section of task 2, the criterion of "comfort" was cited in only 10 answers on 52 concerning the choice of the screen zone. However, the criterion of "visual field clear" was cited in 23 answers making it the main criterion on which choices were based.

The hypothesis is therefore rejected.

- H7: Most chosen screen zones will be the same as observed during the exploratory research *(see annex n°3 – chart 26)*

We can see on those two charts representing the 9 different screen zones that most popular screen zones are the same. The seventh then the first then the eighth and nothing in the fifth and sixth zone. The three main positions (7^{th}, 1^{st} and 8^{th}) seem to be very well established among gamers and developers.

The hypothesis is therefore accepted.

- H8: Most frequent chosen health meter type will be the same as observed during the exploratory research *(see annex n°3 – chart 27)*

We can see in this chart that health meter type chosen by participants (40 answers) has a similar distribution than those of games observed during the second analysis of the exploratory research. First, a bar health meter (44,44% and 60%) followed by bar & points health meter (27,78% and 20%) then points health meter (13,89% and 10%) and the rest is split between vertical bar (13,89% and 5%) and visual effects (0% and 5%). The bar (with or without points) health meter seems to be very well established among gamers (80% of our answers) and developers (more than 70% of games observed).

The hypothesis is therefore accepted.

d. *Conclusion of Task 2*

The second task has led us to interesting conclusions.

It seems that the experience of a player has little to no influence on the time he/she needs to decide where he/she would display a health meter. This is the opposite of what we expected, we thought that more experienced players will be more aware of what they want as health meter in a video game and will, therefore, execute the task faster.

We also determined that comfort is not the main criterion to choose a screen zone to display a health meter. The main criterion to choose a screen zone was "will it negatively impact my field of view?" In general, it seems players don't want a fancy, visible health meter but rather a discreet, well designed one. It should be recognizable without taking too much space on the screen, maybe it shouldn't be displayed when everything is fine but only when needed.

Moreover, while watching videos to fill in data charts, we observed two recurrent visual patterns among participants. It seems that participants, when asked to choose a screen zone where to put the health meter, also begun by looking at screen zone n°5 followed by, zone n°7 then zone n°1 (those two were switched in the second pattern) to finally look at screen zones at the right of the screen (n° 3, 6 and 9 in no particular order). This might be explained by the fact that participants are used to seeing those type of health meters in those screen zones and will therefore look and consider putting the health meter there first.

Finally, we have seen that the shape and position used in most games observed in the exploratory research are the same used by participants when asked to put a health meter somewhere. The 1st, 7th and 8th screen zone are the most frequently used with a bar (with or without points) health meter. It might be because players are used to seeing those type of health meter in those screen zones. However, players don't seem to be confused when they encountered another type of health meter or a health meter in another screen zone. If it is well designed, players will recognize it most of the time.

e. *Sum-up of hypothesis for Task 2*

ID	Hypothesis	First analysis
HO	Mean time to execute the task depends on hours played (experience)	Rejected
H1	Mean time to click on the health meter depends on the number of favorite genres	Rejected
H2	Mean time to click on the health meter depends on the number of gaming devices owned	Rejected
H3	Number of answers matching reality depends on hours played (experience)	Accepted and rejected
H4	Number of answers matching reality depends on mean time to execute the task	Rejected
H5	Mean time to execute the task depends on the mean number of fixations in the chosen zone	Accepted and rejected
H6	Choices of screen zones are mostly based on comfort criteria	Rejected
H7	Most chosen screen zones will be the same as observed during the exploratory research	Accepted
H8	Most frequent chosen health meter type will be the same as observed during the exploratory research	Accepted

D. *Results for Task 3*

a. *What we are looking at*

During task 1, participants were asked to play 4 games consecutively for 5 minutes and were asked to fill a self-reported satisfaction questionnaire (User Experience Questionnaire) to measure their overall feeling about the system (the health meter).

Data were collected during this first task using the eye-tracking device:

- Amount of saccade on the health meter in various situations
- Amount of fixation on the health meter in various situations
- The perspicuity scale and efficiency scale in the UEQ

With those results, we can accept or reject the following hypothesis:

- H0: Amount of saccade per game depends on hours played (experience)
- H1: Amount of fixation per game depends on hours played (experience)
- H2: Fast-paced game (*Furi* and *Nuclear Throne*) has a higher number of saccade than slower games (*Lovers in a Dangerous Spacetime* and *Wolfenstein II*)
- H3: Slow-paced game *(Lovers in a Dangerous Spacetime* and *Wolfenstein II*) has a higher number of fixation than fast-paced games (*Furi* and *Nuclear Throne*)
- H4: The strategy of the player in-game changes based on the health meter initial state or general behavior (change of behavior during gameplay phase)
- H5: The “good” game’s health meter (*Furi*) performed better on the perspicuity scale and efficiency scale than the three other games

b. *Analysis*

Amount of saccade and fixation on the health meter in various situations: *(see annex n°3 – chart 28)* we have counted the numbers of saccades (the participant looks quickly at something without fixing it) and the numbers of fixation (the participant look at something more than a half of a second) in various situations. Those situations are calm phase (there is no action on screen), action phase (during a fight or similar), character's death (the player lost the game), enemy dead or after killing an enemy (the player has defeated an enemy), health back (when the player is regaining health), hit (when the player is hit by an enemy), at start (as soon as the player can control the character).

The perspicuity scale and efficiency scale in the UEQ: we used the Data Analysis Tool designed by Dr. Martin Schrepp[65] to analyze the results of our UEQ for each game. Although the UEQ offers a wide variety of scales (attractiveness, dependability, stimulation or novelty), we decided to mainly focus on the perspicuity and efficiency scales as there are the two points we are most interested in.

The perspicuity scale measures the degree of understandability of a system for the user (easy to get familiar with) and the efficiency scale measures the efficiency of the system for the user (easy to use without effort). Both scales go from -3 (horribly bad) to 3 (extremely good). However, a mean value inferior to -0,8 is considered negative and a mean value superior to 0,8 is considered positive.

Nonetheless, we have to carefully take those results into account as the experimentation included only six participants which might be enough and better than nothing according to UX Designer Célia Hodent[66].

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[65]User Experience Questionnaire (UEQ) : https://www.ueq-online.org/

[66]Hodent, C. (2018). *The Gamer's Brain: How Neuroscience and UX can Impact Video Game Design*. https://doi.org/10.1201/9781315154725

c. *Acceptation or rejection of hypothesis for Task 3*

- H0: Amount of saccade per game depends on hours played (experience)

We decided to compare the amount of saccade on the health meter in each game with the experience of each participant. Although, some participants tend to look more at the health meter in a couple of games, it seems there are no correlations between the two elements of the hypothesis.

The hypothesis is therefore rejected.

- H1: Amount of fixation per game depends on hours played (experience)

We decided to compare the amount of fixation on the health meter in each game with the experience of each participant. We ended up with the same conclusion as the hypothesis H0.

The hypothesis is therefore rejected.

- H2: Fast-paced game (*Furi* and *Nuclear Throne*) has a higher number of saccade than slower games (*Lovers in a Dangerous Spacetime* and *Wolfenstein II*)

Furi and *Nuclear Throne* can be considered as fast-paced games: there is little to no calm phase during the gaming session where the player can calm down, take a look at the health meter, the ammo left, etc. Because of that, we supposed that the rhythm of the gameplay allowed less fixation but more saccade on the health meter than slower games as *Lovers in a Dangerous Spacetime* and *Wolfenstein II*. This gameplay also implies that damage is taken more often, and the player will look more often at the health meter.

When looking at the amount of saccade in the chart at annex n° …, we can see that there is no correlation between the two elements of the hypothesis.

The hypothesis is therefore rejected.

- H3: Slow-paced game (*Lovers in a Dangerous Spacetime* and *Wolfenstein II*) has a higher number of fixation than fast-paced games (*Furi* and *Nuclear Throne*)

This hypothesis is basically the opposite of hypothesis H2: a slow gameplay allows the player to look (fixation) at the health meter more often than in a fast-paced game.

When looking at the amount of fixation in the chart at annex n° …, we can clearly see that participants had a higher tendency to look even briefly at the health meter in *Lovers in a Dangerous Spacetime* and *Wolfenstein II* than in *Furi* and *Nuclear Throne*.

The hypothesis is therefore accepted.

- H4: The strategy of the player in-game changes based on the health meter initial state or general behavior (change of behavior during gameplay phase)

To accept or reject this hypothesis, we had to analyze gaming sessions of each participant for each game.

In *Furi*, we have observed that participants would be more cautious when attacking after seeing the damage the enemy could do. This effect was amplified after seeing the character they played put KO on the ground.

In *Lovers in a Dangerous Spacetime*, not a single participant used the shield of the spaceship and none panicked when being under attack. This could be explained by the size of the health meter that seems really big and hard to empty.

In *Nuclear Throne*, it is common to die. The game is a rogue-like which means that it is impossible to progress without dying and that level will be different in each gaming session. We imposed participants to play with a character that has only a 2-HP health meter. That means that participant could die with only one hit taken. We observed the same behavior in every participant: they rush enemies during the first two games and realizing how fragile the character is, they act much more cautiously and take little to no risk.

In *Wolfenstein II*, we observed overall the same behavior as in *Nuclear Throne*: after dying twice, participants tend to be more cautious when encountering enemies.

With all those conclusions based on observations during the test and on recording, we can suppose a correlation between the two elements of the hypothesis.

The hypothesis is therefore accepted.

- H5: The “good” game’s health meter (Furi) performed better on the perspicuity scale and efficiency scale than the three other games. *(see annex n°3 – chart 29)*

As we can see in the chart, the game with the highest perspicuity score is *Lovers in a Dangerous Spacetime* while it also shares the best efficiency score with *Nuclear Throne* and *Wolfenstein II*. *Furi*, although being the “good” game in the selection, did not outperform the two games present in both chart (*Nuclear Throne* and *Wolfenstein II*) and the least-good game (*Lovers in a Dangerous Spacetime*).

It seems there is no correlation between the results of the UEQ and the success of the game. The explanation could be that even if the health meter is not perfect, it is working well enough anyway. The hypothesis is therefore rejected.

d. Conclusion of Task 3

This third task was the most important in this research as it put participants in a gaming situation in which the health meter functions. This last task has also led us to a variety of conclusions.

In the first place, it seems that the experience of the player has only a small impact on the frequency of looking at the health meter. This is the opposite of what we thought: a less experienced player will look more often at the health meter to understand what's happening on screen. When participants were playing, they were certainly in a state of flow where the health meter was only an indicator to help them understand a small part of the gameplay experience. Not everything that happens on screen revolves around the health meter even though it is the element that will put an end to the gameplay experience if it reaches a certain state.

Secondly, it seems that participants were looking at it only during stressful moments when there are a lot of enemies on screen or when enemies attacked them by surprise. Participants adjusted their behaviors, decisions and actions around the health meter. They won't necessarily take it into account when everything's fine, but we will adapt their will of doing something or taking a risk when it reaches a critical state (near the "Game Over"). This was particularly seen during *Nuclear Throne* gameplay sessions.

Moreover, we have also observed that the score on the perspicuity scale and efficiency scale is not relevant when talking about game success. Once again, although the notion of health/life is one of the most important elements of a game, the game itself does not revolve only around it. We could compare the health meter of a game to the check engine light of a car. The check engine light triggers a user's reaction when it reaches a certain state (when it turns on), it seems that the health meter functions the same way for the players we have observed.

Finally, talking about understanding a health meter: if it makes a bit of sense, it seems players will always understand it no matter its shape or behavior.

e. Sum-up of hypothesis for Task 3

ID	Hypothesis	First analysis
HO	Amount of saccade per game depends on hours played (experience)	Rejected
H1	Amount of fixation per game depends on hours played (experience)	Rejected
H2	Fast paced game (*Furi* and *Nuclear Throne*) has a higher number of saccade than slower games (*Lovers in a Dangerous Spacetime* and *Wolfenstein II*)	Rejected
H3	Slow-paced game *(Lovers in a Dangerous Spacetime* and *Wolfenstein II*) has a higher number of fixation than fast-paced games (*Furi* and *Nuclear Throne*)	Accepted
H4	The strategy of the player in-game changes based on the health meter initial state or general behavior (change of behavior during gameplay phase)	Accepted
H5	The "good" game's health meter (*Furi*) performed better on the perspicuity scale and efficiency scale than the three other games.	Rejected

VIII. General conclusion

Health meters within video games are crucial to the user's experience. We have seen throughout this paper, the importance of thinking the health meter as an individual element working on its own but also as part of a whole of other elements constituting the user's interface.

We have concluded with our exploratory research that there were, in fact, no patterns of health meter position or behavior. It seems that development studios follow no guideline to design health meters and they tend to replicate what has been already done and proved working fine. It is true that they do not have to reinvent the wheel every time but once again, how to be sure that the player understands this element of the user's interface?

The experimental research we have done using an eye-tracking device led us to a variety of interesting conclusions.

We have observed throughout the three tasks participants were asked to accomplish that the experience of the player has little to no impact on the ability to choose a position and behavior for a health meter or on the frequency of looking at it during a gaming session.

However, the ability to recognize a health meter quickly seems to be strongly impacted by the experience of the player: the less experience, the less time taken to spot what looks like a health meter.

During Task 1, we have observed that several characteristics of a health meter could help players to spot it more easily. It seems users usually associate the color green or red to health meters as well as the first (Top-left) and seventh (Bottom-left) screen zones. We also observed that when the health meter displayed an icon like a heart or a cross, players took less time to identify it as a health meter.

During Task 2, we have observed that players seem to want a discreet health meter, something that wouldn't take them out a potential state of flow. It seems that the shape and behavior of a health meter are not important if players know when it is reaching a critical state. We have also observed two recurrent visual patterns among participants. They were looking, in order, at the following screen zones:

- First pattern: 5, 7, 1, 2
- Second pattern: 5, 1, 7, 8

During Task 3, we have observed that players would generally look at the health meter when they were in a critical situation: a lot of enemies around, they don't have a lot of health left, etc. It seems that the health meter is something that players would only use in critical situations and is not really needed during calm phases or when no damage is taken.

The health meter is therefore a communication element that is strongly anchored in video games, in the player's habits and developers's priorities. No matter its shape or behavior, the most important is that the player understands it. However, there are things that development studios could implement in health meter systems to make them more recognizable and to improve the player's immersion. It seems, therefore, that the position and behavior of the health meter affect the behavior of the player and his/her understanding of the game.

Results of this paper must be considered with prudence as the database of our exploratory research only includes games from 2015 to 2017, patterns might have emerged during the last two years although we doubt it. Another point is that our experimental research only includes 6 participants because of time and logistic limitations. We think that other results could have been observed with more participants.

IX. Recommendations

Based on our conclusions, we can issue recommendations concerning health meters for the attention of the video game industry and the scientific world in the field of video games:

- Play test the user interface regularly as it is the main canal of communication between the user and the system.
- Value the perspicuity of the health meter over its shape or design. A fancy health meter will be useless if players cannot understand its way of working within seconds.
- Use color that players associate with health. We have concluded that red and green are the colors most associated with health.
- Use a health-related icon easily understandable alongside the health meter. It seems that players tend to spot a health meter more easily and quickly when it is accompanied with a health-related icon (heart, cross, etc.).
- Don't put the health meter on the right side of the screen as it is not a position where players expect to see a health meter. It would be better to use the first (Top-left) and seventh (Bottom-left) as it seems players will look at those screen zones first.
- Consider hiding the health meter when it is not needed or use a diegetic health meter. It seems players value the immersion and might be annoyed by a health meter reacting when damage is taken but without being in a critical state. Avoid health meters that could take the user out of a state of flow.

X. Bibliography

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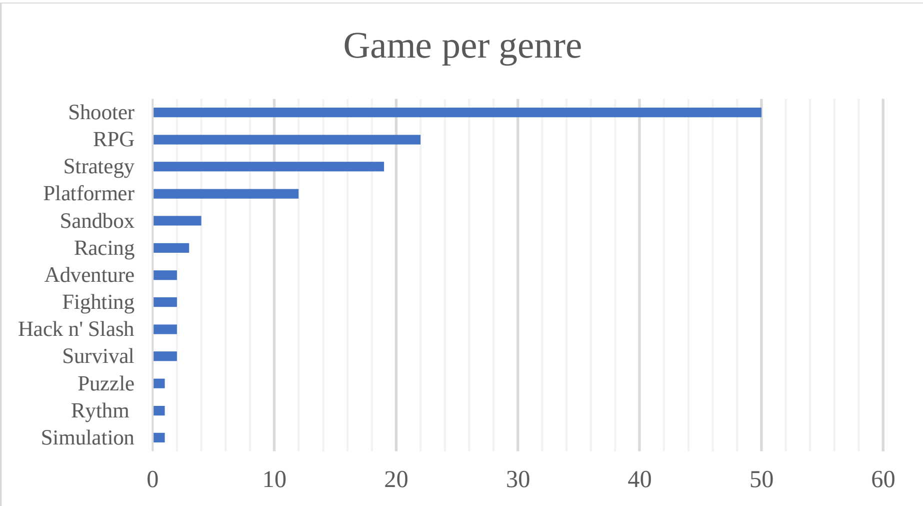
XI. Annex n°1 – Exploratory Research Charts

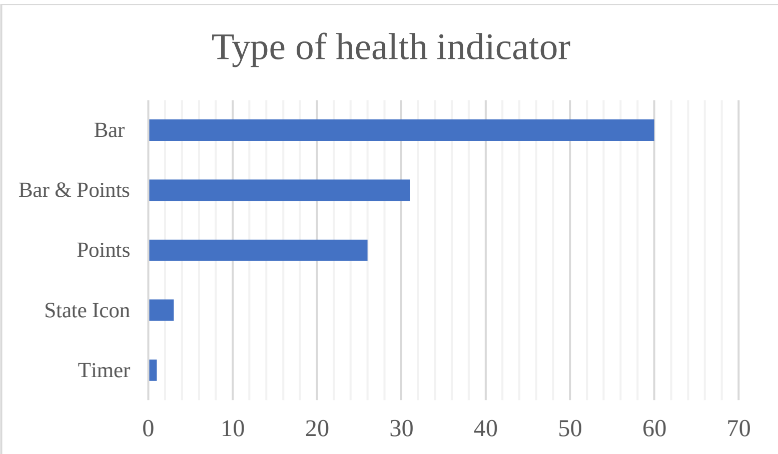
1. *Health indicator per screen zone:*

1st Health bar per screen zone		
33	4	4
2	3	0
38	19	12
	Other :	6

2. *Games per genre:*



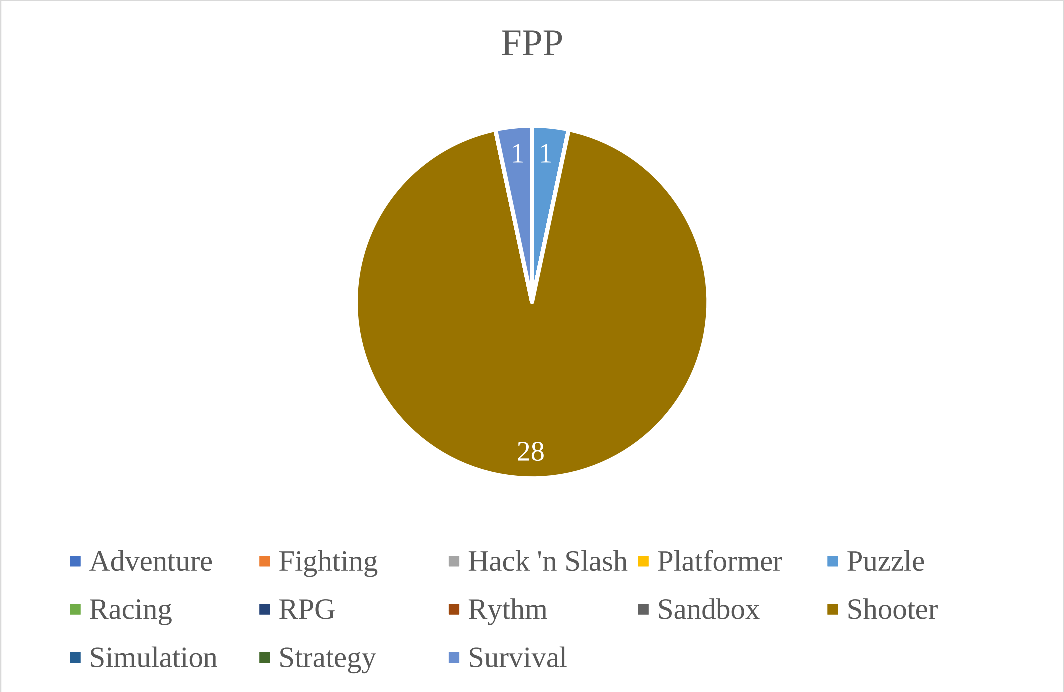
3. *Games per type of health indicator:*



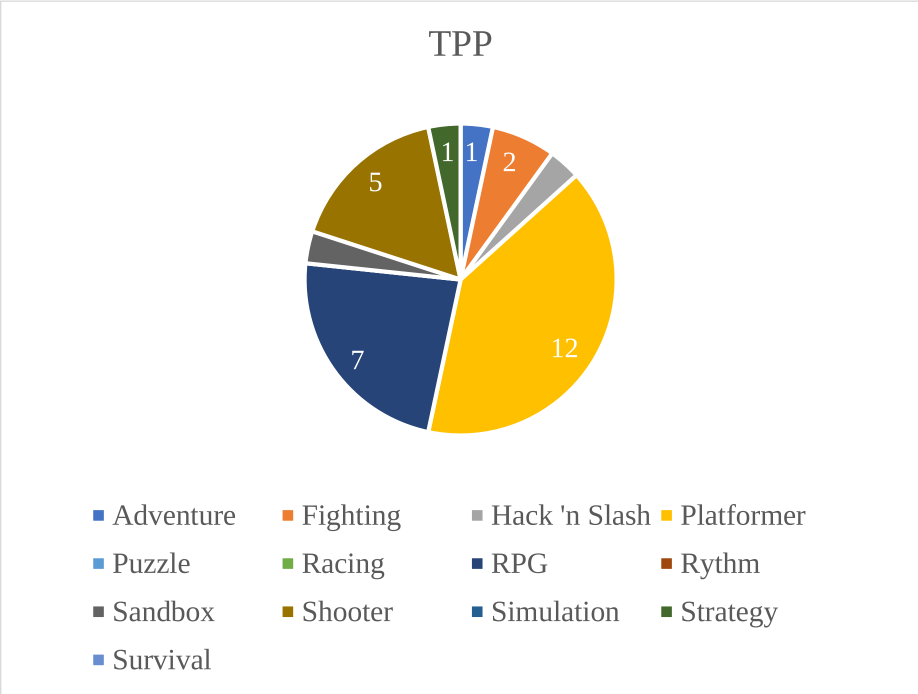
4. *Type of health indicator per game genre:*

	Bar	Bar & Points	Points	State Icon	Timer
Adventure	1	0	1	0	0
Fighting	2	0	0	0	0
Hack 'n Slash	1	1	0	0	0
Platformer	5	2	5	0	0
Puzzle	0	0	0	0	1
Racing	1	1	0	1	0
Role-Playing Game	12	5	5	0	0
Rythm	0	0	1	0	0
Sandbox	3	1	0	0	0
Shooter	28	12	10	0	0
Simulation	0	1	0	0	0
Strategy	7	8	4	0	0
Survival	0	0	0	2	0

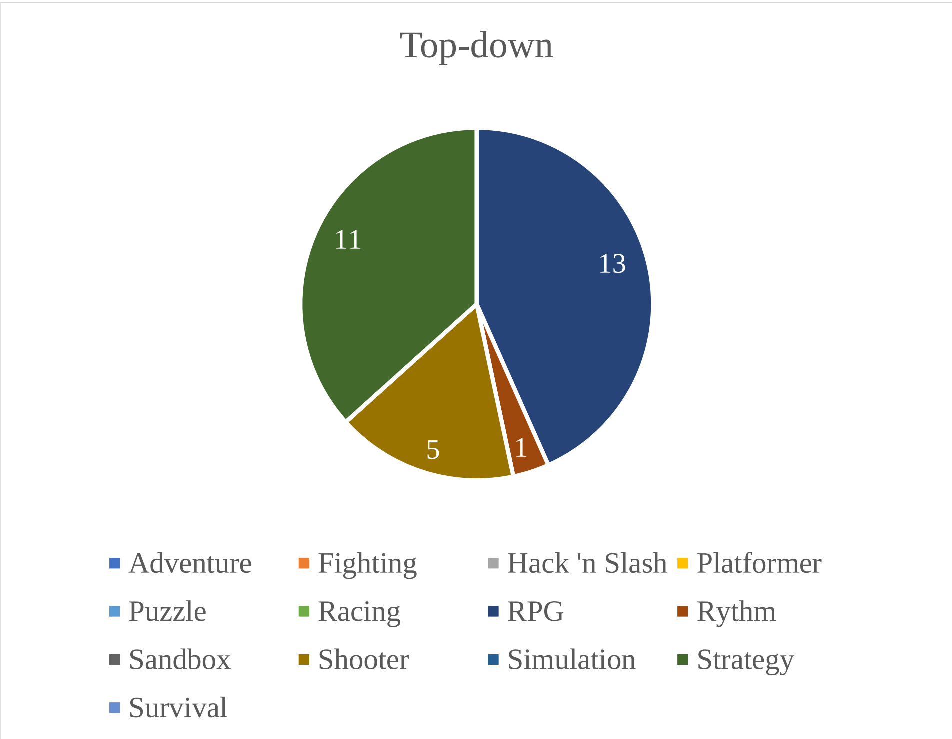
5. *Game genre per POV (FPP):*



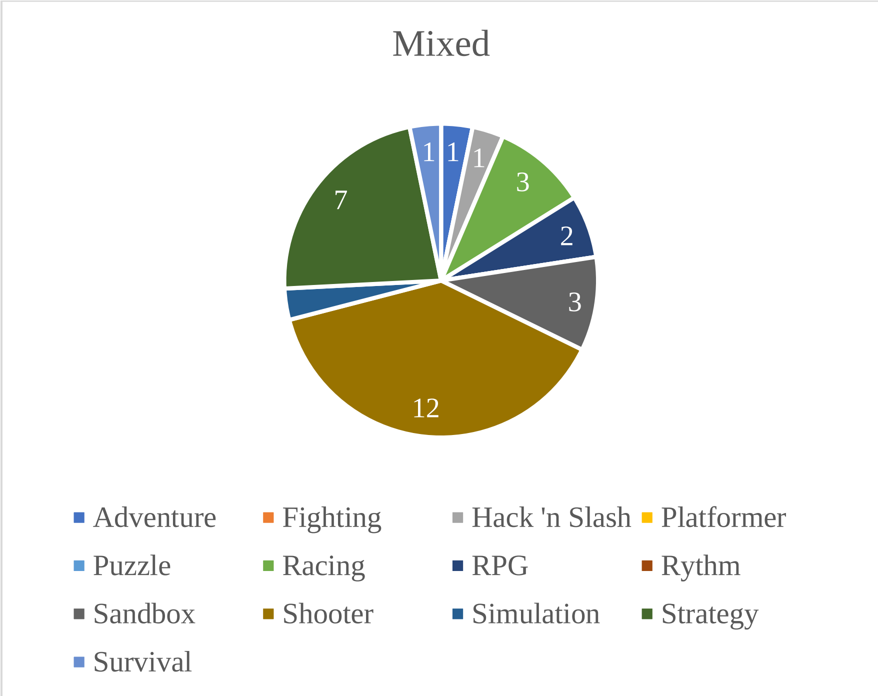
6. Game genre per POV (TPP):



7. Game genre per POV (Top-down):



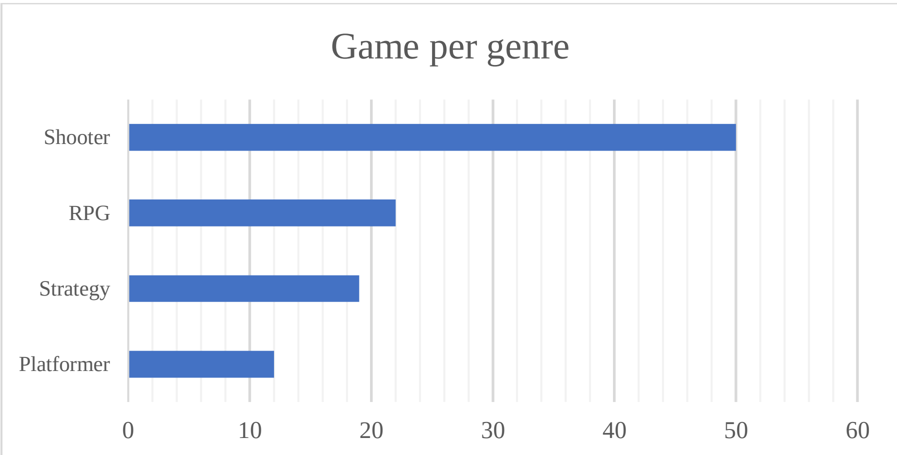
8. Game genre per POV (Mixed):



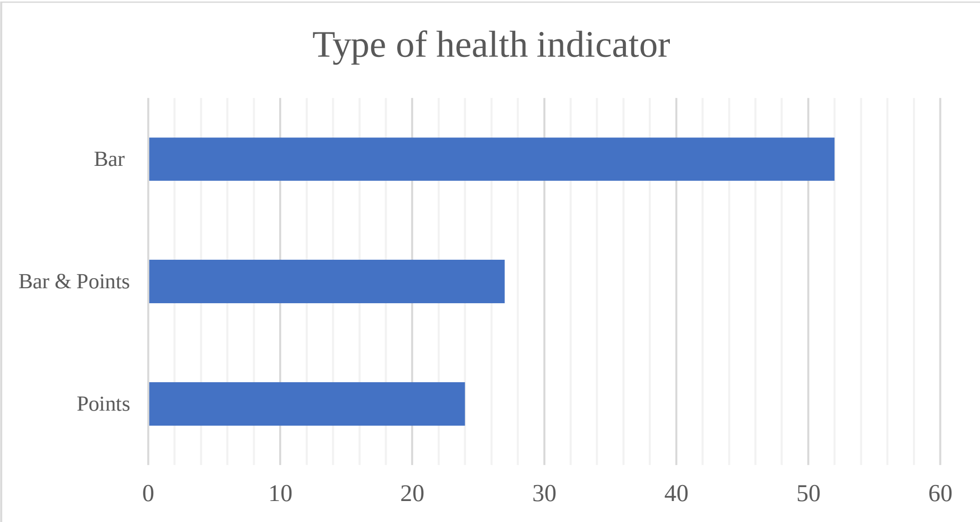
9. Health indicator per screen zone (second analysis):

1st Health bar per screen zone		
28	4	3
2	3	0
30	19	9

10. Games per genre (second analysis):



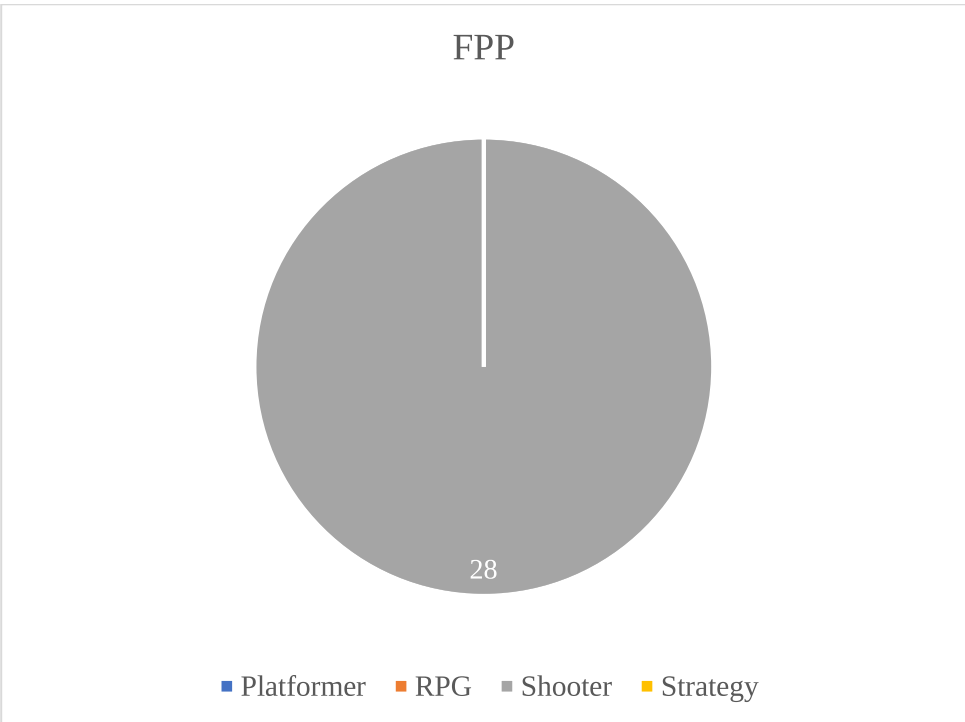
11. Games per type of health indicator (second analysis):



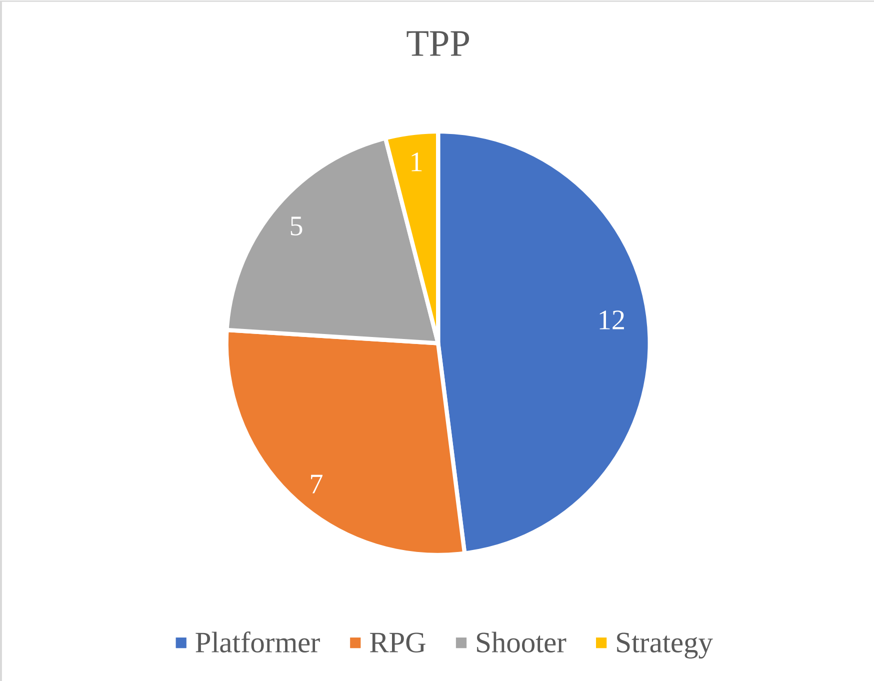
12. Type of health indicator per game genre (second analysis):

	Bar	Bar & Points	Points	State Icon	Timer
Shooter	24	9	4	0	0
Role-Playing Game	11	3	4	0	0
Strategy	3	5	2	0	0
Platformer	5	2	0	0	0

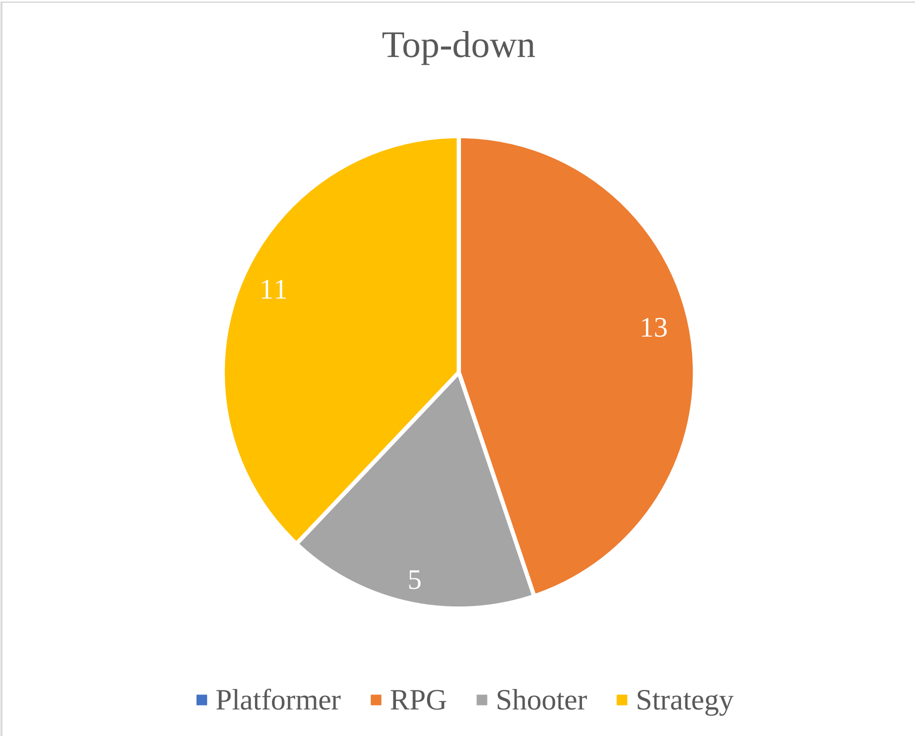
13. Game genre per POV (FPP – second analysis):



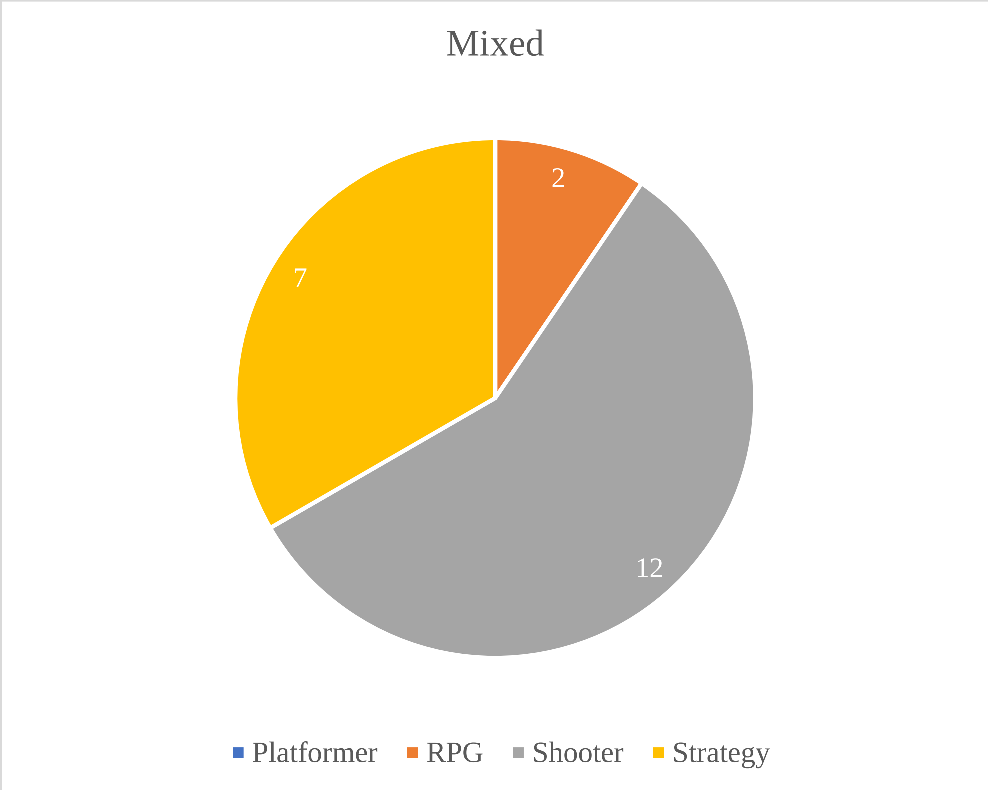
14. Game genre per POV (TPP – second analysis):



15. Game genre per POV (Top-down – second analysis):



16. Game genre per POV (Mixed – second analysis):



XII. Annex n°2 – Top-rated games chart and less good-rated games chart

1. *Top-rated games chart*

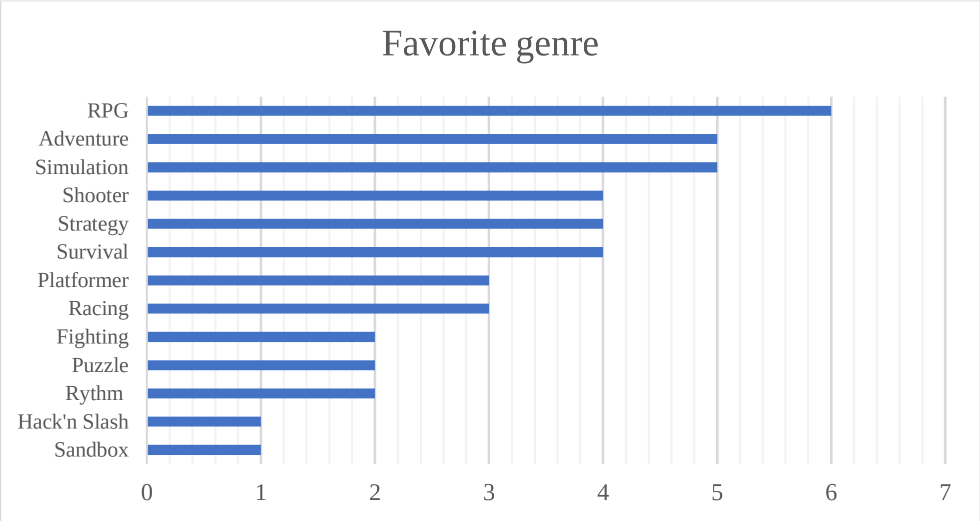
	POV	FPP			TPP			Top-down			Mixed		
	YEAR	2015	2016	2017	2015	2016	2017	2015	2016	2017	2015	2016	2017
HEALTH INDICATOR BEHAVIOR	Bar from right to left	System Shock : Enhanced Edition	Titanfall 2	Destiny 2	The Witcher 3 : Wild Hunt	Dark Souls III	Nioh : Complete Edition	Helldivers	Xcom 2	Starcraft Remastered	Grand Theft Auto V	Furi	PlayerUnknown's Battlegrounds
	Score	85	86	83	93	89	84	83	88	85	96	76	86
	Bar from right to left & points towards 0	Dying Light	Overwatch	Prey	Downwell	Dragon's Dogma : Dark Arisen	/	Nuclear Throne	Grim Dawn	The Legend Of Heroes : Trails In The Sky The 3rd	Total War : Attila	Total War : Warhammer	Total War : Warhammer II
	Score	75	91	82	81	81	/	88	83	83	80	86	87
	Bar downwards	/	Dishonored 2	/	Mega Man Legacy Collection	/	/	Pillars Of Eternity	Stardew Valley	Torment : Tides of Numenera	Evolve (Hunter)	/	/
	Score	/	86	/	85	/	/	89	89	81	77	/	/
	Points towards 0	Tom Clancy's Rainbow Six Siege	/	Wolfenstein II : The New Colossus	/	Final Fantasy X / X-2 HD Remaster	/	The Age Of Decadence	Hex : Shards of Fate	Pyre	/	/	/
	Score	79	/	86	/	83	/	81	87	82	/	/	/

2. *Lower-rated games chart*

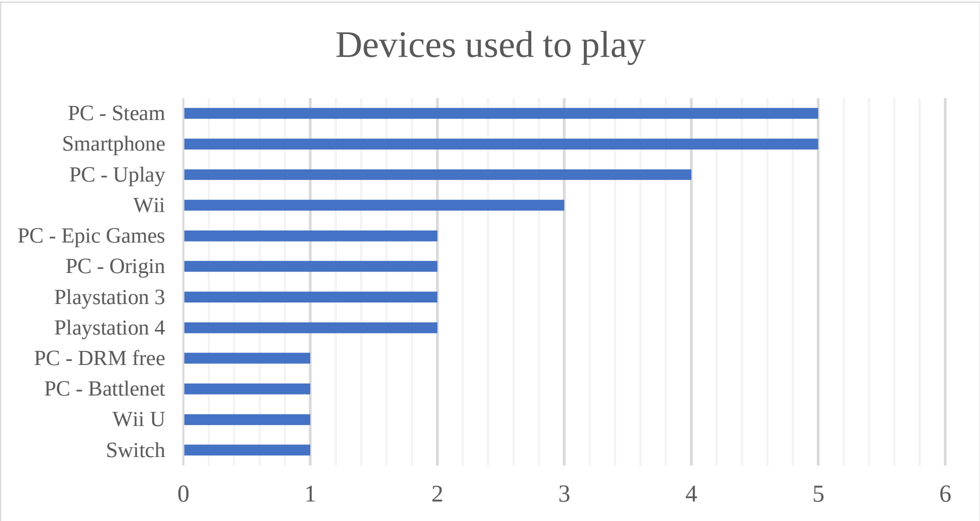
	POV	FPP			TPP			Top-down			Mixed		
	YEAR	2015	2016	2017	2015	2016	2017	2015	2016	2017	2015	2016	2017
HEALTH INDICATOR BEHAVIOR	Bar from right to left	Pathologic Classic HD	Far Cry Primal	Call of Duty : WWII	Dark Souls II : Scholar Of The First Sin	ICEY	BLEED 2	Shadowrun : Hong Kong	Xcom 2	Planescape : Torment - Enhanced Edition	Evolve (Monster)	Halcyon 6 : Starbase Commander	Everspace
	Score	76	74	73	79	84	83	81	88	85	77	71	79
	Bar from right to left & points towards 0	Battlefield : Hardline	Shadow Warrior 2	Lawbreakers	Apotheon	Dragon's Dogma : Dark Arisen	/	Nuclear Throne	Grim Dawn	Battle Brothers	Star Wars : Battlefront	Total War : Warhammer	Star Wars : Battlefront II
	Score	71	78	76	78	81	/	88	83	80	72	86	65
	Bar downwards	Battlezone 98 Redux	/	/	Lovers in a Dangerous Spacetime	/	/	Pillars Of Eternity	Shadow Tactics : Blades of the Shogun	Torment : Tides of Numenera	Mad Max	/	/
	Score	75	/	/	80	/	/	89	85	81	73	/	/
	Points towards 0	Turok Remastered	/	Wolfenstein II : The New Colossus	/	Final Fantasy X / X-2 HD Remaster	/	The Age Of Decadence	Duelyst	Pyre	/	/	/
	Score	67	/	86	/	83	/	81	82	82	/	/	/

XIII. Annex n°3 – Experimental research charts

1. *Favorite genre of participants*



2. *Devices used to play of participants*



3. *Task 1 - Participants know the game on the screenshot (Y/N)*

Participants	Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	Sc7	Sc8	Sc9	Sc10	Sc11	Sc12	Total right answers
P1	N	N	N	N	N	N	N	N	N	N	N	N	0
P2	Y	N	N	Y	N	N	N	N	N	N	Y	N	3
P3	Y	N	N	N	N	N	N	N	N	N	Y	N	2
P4	Y	N	N	Y	N	N	N	N	N	Y	Y	N	4
P5	N	N	N	Y	N	N	N	N	N	N	N	N	1
P6	N	Y	N	Y	N	N	N	N	N	N	N	N	2
Game awareness	3	1	0	4	0	0	0	0	0	1	3	0	

4. *Task 1 - Time before the first fixation on what the participant thinks is the game's health meter (in seconds)*

	Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	Sc7	Sc8	Sc9	Sc10	Sc11	Sc12	
Participants	Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	Sc7	Sc8	Sc9	Sc10	Sc11	Sc12	Mean time before first fixation
P1	0,947	0,563	0,442	0,38	0,258	1,115	2,616	0,727	3,182	0,332	0,415	0,595	0,96
P2	0,455	0,644	0,447	0,535	0,186	0,851	1,004	2,749	3,993	0,3	0,289	0,581	1,00
P3	0,675	9,282	1,118	0,415	1,795	1,799	2,565	0,33	0,919	0,823	0,639	13,047	2,78
P4	0,231	13,077	1,521	0,239	2,241	1,785	2,605	1,647	2,111	0,51	0,645	2,375	2,42
P5	0,849	2,923	1,808	0,977	0,846	1,741	1,525	3,083	1,583	1,214	0,223	2,753	1,63
P6	0,583	8,783	1,538	0,558	2,802	5,473	5,696	4,057	2,089	1,497	1,71	2,033	3,07

5. *Task 1 - Time for the participant to click on what he/she thinks is the game's health meter after the first fixation on it (in seconds)*

	Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	Sc7	Sc8	Sc9	Sc10	Sc11	Sc12	
Participants	Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	Sc7	Sc8	Sc9	Sc10	Sc11	Sc12	Mean time
P1	0,642	0,17	0,467	0,509	1,085	2,627	0,263	0,527	2,111	2,365	0,448	1,595	1,07
P2	0,43	5,509	1,383	0,337	1,437	0,127	4,912	1,63	0,051	1,415	1,367	1,753	1,70
P3	1,643	7,591	0,842	6,467	0,243	5,742	3,254	11,565	2,17	0,261	0,681	6,102	3,88
P4	1,41	8,261	1,019	1,628	1,449	0,612	0,811	0,18	6,449	0,581	0,426	8,723	2,63
P5	0,577	5,054	1,278	1,086	0,096	1,631	1,663	1,506	3,427	1,3	0,886	1,601	1,68
P6	5,195	7,432	20,326	3,57	6,231	7,45	5,82	0,009	6,97	4,085	1,833	2,293	5,93

6. *Task 1 - Time total to execute the task (in seconds)*

	Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	Sc7	Sc8	Sc9	Sc10	Sc11	Sc12	
Participants	Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	Sc7	Sc8	Sc9	Sc10	Sc11	Sc12	Mean time
P1	2,536	0,956	1,351	1,269	1,601	4,857	4,969	1,981	8,475	3,029	1,278	2,785	2,92
P2	1,34	6,797	2,277	1,407	1,809	1,575	6,92	3,868	7,935	2,015	1,945	2,915	3,40
P3	2,993	10,973	3,078	7,297	3,347	9,34	8,384	12,225	4,008	1,907	1,959	19,992	7,13
P4	1,872	17,893	4,061	2,105	3,033	2,958	4,399	3,474	10,671	1,601	1,716	13,473	5,60
P5	2,275	10,9	4,894	3,04	1,788	5,113	4,713	4,66	6,593	3,728	1,332	3,905	4,41
P6	6,361	24,998	23,402	4,686	11,835	18,396	17,212	8,105	11,148	7,079	5,253	6,359	12,07

7. *Task 1 - Is the answer correct (Y/N)*

	Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	Sc7	Sc8	Sc9	Sc10	Sc11	Sc12	
Participants	Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	Sc7	Sc8	Sc9	Sc10	Sc11	Sc12	Total right answers
P1	Y	N	Y	Y	Y	N	N	Y	Y	Y	Y	N	8
P2	N	N	Y	Y	Y	Y	N	Y	Y	Y	Y	N	8
P3	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	11
P4	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	11
P5	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	9
P6	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	10
Right answer per screenshot	4	3	6	6	6	5	3	6	6	6	6	0	

8. *Task 1 – Chart for H0, H1 & H2*

Participants	Mean time	Hours played per week (experience)	Numbers of favorite genre	Numbers of devices owned
P1	2,92	Less than 2	10	3
P2	3,40	Between 4 & 6	7	3
P3	7,13	More than 12	9	6
P4	5,60	Between 6 & 8	4	6
P5	4,41	Between 6 & 8	7	8
P6	12,07	Between 8 & 10	5	3

9. *Task 1 - H3: Number of right answers depends on hours played (experience)*

Participants	Total right answers	Hours played per week (experience)
P1	8	Less than 2
P2	8	Between 4 & 6
P3	11	More than 12
P4	11	Between 6 & 8
P5	9	Between 6 & 8
P6	10	Between 8 & 10

10. *Task 1 – H4: Number of right answers depends on time to click on the health meter (more time = more right answers)*

Participants	Mean time	Total right answers
P1	2,92	8
P2	3,40	8
P3	7,13	11
P4	5,60	11
P5	4,41	9
P6	12,07	10

11. *Task 1 - H5: Mean time taken by a participant to click on what he/she thinks the game's health meter is after his/her first fixation on it depends on hours played (experience)*

Participants	Mean time	Hours played per week (experience)
P1	1,07	Less than 2
P2	1,70	Between 4 & 6
P3	3,88	More than 12
P4	2,63	Between 6 & 8
P5	1,68	Between 6 & 8
P6	5,93	Between 8 & 10

12. *Task 1 - H6: Right answers depend on the mean time taken by the participant to click on what he/she thinks the game's health meter is*

Participants	Mean time	Total right answers
P1	1,07	8
P2	1,70	8
P3	3,88	11
P4	2,63	11
P5	1,68	9
P6	5,93	10

13. Task 1 - H7: Mean time to click on the health meter depends on the health meter's position on screen

		Screenshots											
		Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	Sc7	Sc8	Sc9	Sc10	Sc11	Sc12
	Screen zone	1	2	1	7	1	Following character	7	7	8	9	1	2
Participants	P1	2,536	0,956	1,351	1,269	1,601	4,857	4,969	1,981	8,475	3,029	1,278	2,785
	P2	1,34	6,797	2,277	1,407	1,809	1,575	6,92	3,868	7,935	2,015	1,945	2,915
	P3	2,993	10,973	3,078	7,297	3,347	9,34	8,384	12,225	4,008	1,907	1,959	19,992
	P4	1,872	17,893	4,061	2,105	3,033	2,958	4,399	3,474	10,671	1,601	1,716	13,473
	P5	2,275	10,9	4,894	3,04	1,788	5,113	4,713	4,66	6,593	3,728	1,332	3,905
	P6	6,361	24,998	23,402	4,686	11,835	18,396	17,212	8,105	11,148	7,079	5,253	6,359
	Mean time per screenshot	2,90	12,09	6,51	3,30	3,90	7,04	7,77	5,72	8,14	3,23	2,25	8,24

14. Task 1 - H8: Mean time before the first fixation on what the participant thinks the game's health meter is depends on the health meter's position on the screen

		Screenshots											
		Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	Sc7	Sc8	Sc9	Sc10	Sc11	Sc12
	Screen zone	1	2	1	7	1	Following character	7	7	8	9	1	2
Participants	P1	0,947	0,563	0,442	0,38	0,258	1,115	2,616	0,727	3,182	0,332	0,415	0,595
	P2	0,455	0,644	0,447	0,535	0,186	0,851	1,004	2,749	3,993	0,3	0,289	0,581
	P3	0,675	9,282	1,118	0,415	1,795	1,799	2,565	0,33	0,919	0,823	0,639	13,047
	P4	0,231	13,077	1,521	0,239	2,241	1,785	2,605	1,647	2,111	0,51	0,645	2,375
	P5	0,849	2,923	1,808	0,977	0,846	1,741	1,525	3,083	1,583	1,214	0,223	2,753
	P6	0,583	8,783	1,538	0,558	2,802	5,473	5,696	4,057	2,089	1,497	1,71	2,033
	Mean time per screenshot	0,62	5,88	1,15	0,52	1,35	2,13	2,67	2,10	2,31	0,78	0,65	3,56

Task 1 - H9: Health meters of good rated games are seen, on average, quicker than those of lower-rated games

		Screenshots											
		Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	Sc7	Sc8	Sc9	Sc10	Sc11	Sc12
	Good rated or less good rated	G	L	L	G	L	L	G	L	L	G	G	G
Participants	P1	0,947	0,563	0,442	0,38	0,258	1,115	2,616	0,727	3,182	0,332	0,415	0,595
	P2	0,455	0,644	0,447	0,535	0,186	0,851	1,004	2,749	3,993	0,3	0,289	0,581
	P3	0,675	9,282	1,118	0,415	1,795	1,799	2,565	0,33	0,919	0,823	0,639	13,047
	P4	0,231	13,077	1,521	0,239	2,241	1,785	2,605	1,647	2,111	0,51	0,645	2,375
	P5	0,849	2,923	1,808	0,977	0,846	1,741	1,525	3,083	1,583	1,214	0,223	2,753
	P6	0,583	8,783	1,538	0,558	2,802	5,473	5,696	4,057	2,089	1,497	1,71	2,033
	Mean time per screenshot	0,62	5,88	1,15	0,52	1,35	2,13	2,67	2,10	2,31	0,78	0,65	3,56

15. Task 2 - Participants know the game on the screenshot (Y/N)

Participants	Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	Sc7	Sc8	Sc9	Sc10	Sc11	Sc12	Games awareness per participant
P1	N	N	N	N	N	N	N	N	N	N	N	N	0
P2	N	N	N	N	N	N	N	N	N	N	N	N	0
P3	N	N	N	N	N	N	N	N	N	N	N	N	0
P4	N	N	N	N	N	N	N	N	N	N	N	N	0
P5	N	N	N	N	N	N	N	Y	N	N	N	N	1
P6	N	N	N	Y	N	N	N	N	N	N	N	N	1
Game awareness per screenshot	0	0	0	1	0	0	0	1	0	0	0	0	

16. Task 2 - The chosen screen zone where the participant would put a health meter

Participants	Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	Sc7	Sc8	Sc9	Sc10	Sc11	Sc12
P1	7	1	7	7	7	1	7	8	7	2	7	1
P2	7	1	Following character	1	Following character	1	Following character	7	Following character	9	1	1
P3	8	7	1	7	Following character	1	4	7	8	7	8	1
P4	7	7	4	2	Following character	7	1	7	Following character	In a menu	Following character	2
P5	7	2	1	7	Following character	1	1	1	7	8	1	7
P6	7	2	1	7	1	1	8	7	7	Following character	Following character	7

17. Task 2 - The numbers of fixations in the chosen zone before choosing it

Participants	Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	Sc7	Sc8	Sc9	Sc10	Sc11	Sc12	Mean number of fixations in chosen zone per participant
P1	6	3	3	8	13	5	4	13	4	12	7	4	6,83
P2	6	7	23	17	13	8	15	27	17	9	31	11	15,33
P3	8	10	11	26	28	5	3	9	4	8	8	6	10,50
P4	7	4	7	5	9	5	5	7	8	/	13	5	6,25
P5	5	7	12	10	6	4	8	9	11	8	9	6	7,92
P6	9	4	8	5	15	6	5	11	7	10	10	5	7,92
Mean number of fixations in chosen zone per screenshot	6,83	5,83	10,67	11,83	14,00	5,50	6,67	12,67	8,50	7,83	13,00	6,17	

18. *Task 2 - Time to execute the task (in seconds)*

Participants	Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	Sc7	Sc8	Sc9	Sc10	Sc11	Sc12	Mean time to execute the task per participant
P1	7,062	5,621	5,365	8,858	10,3	4,369	8,341	7,933	6,562	5,396	7,577	3,74	6,76
P2	9,208	19,862	18,998	35,843	6,838	8,654	12,934	42,325	9,826	13,901	19,562	9,243	17,27
P3	11,289	10,772	12,75	18,107	23,635	13,892	9,241	13,471	6,999	16,846	11,629	6,916	12,96
P4	10,957	17,225	5,826	6,604	6,373	7,885	7,436	9,192	5,814	10,765	15,225	6,426	9,14
P5	7,409	8,659	25,921	13,439	14,531	8,363	22,27	22,03	12,088	17,136	12,614	6,794	14,27
P6	8,091	6,361	5,645	14,765	10,03	9,96	5,998	10,296	8,978	5,857	6,749	6,581	8,28
Mean time to execute the task per screenshot	9,00	11,42	12,42	16,27	11,95	8,85	11,04	17,54	8,38	11,65	12,23	6,62	

19. *Task 2 - The answer given by the participant matches with reality*

Participants	Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	Sc7	Sc8	Sc9	Sc10	Sc11	Sc12	Right answers per participant
P1	N	N	N	Y	N	N	N	Y	N	N	N	N	2
P2	N	N	N	N	N	N	N	N	N	N	N	N	0
P3	N	N	Y	Y	N	N	N	N	Y	Y	N	N	4
P4	N	N	N	N	N	Y	Y	N	N	N	N	N	2
P5	N	N	Y	Y	N	N	Y	N	N	N	N	Y	4
P6	N	N	Y	Y	Y	N	N	N	N	N	N	Y	4
Right answer per screenshot	0	0	3	4	1	1	2	1	1	1	0	2	

20. *Task 2 - Explanation of his/her choice by the participant*

Comfort	10
Visual field	23
Comparison	4
Habits	15
Unanswered	20

Bar	24
Bar & points	8
Points	4
Bar going downwards	2
Visual effects	2
Unanswered	32

21. *Task 2 – Chart for H0, H1 & H2*

Participants	Mean time to execute the task per participant	Hours played per week (experience)	Numbers of favorite genre	Numbers of systems owned
P1	6,76	Less than 2	10	3
P2	17,27	Between 4 & 6	7	3
P3	12,96	More than 12	9	6
P4	9,14	Between 6 & 8	4	6
P5	14,27	Between 6 & 8	7	8
P6	8,28	Between 8 & 10	5	3

22. *Task 2 - H3: Number of answers matching reality depends on hours played (experience)*

Participants	Answers matching reality per participant	Hours played per week (experience)
P1	2	Less than 2
P2	0	Between 4 & 6
P3	4	More than 12
P4	2	Between 6 & 8
P5	4	Between 6 & 8
P6	4	Between 8 & 10

23. *Task 2 - H4: Number of answers matching reality depends on mean time to execute the task*

Participants	Mean time to execute the task per participant	Answers matching reality per participant
P1	6,76	2
P2	17,27	0
P3	12,96	4
P4	9,14	2
P5	14,27	4
P6	8,28	4

24. *Task 2 - H5: Mean time to execute the task depends on the mean number of fixations in the chosen zone*

Participants	Mean time to execute the task per participant	Mean number of fixations in chosen zone per participant
P1	6,76	6,83
P2	17,27	15,33
P3	12,96	10,50
P4	9,14	6,25
P5	14,27	7,92
P6	8,28	7,92

25. *Task 2 - H7: Most chosen screen zones will be the same as observed during the exploratory research*

Exploratory research : second analysis

19	3	3
1	0	0
22	15	5

Other : 35

Task 2

20	5	0
2	0	0
26	6	1

Other : 9

26. Task 2 - H8: Most frequent chosen health meter type will be the same as observed during the exploratory research

	Exploratory research : second analysis	Percentage exploratory research	Task 2	Percentage task 2	Task 2 without unanswered	Percentage task 2 without unanswered
Bar	32	44,44%	24	33,33%	24	60,00%
Bar & points	20	27,78%	8	11,11%	8	20,00%
Points	10	13,89%	4	5,56%	4	10,00%
Bar going downwards	10	13,89%	2	2,78%	2	5,00%
Visual effects	0	0,00%	2	2,78%	2	5,00%
Unanswered	0	0,00%	32	44,44%	0	0,00%
Total	72		72		40	

27. Task 3 - Amount of saccade and fixation on the health meter in various situations

Furi

	Saccade on health meter (no fixation)						TOTAL SACCADE	Fixation on health meter						TOTAL FIXATION			
	Calm phase	Action phase	Character dead	enemy dead	When hit	At start		Calm phase	Action phase	Character dead	enemy dead	When hit	At start		Hours played per week (experience)	Numbers of favorite genre	Numbers of systems owned
P1	0	0	2	0	0	0	2	0	0	1	1	0	0	2	Less than	10	3
P2	0	2	1	0	0	0	3	0	0	3	2	0	0	5	Between 4 & 6	7	3
P3	0	0	4	3	5	1	13	0	3	0	0	0	0	3	More than 12	9	6
P4	0	4	0	0	13	0	17	0	0	2	1	2	0	5	Between 6 & 8	4	6
P5	0	3	0	1	2	0	6	0	1	1	1	0	1	4	Between 6 & 8	7	8
P6	0	0	0	0	6	1	7	0	0	1	1	0	0	2	Between 8 & 10	5	3
							48							21			

Lovers in a Dangerous Spacetime

	Saccade on health meter (no fixation)						TOTAL SACCADE	Fixation on health meter						TOTAL FIXATION			
	Calm phase	Action phase	Character dead	Health back	When hit	At start		Calm phase	Action phase	Character dead	Health back	When hit	At start		Hours played per week (experience)	Numbers of favorite genre	Numbers of systems owned
P1	0	0	0	0	4	0	4	0	0	0	0	0	0	0	Less than	10	3
P2	1	2	0	0	3	2	8	3	0	0	0	0	0	3	Between 4 & 6	7	3
P3	0	2	0	0	0	5	7	1	3	0	0	0	0	4	More than 12	9	6
P4	3	0	0	0	0	0	3	7	2	0	2	0	1	12	Between 6 & 8	4	6
P5	2	0	0	0	1	0	3	3	1	0	0	1	0	5	Between 6 & 8	7	8
P6	0	0	0	0	2	0	2	1	2	0	0	0	1	4	Between 8 & 10	5	3
							27							28			

Nuclear Throne

	Saccade on health meter (no fixation)						TOTAL SACCADE	Fixation on health meter						TOTAL FIXATION			
	Calm phase	Action phase	Character dead	After killing an enemy	When hit	At start		Calm phase	Action phase	Character dead	After killing an enemy	When hit	At start		Hours played per week (experience)	Numbers of favorite genre	Numbers of systems owned
P1	0	0	0	0	0	2	2	2	0	0	0	0	1	3	Less than	10	3
P2	0	2	2	0	0	2	6	0	0	0	0	0	0	0	Between 4 & 6	7	3
P3	2	0	0	0	1	4	7	0	1	0	0	0	2	3	More than 12	9	6
P4	4	3	1	1	0	0	9	3	0	0	1	0	0	4	Between 6 & 8	4	6
P5	2	0	1	2	0	0	5	2	0	0	0	0	1	3	Between 6 & 8	7	8
P6	0	0	0	3	0	1	4	1	0	0	1	0	0	2	Between 8 & 10	5	3
							33							15			

Wolfenstein II

	Saccade on health meter (no fixation)						TOTAL SACCADE	Fixation on health meter						TOTAL FIXATION	Hours played per week (experience)	Numbers of favorite genre	Numbers of systems owned
	Calm phase	Action phase	Character dead	After killing an enemy	When hit	At start		Calm phase	Action phase	Character dead	After killing an enemy	When hit	At start				
P1	1	0	1	0	0	1	3	0	0	0	0	0	0	0	Less than	10	3
P2	3	0	1	1	0	1	6	0	0	2	0	0	1	3	Between 4 & 6	7	3
P3	3	10	2	0	0	0	15	2	0	1	1	0	0	4	More than 12	9	6
P4	2	0	0	1	2	1	6	1	2	0	0	1	4	8	Between 6 & 8	4	6
P5	0	1	0	0	1	2	4	1	0	0	3	0	0	4	Between 6 & 8	7	8
P6	5	3	0	0	0	0	8	0	2	0	0	0	1	3	Between 8 & 10	5	3
							42							22			

28. *Task 3 - H5: The "good" game's health meter (Furi) performed better on the perspicuity scale and efficiency scale than the three other games*

	Perspicuity	Efficiency
Furi	1,417	0,75
Lovers in a Dangerous Spacetime	1,833	0,875
Nuclear Throne	1,708	0,875
Wolfenstein II	1,25	0,875

Abstract

A health meter is a common element in a video game. It is a feedback system to let the player knows how he/she is performing in the game and is therefore one of the most important elements in the user interface. In this paper, we analyze how development studios design health meter in terms of position and behavior and how those design choices affect the behavior of the player and his/her understanding of the game. We did an exploratory research to have an overview of possible health meter design patterns and an experimental research using an eye-tracking device to record player's behavior when playing. The findings suggest that, despite there seems to be no health meter design patterns in development studios, the health meter does affect the behavior of the player while playing when it reaches a critical state but also affect the understanding of the game as if it is poorly designed, players might consider the game frustrating or unfair. In addition to our conclusions, we proposed health meter design guidelines for the attention of the video game industry and the scientific world in the field of video games.

Keywords: Human-computer interaction, UX design, video games, eye tracking, usability, health meter