# A Player-centric Game Design Paradigm with Compassion

Game design challenges for players with Parkinson Disease

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***Abstract*—The population playing games vary from young ages to older adults, spread across people with variations of physical and cognitive abilities, and with different physical and mental health conditions. When additional sub-demographics, such as elders, people with specific disabilities or chronic diseases, etc., are taken into account, the territory for accessibility in game design and accessibility related design challenges are underexplored. Although the emphasis on usability in game development somewhat follows common usability guidelines developed for human computer interaction, usability context for games and game-like experiences includes more than the interface or the interaction modality. This body of work presents a player-centric game design paradigm to allow a closer exploration for challenges of designing games for sensitive demographics, with a focus on Parkinson Disease (PD) patients. The contribution is not a clear-cut recipe but an initial model towards designing accessible games for sensitive demographics.**

***Keywords-games; game design; player-centric design; accessibility; parkinson disease; games for health.***

## I. INTRODUCTION

Games have been receiving attention from health and well-being research due to their compelling nature. Over the years, literature on games for health has grown with both use of commercial games and development of custom made games for health interventions [2]-[5]. Although positive results and various key learnings are reported by many studies, clear contributions on reappropriation of existing games for specific purposes or developing games for people with chronic and/or neurological diseases is limited. Researchers have mostly adopted or applied existing game design models [9][19] or developed on an ad-hoc basis in order to create a suitable product without much emphasis on the design practice [4][5][14][15]. Therefore, findings from these studies are fragmented and hard to reconcile for further studies. Lack of a methodology that facilitates design exploration for these demographics seems to be a result of limited design research within games research [21]. Both for the use of existing commercial games and with the purpose of developing custom games, there is a need for further design research to ensure suitability and accessibility of games for special demographics [4][5]. Even for the application of accessibility guidelines, practice for the accessible games does not go much further than the user interface or interaction [16]. A suitable interaction modality and a satisfying user experience are integral to the creation of engaging and enjoyable game experiences. Furthermore, it is essential for the player to be able to see past the interaction modalities while playing a game so that they could fully engage with the activities and events in the game. This paper aims to encourage exploration of these issues by introducing a new design paradigm that helps the researchers to focus on player and player's perception of the system (the game). Games for health research hopes to leverage the compelling nature of games for positive health outcomes; therefore, games that are designed for this purpose need to be player-centred and favouring player's conditions.

Moving forward from the existing research, this paper presents a game design paradigm to explore designing for a set of impairments identified for a special player group—Parkinson Disease (PD) patients. Even though these challenges seem to be specific for PD, the model developed to explore player-centric game design remains relevant regardless of the specificity of the target player group. The model promotes discussion to understand the relation between players' conditions and the layers of the game. For this purpose, the paper is composed of following sections. Section II presents the motivation with a discussion on the challenges of game design for PD patients. Section III explains player-centric design and presents the player-centric design model with further elaboration on the main elements of the model. Section IV ends the paper with a conclusion while also pointing to future work.

## II. MOTIVATION FOR DESIGN RESEARCH

Nielsen and Norman group defines usability as "a quality attribute that assesses how easy user interfaces are to use" [6]. A usable interface should be easy for a user to become familiar with and competent in; to achieve their objective; to discover previously less known attributes when need arises; to recover from an error; and to recall how to use the interface on subsequent visits. Accessibility is also well defined within user experience domain and has been a core element of usability evaluations. Similarly, accessibility of a game refers to the ability to enable the participation of people with disabilities to interact with the game and play without feeling any barriers during their interaction with the game or during overcoming the challenges presented by the game. Extending from usability research, playability and player-game interaction research has finally started gaining some speed to explore practical applications for game

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usability challenges [16]. The interest in the field includes all facets of player experience including but not limited to engagement, immersion, etc.

A set of guidelines was collated to inform developers on the special constraints for their design [11][14][17][18] while also pointing out the lack of further development in the game design discipline. Game design in its practice is agile and opportunistic, yet the design practice itself is under-researched. A study by Isbister and Mueller on variety of interaction modalities especially in the field of movement based games is one of the few that evaluates conditions of interaction and suggests strategies for a more successful design of movement-based systems, mainly games [17]. The guidelines provide insights for the design of interaction modalities, necessary feedback compatible with the interaction device and activity, extends of self-expression, challenges and fun. Among the few studies that attempt to develop games for PD patients, Assad et. al. previously suggested design principles for designing games for PD, particularly for motion based games for rehabilitation purposes [11]. Although informative, the principles are prescriptive for a specific type of game rather than allowing a wider applicability, and the paper does not present a clear methodology for design. Another model named as "extended model" by Gerling et. al [18] inspired the development of the paradigm presented in this paper for two reasons: the model presented in the paper is restricted with the structural constraints of existing models and it is limited in terms of acknowledging the role of the player from a player experience perspective even though there are discussion on accessibility. Nevertheless, the notes on the player's abilities (both cognitive and motor abilities, such as attention span, short-term memory, repetitive input, etc.) to be considered as resources resonates with the perspective of this paper.

### *A. On Challenges of Game Design for PD Patients*

Citing form Sutton-Smith, Zimmermann and Salen [13] refers to game experience as a combination of five dimensions: visual scanning, auditory discriminations, motor responses, concentration and perceptual patterns of learning. Players scan the entire scene based on the visual and auditory signs while concentrating on events and signals provided by the game. They perform actions based on the demands of the game and proceed whilst scanning for visual and auditory cues. This cycle continues as the player carries on playing the game. As they do so, players learn more about the patterns of play and improve their standing against the game from familiarity to higher expertise. At its core, the cycle of play stands on the perceptual understanding of the game world, the processing time of the perceptions, and the response from the player. Swink [10] explains this implicit loop for moment-to-moment play as a correction cycle that demands emphasis on game feel for a continuity of perception. An impairment that creates delay or incapability on any of these stages (impairment of the player or the game) would impact the quality of experience.

Game accessibility requests compassion from the system to bridge the gap between the player and the game in order to reduce the impact of impairment. For example, similar to how a poor visual design of an interface would reduce the usability significantly, a poor visual fidelity of a game world would also reduce the quality of game experience. However, contextual content of games requires far more depth compared to a user interface. The player perceptions of the game world not only stem from the narrative elements that are telling a story of the game world but also the familiarity of the player with the game and game world. Therefore, the player needs a high processing power in order to evaluate all the information they could gather from the game in real time while playing the game. Thus, the system needs to show compassion when player's impairment is getting in the way of their player activity. Without a model that helps breaking down areas that demand processing power and areas to hide delay, it is uneasy to contemplate on how this need could be resolved without frustration.

According to Swink, any delay that breaks the continuity of the experience creates poor game feel [10]. Therefore, the game needs to be responsive for the player inputs. Similarly, any player action in response to the events presented by the game needs to be timely; otherwise, deemed unsuccessful by the game. Hence, the game acknowledges successful behaviour and rewards it while also clearly communicating the consequences upon failure. From a purely game design point of view, this makes sense because facing consequences help bringing meaning to the choices. However, from a player-centric design point of view, especially for players with motor and/or cognitive impairments as in PD, how much time should be evaluated as the time-frame for "timely response" is unclear. The procedures of the game should be forgiving with a suitable error margin and compensating for delays as motor-cognitive processes in player's mind may take longer than an ordinary player.

Research shows that quality of life for PD patients drops over time meaning that activities of daily living, such as dressing, grooming, bathing, self-feeding and functional mobility are jeopardised as disease develops [23]. Even at earlier stages various disturbances and impairments limit the ability of the users while performing tasks that are considered simple; rendering many games inaccessible for this player base. The disturbances and impairments that are commonly observed across PD patients are sensory sensitivities, motor impairments, cognitive impairments and emotional sensitivities. Many of these impairments, especially in early stages of PD, show close similarities to age related changes that are commonly observed among older adults or other health related situations, such as stroke patients [14].

### *B. Impairments due to Parkinson Disease*

*1) Sensory Sensitivities:* Sensory difficulties include not only hearing or vision problems as mostly seen with elders [18], but also sensitivities for sensory overload due to visual and sound stimuli. Occupational therapy for PD advise reducing visual stimuli by reducing confusing patterns (striped-checker), strong colours and hues, and simplifying the load by preventing contrasting visuals and clutter [22]. Visio-spatial disturbances and strong contrasts cause

freezing while clutter overloads cognitive processes with a need of strategising and replanning. There are no specific sensitivities reported about audio; however, the use of metronome and inducing percievable rhythm into daily life are presented to be useful to enhance motor abilities [22].

*2) Motor Impairments:* Main motor impairments observed in PD are trembling fingers and hands (tremor), rigidity, slowness in movement (bradykinesia), and gait problems [22]. Subtle slowness in movement, postural change and gait problems are also seen in elders even though the scale of these differ from PD. Trembling fingers and hands, especially depending on the scale of movement can make it very hard to use an input device or perform button presses while the slowness in movement can increase the response time.

*3) Cognitive Impairments:* Cognitive impairments that are commonly seen with PD are learning and retaining information (working memory), concentration and attention, and executive functions. Executive functions are a set of inter-related cognitive processes that are essential for goal-directed behaviours [1]. Even though they are heavily related to cognitive domains, motor skills and connection between cognitive and motor skills are the main reason why they are absolutely necessary for activities of daily living [1][23]. In order to preserve gait, a person needs to evaluate their surroundings, strategically decide a path of movement, shift their weight and meanwhile check their balance. If they come across an obstacle, they should be able to stop executing their plan and rework a new plan similar to the correction cycle mentioned before. This means all six executive functions are actively used during a simple walking task: attention, inhibition, planning, reasoning, shifting (flexibility), and working memory. Gait disorders share similar issues originating from deficiencies in executive functions and also observed among older adults. This means impairments in executive functions also develop among older adults, perhaps milder than PD. In addition to a previously identified need for task creation frameworks to facilitate purposeful use of games for special demographics [4], it has become appearant that there is a need for a design paradigm that draws attention to the abilities and limitations of the players. Therefore, the player-centric design model is developed to support and inform designing games for rehabilitative and preventative therapies for PD.

## III. PLAYER-CENTRIC DESIGN PARADIGM

Game design is perceived to be player centered; however, authorial intent and its dissonance with the nature of designer's perception of the player may jeopardize this. This section discusses player-centric design while suggesting a player-centric model for designers to explore and understand the human nature of their target audience.

### *A. Player-centric Design*

It is commonly thought that player-centric design is an extension of the user-centred design. On one hand, one can argue that game design is inherently player-centric since it always questions what the player is doing, what they are allowed to do, objectives, rewards, consequences for the player, and how the player is supposed to feel during the gameplay experience. Therefore, it would be unfair to suggest that game design is not player-centric. On the other hand, game design practice is a creative endeavour as well, meaning that it could carry a separate authorial intent due to its creative nature. Therefore, the intent of the designer in making of a game may be slightly different than the intent or expectations of a player while stepping into the magic circle of the game. Besides, game design practice could also be perceived as play-centric, putting emphasis on gameplay over other elements of the game. A designer can argue for a different act between challenge and motivation, intended difficulty of the game or intended interaction for an intended experience based on the authorial creative endeavour or play focus. In response to all these arguments, player-centric design is centred with empathy to the player and aims to provide a positive experience to the player despite contradictions with creative pursuit [9]. Therefore, player-centric design puts the player before the creator.

### *B. A New Model for Player-centric Design*

The model seen in Fig. 1 attempts to merge player's perspective with formal elements of games in order to enable a deeper discussion on game design challenges for special demographics. Literature has a few well recognised frameworks for game design—Schell's, Fullerton's and Adams' [9][19][20]; however, these do not allow to closely look at underlying concepts of games or dismantle a complete game experience into its thinner slices. Such granularity would be very helpful for designing games for impaired players.

Schell's design tetrad remains quite high level while Fullerton's is too low level without any visible interplay between and above the formal elements or much consideration on player's stance [19][20]. On the other hand, Adams' model is based on interaction design, presenting an interaction model between the player and the game, yet does not encourage explorations on sensory complexity of games more than perceiving them as user interfaces [9]. Although Adams' could be a much clearer approach that allows the use of existing HCI research for games, it creates further ambiguity on the potential needs of games on a visual and contextual level. Gerling et. al's "extended model" presents a useful basis for designing for older adults [18]; however, the analysis lacks a wider perspective on the interplay between the elements of the model as a game design paradigm and a player-centric focus for the designer to explore the position of the player in this context especially for the needs/issues of special demographics.

In order to create a player-centric focus, the proposed model (Fig. 1) combines layers of player experience—as inspired from Garret on the planes of user experience [7][8]—with Adam's game design model [9]. The layers of the model and elements of these layers are also discussed further in the following subsections.

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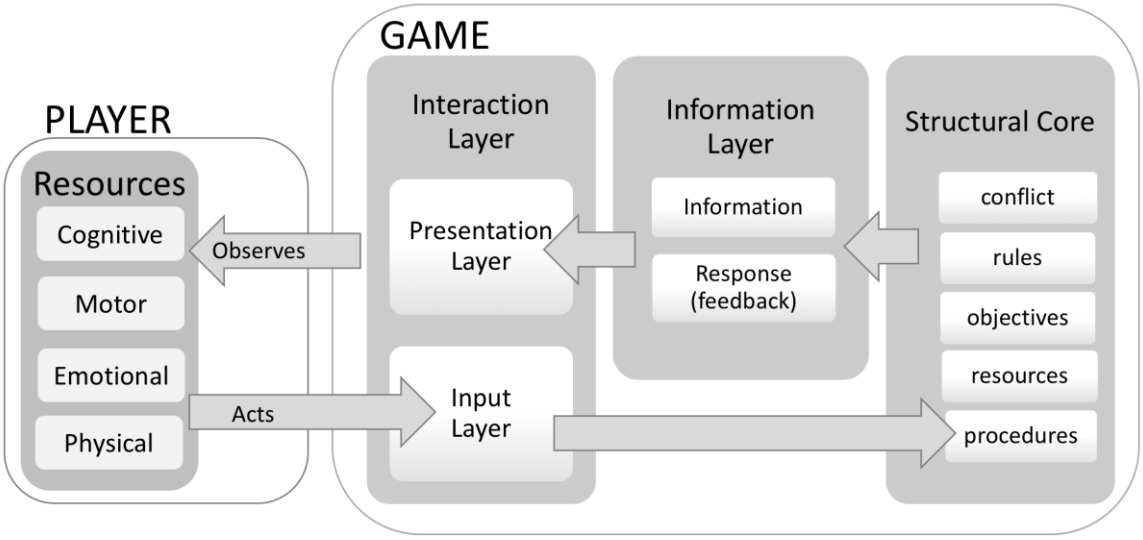


Figure 1. A player-centric game design model favouring the capabilities of the player and perceiving the system from player's point of view

*1) Interaction Layer:* Interaction layer represents the overlapping space of game world and player's world. Via this layer, player sends input to the game world, observes the results of their input and receives a response from the game world. Interaction takes place between the player and the game world. It is either started by the player via an input, or by the game world via an event presented with the presentation layer. When it is initiated by the player, the game responds; when it is initiated by the game via presentation layer, the player responds via input layer. In both cases, information layer feeds the presentation layer with necessary data. Interaction layer is composed of presentation layer and input layer.

*a) Presentation Layer*: Presentation layer can also be thought as sensory layer encompassing audio, visual and haptic presentation of the current status of the game. This includes continuous presentation of the game world and the game's response to the player inputs. Any feedback generated in response to the player inputs is presented by the presentation layer. Clarity of presentation and a suitable composition of audio-visual elements are essential for readability. Based on movement advice of PD handbook [22], a suggestion to facilitate performance of motor skills is using sensory stimuli that provides a perception of rhythm. Since the cognitive difficulties include attention and concentration, any support to conciously activate attention and maintain concentration is very useful in daily life, therefore for the presentation layer as well.

*b) Input Layer:* Input layer is responsible for the interaction device, input techniques, clarity of input mapping, directness, sensitivity and consistency of input. A common goal for a game controller is effortless use with which the input device feels like the extension of the body [10]. It is important to note that PD has some symptoms, such as tremor, bradykinesia or hypokinesia that may cause difficulty in using an input device or perform an input action within a required time-frame. Therefore, additional research into input devices and interaction modalities would be useful. Moreover, further research on familiarity of the player group, mental model, and restrictions of disease stages for input modality is expected to improve the design.

*2) Information Layer:* Information layer sits in the middle of presentation layer and structural core of the game, and interprets outputs of the core system in a readable format for the player. Cues for meaning making (semantics), affordances and limitations for the player [12], contextual visual material, data organisation, response of the game (feedback for the player), and any information, such as score, status, outcomes, etc., belongs to this layer. Even though the information is generated by the core layer of the game, its interpretation is handled in information layer and passed to the presentation layer for the player to see.

*3) Structural Core:* Structural core of a game comprises formal elements [19]. Both the information layer and the presentation layer are dependent on the core structure of the game while also creating meaning for it. From player's point of view, the core of the game may be completely invisible as their perception is shaped by the presented information (based on how it is interpreted by the information layer). Therefore, discoverability, learnability and consistency of the system need to be resolved at this layer so that relevant information could be fed to the information layer.

Procedures are the first point of interaction with the input from the player. They are integral for moment-to-moment gameplay and define the chain of moves to perform actions in the game. Reiterating the previous discussion on correction cycle (see Section II, *A* and *B.3)*, a delay in any

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stage of player performance will make the time-frame of user input longer. For example, double jump could require hitting the jump button twice within a second in order to perform double jump. This seemingly simple action could pose a problem for a person with rigidity or sloweness of movement, who might find hitting the same button twice hard to repeat within a second's window. Another example is the number of steps necessary to do something, such as the steps to be performed to bake a cake. For a person with memory issues, remembering those would be really hard, therefore frustrating to perform. Thus, procedures should be catered for a longer grace time, simple recovery (this does not mean game needs to be easy), shorter and less complex chain of actions for learnability and retaining information. On top of these, additional compassion for impairments would make a big difference. When done right, the core game demands less player resources or compensates for those when necessary. The player resources are explained below in item 4.

Contextual content works with the formal elements and supports meaning making. Objectives, rules, procedures, affordances and limitations become meaningful with the help of contextual content. While being important for engaging the audience, contextual content is also important for maintaining attention and motivation. In order to develop content based on the interests of the target audience (elders, kids, young adults, etc.), a participatory approach or persona studies would be preferable.

*4) Resources:* Rather than the resources discussed for formal elements of the game, the resources referred in this model is intrinsic player resources. Intrinsic player resources are cognitive skills, motor skills, physical abilities and emotional abilities (physical and emotional stamina). These are within the power of the player and do not belong to the in-game economy. They are not generated by the game or in the game; however, they are brought in and used by the player, yet consumed by the game. They are limited, and refresh time for these vary from person to person. For example, after long hours of play, the physical stamina of a player may drop, and they may not be able to function as prompt as they were at the beginning of the play. This is an example of player spending their physical ability resource. For a suitable design tragetting players with health related difficulties and in order to prevent frustration, designers need to study how these resources are effected by the disease.

### C. Strengths and Limitations of the Model

The player-centric design paradigm, as seen in Fig. 1, is developed as a bi-product of design research for game based rehabilitation of PD. Previous sub-sections presented further details on the layers of the model with a focus on constraints for PD. The purpose of the model is to promote further discussion on the elements of game design with a player-centric focus; therefore, the main strength of the work originates from the incorporation of user experience model to ensure this. It is by no means a complete model, yet welcomes exploration in those layers, and encourages analytical thinking towards player-centric design. The main limitation of the paradigm is its theoretical nature even though it has emerged from the design process of a game for players with PD.

The model stands as player-centric, yet the principles of user-centered design and their alignment with the model has not been completely examined. A useful improvement would be development of a set of questions for each layer to prompt the designer while using this paradigm in their design practice. In addition, the discussion on information layer is less explored compared to the other layers and could benefit from further contemplations on the relation between contextual elements and information layer, especially for the potential impacts of these on players' resources. Finally, an additional angle with playability concept and a discussion on how playability relates to this model would be informative.

## IV. CONCLUSION AND FUTURE WORK

In this paper, a newly developed player-centric design paradigm is presented to improve game design practice for special demographics. The model has extended existing game design models with inspiration from user experience field in order to present a player focused practice for game design. The layers of the model are discussed by employing a PD focused impairment analysis. Future work includes verification of the presented paradigm with the analysis of existing games and the development of new ones.

## REFERENCES

[1] A. Diamond, "Executive functions," *Annual review of psychology*, vol. 64, pp. 135-168, 2013.

[2] D. Levac, S. Glegg, H. Colquhoun, P. Miller, F. Noubary, "Virtual reality and active videogame-based practice, learning needs, and preferences: A cross-Canada survey of physical therapists and occupational therapists," *Games for health journal* 6, no. 4, pp. 217-228, 2017.

[3] A. E. Staiano, and R. Flynn, "Therapeutic uses of active videogames: a systematic review," *Games for health journal*, vol. 3.6, pp. 351-365, 2014.

[4] A. T. Bayrak, B. Wünsche, C. Lutteroth, "Reviewing the Evidence: n Pursuit of a Framework for Parkinson Disease Rehabilitation with Games," *The Promise of New Technologies in an Age of New Health Challenges*, p. 9, 2016.

[5] B. Bonnechère, *Serious Games in Physical Rehabilitation*, Springer, 2018.

[6] J. Nielsen, "Nielsen norman group," [Online]. Available from *https://www. nngroup. com*, 2016.

[7] C. Macklin, and J. Sharp. *Games, Design and Play: A detailed approach to iterative game design*, Addison-Wesley Professional, 2016.

[8] J. J. Garrett, Elements of user experience, the: user-centered design for the web and beyond, Pearson Education, 2010.

[9] E. Adams, *Fundamentals of game design*. Pearson Education, 2014.

[10] S. Swink, Game feel: a game designer's guide to virtual sensation. CRC Press, 2008.

[11] O. Assad et al., "Motion-based games for Parkinson's disease patients," In *International Conference on Entertainment Computing*, pp. 47-58, Springer, Berlin, Heidelberg, 2011.

 ISBN: 978-1-61208-670-5 

[12] D. A. Norman, Emotional design: Why we love (or hate) everyday things, Basic Civitas Books, 2004.

[13] K. Salen Tekinbaş, and Eric Zimmerman, *Rules of play: Game design fundamentals*, MIT press, 2004.

[14] M. Balaam et al., "Motivating mobility: designing for lived motivation in stroke rehabilitation," In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, ACM, pp. 3073-3082, 2011.

[15] A. C. de Barros, J. Cevada, À. Bayés, S. Alcaine, B. Mestre, "User-centred design of a mobile self-management solution for Parkinson's disease," In *Proceedings of the 12th international conference on mobile and ubiquitous multimedia*, ACM, p. 23, 2013.

[16] L. Caroux, K. Isbister, L. Le Bigot, N. Vibert, "Player–video game interaction: A systematic review of current concepts," *Computers in Human Behavior* 48, pp. 366-381, 2015.

[17] K. Isbister, and F. "Floyd Mueller. "Guidelines for the design of movement-based games and their relevance to HCI," *Human–Computer Interaction* 30.3-4, pp. 366-399, 2015.

[18] K. M. Gerling, F. P. Schulte, J. Smeddinck, M. Masuch, "Game design for older adults: effects of age-related changes on structural elements of digital games," In *International Conference on Entertainment Computing*, Springer, Berlin, Heidelberg, pp. 235-242, 2012.

[19] T. Fullerton, Game design workshop: a playcentric approach to creating innovative games, CRC press, 2008.

[20] J. Schell, *The Art of Game Design: A book of lenses*. AK Peters/CRC Press, 2014.

[21] A. Kultima, "Game design research," Proceedings of the 19th International Academic Mindtrek Conference, ACM, 2015.

[22] A. Aragon, B. Ramaswamy, J. C. Ferguson, *The professional's guide to Parkinson's disease*, Parkinson's Disease Society, 2007.

[23] G-M. Hariz, L. Forsgren, "Activities of daily living and quality of life in persons with newly diagnosed Parkinson's disease according to subtype of disease, and in comparison to healthy controls," *Acta Neurologica Scandinavica* 123.1, pp. 20-27, 2011.

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