Designing the Vertigo Experience: Vertigo as a Design Resource for Digital Bodily Play

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ABSTRACT

Vertigo can be described as an attempt to momentarily destroy the stability of perception and inflict a kind of voluptuous panic upon an otherwise lucid mind. Vertigo has, however, not been generally considered as a design resource and we believe it to be under-explored in the area of digital bodily play. To investigate how vertigo could be considered as a design resource in this context, we conducted a review of relevant literature and held a design workshop with nine students to explore the potential of vertigo as a design resource for digital bodily play. From our exploration we identify five key design themes that designers might consider when designing a Vertigo Experience. Through this work we hope to encourage designers of bodily play experiences to consider vertigo as a design resource in their games.

Author Keywords

Vertigo; play; game design; body

ACM Classification Keywords

H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

INTRODUCTION

Caillois [5] suggests that all games fall into four categories, competition, chance, mimicry and finally, vertigo. Caillois describes games of vertigo as "an attempt to momentarily destroy the stability of perception and inflict a kind of voluptuous panic on an otherwise lucid mind" [5, p.23]. Scholars such as Kenyon have built upon this definition by suggesting that "physical experiences providing, at some risk to the participant, an element of thrill through...speed, acceleration, sudden change of direction, or exposure to dangerous situations" [19] are inherently attractive to humans, since "man has always been attracted to activities in which he is unable to maintain complete control of his body or his immediate environment" [19]. This fascination with the pursuit of vertigo

can be argued to be the reason behind many people's love of extreme sports such as rock climbing, skiing and skydiving [1, 19].

Theme parks and fairs have catered to this pursuit through the use of ride machinery. These machines allow a person to lose control of their environment and experience a sense of thrill. However, these devices are catered towards creating an experience in a mechanical way, and not in a digital way, resulting in them often being expensive and not generally interactive.

For the purpose of this paper, we define the Vertigo Experience as a bodily experience that momentarily destroys the stability of perception and affects the whole body, while extending it here to investigate what role digital technology can play in achieving this. Furthermore, we consider bodily play as leaning on established fields such as Exertion Games [25] (bodily) and play. Recent explorations using new virtual reality technology like the Oculus Rift, has led to the experimentation of game design involving vertigo elements. Both industry designers and researchers have begun to design play experiences with a vertigo theme, such as allowing a player to walk a virtual plank suspended high between two buildings [15], or allowing a player to experience the feeling of flying, by being held aloft on a sheet suspended by four other players [6].

We believe this suggests that digital technology is capable of supporting these experiences on a smaller scale than theme park rides and simulators and highlight that despite these explorations, a structured approach of how to design for a Vertigo Experience is lacking. Therefore, in this paper, we approach the topic of using vertigo as a design resource for digital bodily play and highlight key design themes in an attempt to start a discussion of how to use vertigo as a design resource. We begin by exploring work related to Vertigo Experiences in game design and HCI. We then describe a design workshop we held in order to explore how to design Vertigo Experiences by engaging in low-fidelity prototyping. Finally we discuss the results of this exploration through the articulation of five design themes for designing a Vertigo Experience. With this work we aim to encourage designers of bodily experiences to also consider vertigo as a design resource in their own work.

RELATED WORK

Vertigo Experiences and The Body

Shusterman [32] describes the body as the indispensable medium for all perception, and this is certainly the case for Vertigo Experiences, which affect the whole body and the bodies perception. In HCI the use of the body in combination with digital technologies has been explored through whole body interaction [9, 12]. Further, the advancement in digital technology has led to the creation of more powerful sensing technologies that can be utilised to encourage bodily play. Using the body as a primary source of input in digital games has been explored through Exertion Games, digital games that require a form of physical effort as a virtual game input, have gained popularity within the HCI field [27].

Expanding on this field, Mueller and Isbister [23] offer the Movement-Based Game Guidelines. These guidelines provide many example cases for creating movement based games, and one example in particular could be said to relate to vertigo games [24] since, in this game, the player is required to hang by ones arms from a steel bar to avoid falling into a virtual river projected beneath them. However, in this example the role of vertigo has not actually been explored, instead the authors encourage designing for fatigue. This supports our belief that the topic of using vertigo as a design resource has not yet been fully considered by designers.

Digital Vertigo Experiences

Game designer Bateman reflects on Caillois' definition of vertigo, stating how "very little has been written about the [vertigo] of videogames, despite the fact it is an increasingly potent force in popular games" [2]. Bateman argues that technological limitations are the reason that it is only recently that games including vertigo principles are gaining popularity.

Game designers such as Salen and Zimmerman [30] also suggest there is a lack of designing solely for vertigo experiences, suggesting that vertigo can only support other game elements in the form of creating motion sickness and player disorientation, giving games like *Unreal Tournament* as an example. This opinion is supported by Rutter and Bryce who consider vertigo as a dominant play category in some digital games, providing *Sonic the Hedgehog* as an example, again emphasising the disorientation to the player when Sonic moves quickly [29, pp.79-80]. These works suggest vertigo has been a resource in some digital games, but highlight that vertigo has not been considered as a bodily play experience, further suggesting that there appears to be a lack of consideration regarding how the Vertigo Experience depicted on the screen can be extended to the player in the real world.

However, some work has explored what happens when you combine the screen and body. *Ascent* [8], for example, is a mountain climbing game designed for the first person perspective via the use of an Oculus Rift. The game creates a series of missions for the player to complete by placing them in an accurate recreation of popular mountain trails. Players look around the game world by moving their head and climb with by pressing a button on a game controller. Of interest is that this work describes a game that has considered one of Caillois' original examples of vertigo - mountain climbing - and suggests how digital technology could be used to realise the experience. However, body interaction is limited, highlighting that there is still a gap in game design knowledge when considering how the body can be fully engaged in digital Vertigo Experiences.

Vertigo and the Digital Body

Caillois describes how "powerful machines", such as fairground rides can be used to create Vertigo Experiences [5, p.25]. Schnadelbach et. al. [31] investigated extending the individual experience of riding an amusement park ride to a group of spectators. A wearable system recorded and transmitted heart-rate, audio, acceleration and video data of the wearer to a specially constructed spectator interface and a study of the system suggested a greatly improved spectator experience. Marshall et. al. [21] investigated allowing the player to control a ride via their breathing. The system described rotated a bucking bronco ride anti-clockwise when the rider was breathing out and clockwise when breathing in, gradually getting more difficult resulting in the rider struggling to hold on as they became more disorientated. This exploration found that allowing the user to feel a gradual loss of control during the experience could proportionally improve the overall experience. Hämäläinen et. al. [13] discuss the work of Marshall et. al. [21] and present gravity as a design resource in movement-based games. Although this work does make reference to vertigo, it primarily considers gravity and in the case of [21] considers it a gravity game and not a Vertigo Experience.

The work of Kajastila et.al. [18] describes a vertical platforming game played by physically jumping in the real world on a trampoline. The jumping motion of the player in the physical world translates to the virtual world and was mapped accurately enough for the player to guide their avatar from platform to platform. Overtime, participants' performance increased indicating that such a game could improve real world skills through bodily play. However, this game is primarily seen as a training tool and the paper does not discuss vertigo directly, but we believe it a good example of the type of technology that designers of Vertigo Experiences could employ.

Summary of Related Work

This review of related work has highlighted that although elements of Vertigo Experiences are present in several digital games and play, a structured understanding of how to use vertigo as a design resource for digital bodily play is still missing. Additionally, despite the advancement in digital technology such as the Oculus Rift, how to design Vertigo experiences from a bodily play perspective has not been considered. To this end, we held a design workshop with post-bachelor degree students in order to explore the potential of using vertigo as a design resource in digital bodily play.

VERTIGO DESIGN WORKSHOP

In order to probe the space of using vertigo as a design resource in digital bodily play, we held a three hour design workshop with nine participants (eight students and one lecturer) and presented them the challenge of designing games

and play around vertigo. The structure of the workshop followed an iterative and reflective process of ideation, prototyping and discussion. We encouraged the use of low-fidelity prototyping in order to encourage the development of ideas within the time frame. In teams of two (one team of three), the participants were asked to develop a Vertigo Experience in the three hour period. Participants were also given the choice to use a custom built "Galvanic Vestibular Stimulator" (GVS) device in order to inspire and further ideate any design ideas through the use of a functional technology that can facilitate vertigo through causing an individual to lose control of their balance (which we explain further below).

We also provided the teams with Caillois' vertigo definition at the start of the workshop, and later provided several possible vertigo themes we probed from our previous review of literature. We provided these themes in the form of dimensions (main word), and the extremes of these dimensions (brackets): Mechanic (Gameful/Playful), World (Real/Virtual) and Effect (Accidental/Intentional). These themes were offered as a guide and the participants were told that they were free to either use or ignore them as they wished. The themes were introduced after the participants had already spent thirty minutes ideating their designs. Finally, through feedback sessions, the groups design ideas and paper prototypes were presented to allow for group discussion and feedback. The entire process was both video and audio recorded to allow for later data analysis.

Galvanic Vestibular Stimulation as a Vertigo Interface

(a) GVS Circuit.

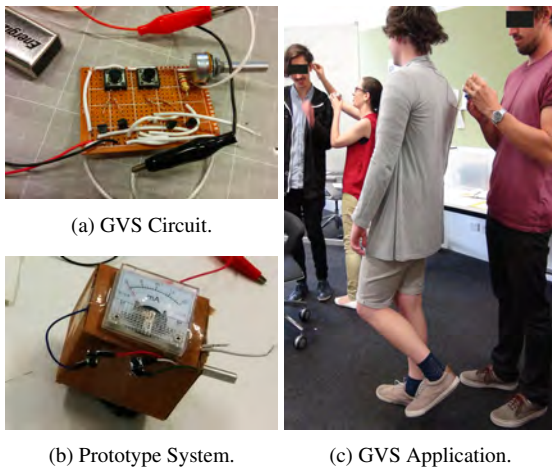(b) Prototype System.   (c) GVS Application.

Figure 1: The system circuit (a), how it looked to participants (b), and GVS application (c) where person on right is controlling person on left who has the GVS attached behind the ears.

One way of inducing a sense of vertigo in players according to Caillois is through the use of "powerful machines", such as fair ground rides or simulators. However, he also suggested that "these machines would obviously surpass their goals if it were only a question of assaulting the organs of the inner ear, upon which the sense of equilibrium is dependent" [5, p.26]. Of interest is that today, technology has allowed for such an effect to be experienced.

Galvanic vestibular stimulation is a simple and safe system that is capable of affecting the vestibular organs of the inner ear [10]. A GVS system affects a person's vestibular system through the electrical stimulation of two electrodes, an anode and a cathode, which are placed either side of a person's head on the mastoid bones behind the ear. A small current of around 1 mA - 2.5 mA is then passed through the electrodes. The resulting effect is that an individual feels a *pull* towards the anode and thus the system affects ones sense of balance.

GVS has been explored in the area of psychology [33], physiology [11] and recently interactive user experiences. For example, Maeda et. al. [20] describe a GVS system which allows one person to control another via a remote control, affecting the wearers balance. Nagaya et. al. [26] investigated a novel experience where a person's perception and balance is altered via GVS based on the choice of music being played. GVS has also shown potential as a training tool [22], allowing astronauts in training to become familiar with symptoms they might encounter during a real expedition.

Although we are aware of other potential technologies that could support a Vertigo Experience (such as Electronic Muscle Stimulation(EMS) [28]) we chose to use GVS at this stage since 1) it does not require much set up, which was important for the workshop time frame, and 2) it affects balance in precisely the way Caillois suggested was necessary to experience vertigo without "powerful machines".

GVS System
The GVS systems (see figure 1b) we used were custom built and three identical circuits were created in total for use in the workshop (see figure 1a). Each system consisted of an H-bridge built from four NPN transistors, two push buttons to activate the H-bridge, a current meter and a 5K potentiometer to allow for system calibration and guard resistors to ensure the current would not go over 2.5 mA. The system was powered by a single 9V battery and self adhesive electrodes (attached via cables) allowing for easy placement on participants' mastoid bones.

Before attaching the electrodes the area was cleaned with EEG preparation gel to remove skin oils and reduce impedance to ensure good skin conductivity. Once the electrodes were attached the system could be calibrated by ensuring first that the potentiometer was at its highest resistance before pressing the button. The current was increased by slowly turning the potentiometer until the user felt an effect. This calibration stage was necessary since skin resistance can differ between people.

It is important to note that the goal of the workshop was not to evaluate the GVS system, but to encourage discussion of designing Vertigo Experiences by allowing the groups to experience a tangible vertigo effect. As both Shusterman [32] and Fogtmann et. al. [12] explain, when designing interaction catered for the body, it is important to know how the body moves and feels when experiencing that interaction. Therefore, we felt it necessary that rather than allow groups to ideate solely without using any technology, we wanted to allow them to experience a vertigo feeling for themselves. Ad-

ditionally the use of a technology as a facilitator for ideation has been suggested to allow researchers to plan and create new technologies through co-designing with users [14].

Workshop Games

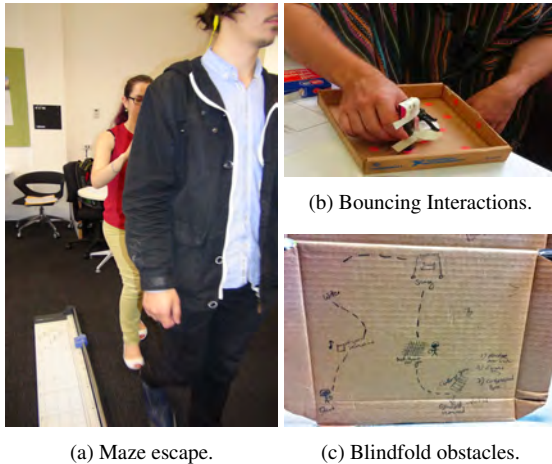(a) Maze escape.   (b) Bouncing Interactions.   (c) Blindfold obstacles.

Figure 2: Several prototype games being described by participants.

The workshop concluded with a discussion about the design process and the participants' thoughts about using vertigo as a design resource for bodily play. Here we articulate the game ideas in order to provide a greater context to the design themes we introduce later.

Of all four groups who took part in the workshop, at least one person from each group chose to wear the GVS system in order to experience the effect. Figure 1c shows participants testing the GVS system. Each participant who had the electrodes attached felt an effect, with all of them losing their balance at various stages of playing with the system, suggesting that the GVS technology was able to induce a sense of vertigo in the participants. There were five different types of games discussed in total as one group considered two different ideas. As part of the presentation the groups also discussed how they imagined their prototype games would integrate with digital technology, and this is what we describe in the next sections.

Group One - Bouncing Interactions
The first group considered jumping and bouncing as their main gameplay mechanics, describing that they wanted players to wear "boncy" shoes in order to move around their proposed game area. Players, they explained, would be required to jump on a series of lights that would randomly illuminate on the floor (illustrated with stickers in figure 2b) in order to score points. The group explained that they wanted to use the shoes to make it difficult to remain in control *"while you're springing around trying to hit these goals, you're kind of going all over the place, so it makes it really hard and haphazard and crazy"* - P1.

This group also stated that they found bouncing was a really *fun* aspect, demonstrating this in the workshop by using the bouncy nature of the office chairs to move around the room. They explained that by trying out different ways of bouncing

and from trying the GVS system, they could imagine different types of games based on the premise of bouncing, *"Yea it's a good framework here you can sort of add anything into it and it just sort of makes it more fun."* - P2. They also emphasised how the body played a key part in their game design, *"Yea [we were] just trying to maximise enjoyment and the bodily kind of action."* - P1.

Group Two - Blindfolded Obstacles
The second group presented their concept as a cooperative experience where one blindfolded player wearing headphones would be guided through a world filled with both real and virtual obstacles, by another team of players providing audio directions to the individual player. Presented as a cardboard drawing (figure 2c) and acted out by the participants, they explained that the challenges they thought could be faced by the blindfolded player would include divulging a secret before being allowed to proceed further (creating a sense of panic), navigating dangerous terrain such as a bridge that would lose planks and using a swing whilst remaining blindfolded (challenging perception). The participants suggested how they saw their game as more of an unstructured and spontaneous activity, *"there needs to be a lot of spontaneity and not too much structure of rules, because the spontaneity of a game like this and the activities create the thrills and the tension"* - P9. The participants also explained how they considered anticipation to be a core mechanic of their game also, *"just, um the sense of apprehension,and expectation and anticipation that felt like, that was part of the fun"* - P3.

Group Three - Escape the Room and Fear
The third group described two different game ideas, one an escape the room game and the second a Vertigo Experience based on fear. The participants explained that they were influenced by feeling the GVS effect and spent time considering how that feeling could be capitalised on in games for vertigo. They described an escape the room scenario where GVS could attempt to *"replicate a supernatural sense of where things are"* - P5, where players would be subtly *drawn* towards specific objects that they would need in order to solve the puzzle in the room.

The second idea the group presented was a cooperative game where one player would secretly take the role of a horror figure in a fear experience, whilst other players were trying to get away from this player. However, again using GVS or similar, the players would lose their sense of balance as the horror figure approached, making escape more difficult, *"so that experience of fearing that thing, almost as if it affected [you]...it felt like it affected you on a supernatural level and its coming from different wavelengths [it] could be a fun emotion to play along with"* - P6.

Group Four - Cooperative Maze Escape
The final group described their game idea as a two-player game where one player would guide and control another player as they traverse a maze (shown in figure 2a). In the suggested game, one player would have a virtual birds eye view of the maze and is responsible for navigating both themselves and the other player through the space. Both players, the group explained, would experience the navigation effects

via GVS system, which would actually be controlled by the navigator (the person behind in 2a).

Initially the group experimented with the GVS whilst the player in the maze was blindfolded, but found that destabilising effect of GVS was heightened by adding a visual component, allowing for the player to see how they were falling, *"We realised while actually testing it out [GVS] we both presumed that by closing your eyes would make it easier to feel the impact of what direction to turn, but we soon realised that apparently, [P8] couldn't tell which direction [P8 was] falling in - so I was saying "Go left! Go left!" and [P8 wasn't] going left, so ... we decided to bring the visual aspect back into it and just have you see which direction you were falling"* - P7. The group also favoured mixing real life and the virtual world by saying they imagined the visual aspect would appear via a virtual reality display, indicating that a combination of a VR game and a GVS system could create an intriguing and rich Vertigo Experience, *"also the use of the natural vertigo that the [VR] creates and the like, I don't know if you guys have seen the roller coaster [VR] and people fall over? But the use of [GVS] to exploit that further or to control it, would be interesting"* - P8.

Summary
The discussion of game ideas allowed us to explore our research topic and in order to extract further insight from the workshop we employed a qualitative approach, using grounded theory with open coding, to analyse the workshop data. We first transcribed audio and video recordings of the workshop and discussion before using Nvivo to code the transcriptions. Once coding was completed, we finally extracted five recurring themes, described in the next section.

KEY DESIGN THEMES
Here we discuss the key themes that we derived from our analysis.

Control in the Vertigo Experience
Control in the Vertigo Experience refers to several aspects of the experience: Who is in control, player or computer? Is it self control or giving control to someone else? Is the player losing or attempting to maintain control? Each group (G1-G4 hereafter) considered the level of control in their games. G1 introduced an aspect that would reduce player's ability to remain in control of their movement through bouncing. G2 and G4 suggested that giving another person or group of people control of the player's body or actions would create an intriguing Vertigo Experience. G3 on the other hand indicated that enhancing control by offering players a sensing ability could create a novel experience by offering a sort of supernatural aspect to games of vertigo.

Losing Control
The loss of control seemed to be an intriguing theme for our participants with G2, G3 and G4 describing games that would result in some loss of control (losing control when a horror figure approaches for example) and a playful experience. This attraction is supported by existing work such as that of Marshall et. al. [21], who in their breathing controlled bucking bronco system, found that a gradual loss of control can

be used to create an engaging experience. Interestingly flow theory [17] suggests that for an optimal experience to exist, players need to maintain a sense of control. Yet our findings appear to support those of Marshall et. al. suggesting that for a playful Vertigo Experience players require a loss of control.

G2 and G4 did describe ideas that suggested giving self-control to another person could be an interesting aspect to consider in Vertigo Experiences. G2's game reminded us of popular 1980 and 1990s British gameshow Knightmare [7], where one blindfolded player is tasked to navigate a virtual dungeon whilst being told what to do by a dungeon master and group of players, illustrating the mass appeal and entertainment value of this type of experience.

Finally, work by Maeda et.al. [20] describe the ability to control another person through using remote controlled GVS to control the direction of another person. Recently Pfeiffer et. al. [28] also explored controlling another person remotely through the use of EMS. Although these systems have investigated the novelty of controlling another person, we wish to highlight the opportunity that exists for game designers to consider these technologies to create complex and engaging Vertigo Experiences, by considering vertigo and not just control in their designs.

Maintaining/Regaining Control
G1 suggested that the "fun" in their game would come from the players trying to maintain control and perhaps gain mastery over their environment, whilst bouncing around their imagined arena. The novelty of unfamiliar terrain can be seen from children's play areas where bouncy/jumping castles are a prominent feature, to large trampoline parks where the entire traversable surface is made up of trampolines. Kajastila et.al. [18] considered trampolines in their own work, where a player traverses a platform game on screen by jumping in the real world on a trampoline, they found that an engaging experience was created by players trying to maintain control of their actions during the gameplay. We believe that maintaining and regaining control leads to more game like experiences where the regaining and maintaining of control creates the main gameplay challenge. For example, we can imagine a climbing gym containing a moveable climbing wall that changes its inverted angle as a climber climbs. It is this type of experience (gameful) that we think is supported by theory such as Flow theory [17] and this suggests that designers of Vertigo Experiences should consider maintaining and regaining control as a core theme if creating a gameful experience, and explore loss of control for playful experiences.

Structure of the Vertigo Experience
The structure of the Vertigo Experience refers to whether the experience is more gameful or playful in nature and this was considered by the groups with G1 and G4 describing a gameful experience where there is a definite goal, (score the most points and escape the maze respectively), but G2 and G3 considered a mixture of both playful and gameful elements. G2 for example expressed how the spontaneous aspect of their game was important in ensuring Caillois' concept of "voluptuous panic" [5, p.23], but they also employed rules in their game whereby the player would lose the game if they failed a

task. Such unstructured and structured constructs can create different types of Vertigo Experience.

Trajectories [4] have discussed how transitions can create an engaging user experience. Although work on trajectories has not yet directly considered a Vertigo Experience, we see this work as complimenting ours by highlighting the importance narrative structure can play especially if, as G2 did for example, designers wish to combine both playful and gameful aspects in their Vertigo Experience. For example, Alderman [1] reflecting on Kenyon's work [19] has noted that although people pursue vertigo "they do not necessarily achieve it" [1, p.69]. Although structure is important in all games we suggest that for Vertigo Experiences, considering the structure of the Vertigo Experience allows designers the opportunity to address this issue and assist people to *succeed* in their pursuit of vertigo.

Embodiment of the Vertigo Experience
This theme considers how technology can affect the player in the Vertigo Experience. Technology can be used to either create a virtual environment through VR displays, or a real everyday setting that affects the player's body by causing them to overcome tangible obstacles. For example G1's game would take place in the real everyday world, whereas G4 speculated that their game would combine both virtual and real worlds by requiring the players to physically navigate through the real world, whilst visually navigating a virtual space. An example of this combination can also be seen in Inition [15]. In this experience the player walks across a plank in physical space whilst real fans generate wind that the player feels as they traverse the plank, but the visual aspect of a large drop is only possible via the Oculus Rift that the player is wearing.

Directly Affect the Body
G3's horror game idea illustrates how digital technology can directly affect the body to create a Vertigo Experience that also takes place in the real world. When players would try to escape from the "killer" GVS could be used to literally force players to lose control of their balance, stumbling as they try to get away. A tangible experience is also important in this scenario since the body would become affected physically, and be integral to the experience. Work on tangible interactions, such as Ishii and Ullmer [16] have shown the potential for tangible technologies to become adaptive to the environment. We consider such technology as able to enhance a Vertigo Experience by allowing the environment to also become adaptive to the player, as in G3's case where they describe needing to escape a room, perhaps the wrong combination of items would adversely affect the environment causing the room itself to transform, and disrupt the players perception.

Indirectly Affect the Body
G2 said that they considered both the real and virtual world as playing a part in their proposed game, by explaining they would design it so certain rooms would require different types of embodiment. Similarly G1's game causes players to indirectly lose control of their body in the real world where their walking actions would become exaggerated and result in greater difficulty traversing the game arena. Players can also

be indirectly affected through visual stimuli, such as when watching a roller coaster ride playback on a large cinema screen, in such instances some people end up moving with the film. G4 suggested that with their eyes shut the affect of the GVS was not as pronounced as it was with their eyes open, however they also said how combining a direct effect (GVS) with an indirect affect (like watching the same roller coaster film through an Oculus Rift) could exaggerate the experience. Designers of Vertigo Experiences can lean on these findings by considering how the design of the environment can be used and incorporated into the design of the Vertigo Experience.

Effect of the Vertigo Experience
A key consideration of the participants was whether or not the sense of vertigo induced by the games should be intentional or accidental in nature. For example, intentionally causing a player to lose their balance (G2, G4) or to build slowly over time (G3's supernatural feeling). Designers should consider carefully the type of effect their experience requires.

Intentional
Intentional vertigo can be used to greatly alter the type of experience, for example, popular games like spinning races occur when a player spins in place for a set number of revolutions before trying to run to a marker on the opposite end of the room. Digital technology has the opportunity to create this intentional effect through technologies like GVS and by controlling what a player perhaps sees in a virtual setting. We can also envision, learning from findings by Maeda et. al. [20] and Pfeiffer et. al. [28] a novelty in allowing a second person or spectators to control the level of intentional vertigo, by for example, controlling someone in a maze as suggested by G2 and G4.

Accidental
G1 considered an accidental effect by reducing the control players had when bouncing around their game world. Much like spinning around in circles it would be possible to maintain a level of control over your actions until eventually your senses become overwhelmed. Experiences, such as the bucking bronco ride described by Marshall et. al. [21] achieve this by gradually increasing the speed in which a player is turned and by altering the action of the system causing the player to become disorientated and increasing the difficulty.

Immediacy of the Vertigo Effect
Finally, the last theme we highlight here is the immediacy of the vertigo effect. G2 stressed that they enjoyed the sense of suspense and anticipation that was the result of waiting to experience a vertigo affect when observing their colleagues playing with the GVS system. They explained that this feeling of anticipation encouraged part of their design. When designers trigger the effect should be carefully considered as it can, again, alter the experience greatly. We can learn from temporal trajectories [3] to consider when to interrupt the human sensor-control loop, expanding this theory with Vertigo Experiences, but ensuring that by leaning on this theory the user experience is not adversely affected. For example, interrupting a climber during a complex move could cause not

just injury, but frustration. Altering the time between an effect being triggered and being experienced can offer designers of Vertigo Experiences a wide array of opportunities to create novel and interactive user experiences.

Delayed Effect
Anticipation of vertigo effects is key to the design of theme park rides, from the design of queuing areas to show the most dramatic elements of the ride and heighten riders' fear, to the way that rides artificially go slowly upwards and then pause on the edge of the drop before releasing and racing to the ground. Additionally G3 highlighted that fear is strongly linked to feelings of vertigo, and this suggests that delaying the effect could lead to novel experiences, where the anticipation could be key to creating a sense of fear. For example in a horror game setting, the use of small amounts of induced vertigo to maintain an anticipation that the "killer" is going to appear may create a heightened feeling of dread, similar to the way dramatic music can be used prior to an event in horror films.

Immediate Effect
An immediate effect would also at times be required, such as when directly controlling a player in real time. Additionally, if the setting of the Vertigo Experience is in the virtual world an immediate real world stimuli may be required when something happens on screen in order to insure that the player remains immersed in the experience. It is perhaps therefore beneficial to induce an immediate effect in experiences where a high degree of player control is necessary.

CONCLUSION
In this paper we have identified vertigo as an under-explored design resource for digital bodily play. To highlight how vertigo could be used as a design resource for this context we explored relevant literature and held a design workshop with post-bachelor degree students interested in game design. Through the analyses of data gathered during this exploration we exposed five key themes that we believe are important to consider when designing Vertigo Experiences. Through this exploration we have contributed to design knowledge related to using vertigo as a design resource in digital bodily play experiences, enriching game culture through expanding the design space, by highlighting vertigo as a design resource for game designers.

In future iterations of this work, we aim to expand the design themes and contribute further insight to the design space of designing the Vertigo Experience. Additionally we would like to explore additional technologies that could lend themselves to creating engaging vertigo games and experiences, in addition to GVS, such as, for example, EMS.

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