

Affording Enjoyment in VR Games: Possibilities, Pitfalls, and Perfection

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In this paper, we present research that aims to understand affordances and inhibitors of enjoyment in virtual reality (VR) video games. We apply the GameFlow model to analyse VR and non-VR versions of the same games to identify differences in enjoyment in VR games. Our approach involves conducting qualitative analysis on video game reviews, using GameFlow as a theoretical foundation. We report on our analysis of the games Superhot and Skyrim. We find that affordances are largely consistent between VR and non-VR versions of the same games, with a few key differences related to Feedback, Control, Player Skills, and Immersion. We conclude that GameFlow is applicable to VR games, with the addition of a Comfort element to describe player comfort while playing.

CCS Concepts: • **Human-centered computing** → **Heuristic evaluations**; **Virtual reality**; • **Software and its engineering** → **Interactive games**.

Additional Key Words and Phrases: virtual reality, videogames, enjoyment, player experience, GameFlow

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1 INTRODUCTION

GameFlow [64] is a model of player enjoyment in video games, which includes 38 criteria within eight elements. GameFlow was derived from games user experience heuristics and mapped to the elements of Csikszentmihalyi's [12] concept of flow. The GameFlow model has seen extensive application in the design and evaluation of games and game-like experiences, including extended reality (XR - e.g., virtual, augmented, and mixed reality). However, previous applications of the GameFlow model to XR have focused on evaluating a particular game or experience, rather than seeking to understand enjoyment in these experiences more broadly.

In the study reported in this paper, we aim to apply the GameFlow model to understand how enjoyment can be supported and enhanced in VR games. We also seek to identify inhibitors of enjoyment in VR games. Our ongoing research also aims to test the GameFlow model's applicability to different games and platforms [56–63]. Our approach for the research reported in this paper involves carrying out qualitative analysis of professional game reviews of a selection of VR games, as well as their non-VR counterparts, using the GameFlow model as a theoretical framework. In this paper, we explore previous applications of GameFlow to XR games and experiences, define our methodology and approach, and report on the results of our qualitative analysis of professional game reviews. We conclude that affordances of enjoyment are similar across VR and non-VR games, with the exception of opportunities and issues related to physical involvement. We also propose the addition of a Comfort element to the GameFlow model when considering VR games.

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Table 1. GameFlow elements for an enjoyable game experience [64].

Element	Description
Concentration	The game should require concentration and the player should be able to concentrate on the game.
Challenge	The game should be sufficiently challenging and match the player’s skill level.
Player Skills	The game must support player skill development and mastery
Control	Players should feel a sense of control over their actions in the game.
Clear Goals	The game should provide the player with clear goals at appropriate times.
Feedback	Players must receive feedback at appropriate times.
Immersion	Players should experience deep but effortless involvement in the game.
Social Interaction	The game should support and create opportunities for social interaction.

2 GAMEFLOW IN EXTENDED REALITY

The GameFlow model, which consists of eight elements of player enjoyment in games (see Table 1), has been extensively applied to the design and evaluation of games and experiences for a variety of purposes, audiences, platforms, and domains. Among these applications are various XR games and experiences (see Table 2), including designing VR games and simulations [2, 15, 68], evaluating VR experiences [1, 15, 22], analysing and evaluating Augmented Reality (AR) experiences [35, 40, 72, 73], designing AR games [23], and evaluating Mixed Reality (MR) games [25, 65]. XR experiences that the GameFlow model has been applied to include applications for overcoming phobias [1], exercise and sports games and simulations [2, 15, 23, 73], audio-based games [68, 72], artworks [22], and maps [35]. Although a number of studies in VR, AR, and MR have applied the GameFlow model for the purposes of design and/or evaluation, this research has not sought to understand more broadly what constitutes an enjoyable XR experience. In the research reported in this paper, we use the GameFlow model to both evaluate VR games and to build up an understanding of enjoyment in VR games.

3 METHOD

We conducted a qualitative analysis on sets of professional game reviews, using deductive Thematic Analysis [11] with GameFlow as a theoretical framework. Game reviews are appropriate for analysing as data to capture the play experience as they “in some sense, convey the experience of playing video-games” [10]. Previous research has involved analysing game reviews to characterise good and bad games [6], to develop models of the player experience [10], and to compile detailed GameFlow heuristics [60, 62]. This approach offered detailed insights into how the GameFlow criteria are afforded in VR versus non-VR games, as well as identifying opportunities for designing VR games to enhance enjoyment.

We selected two games to analyse that have both VR and non-VR versions, *Superhot* and *Skyrim*. We analysed 10 professional game reviews for each version of each game, as in previous work [60, 62]. Reviews were selected from more popular, reputable critic websites, with longer, more detailed reviews preferred. Table 3 presents the full list of reviews analysed. Table 4 summarises the details of the selected games, including release year, genre, and aggregate review scores according to Metacritic [30].

Table 2. Applications of GameFlow to Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR).

VR Applications	Description
Virtual Showdown [68]	GameFlow criteria used to improve the design of a VR game with audio as primary cues for youth with visual impairment.
La Camera Insabbiata [22]	Questionnaire based on GameFlow used to evaluate award-winning VR artwork.
VR sports training [2]	GameFlow followed to design an Olympic pistol shooting training simulation.
VR phobia apps [1]	Questionnaire based on GameFlow used to evaluate player enjoyment in two VR game prototypes for overcoming fear of heights.
Astrojumper [15]	GameFlow used in the design and evaluation of a VR exercise game.
VR exergame [3]	GameFlow used in the design of a VR exercise game.
Visuo-Haptic Game [39]	Gamification sub-components inspired by GameFlow.
AR Applications	Description
Exertion Interface [73]	Questionnaire based on GameFlow used to evaluate sports exercises in AR, with and without gamification.
Mobile AR games [40]	GameFlow elements used to analyse selected AR games.
Quantum Games [72]	GameFlow used to analyse probabilistic physical AR games with a non-visual (audio only) imaginary ball.
The Skeleton Chase [23]	GameFlow used as a design standard for AR game for increasing physical activity.
MapLens [35]	Questionnaire based on GameFlow used to measure user experience in an AR map for mobile devices.
MR Applications	Description
Age Invaders [25]	GameFlow was used to evaluate a social-physical inter-generational MR game.
Metazoa Ludens [65]	Questionnaire based on GameFlow used to evaluate a system that enables humans to play games with small animals in a MR environment.
Tainted [42]	Questionnaire based on GameFlow used to evaluate an olfactory game.
Exercube [28]	Questionnaire based on GameFlow used to assess an immersive game.
MIRA Rehab software [29]	Interview guided by GameFlow used to evaluate exergame for older people.
Plunder Planet [27]	Questionnaire based on GameFlow used to evaluate adaptive fitness game.
Eyes-Free Yoga [43]	Interview based on GameFlow used to evaluate low vision exergame.

3.1 Selected Games

SuperHot is a first-person shooter (FPS) game in which the player is tasked with defeating all the enemies in a level. In the game, time flows when the player moves and at a speed relative to the player's movements. If the player is standing still, then all enemies and projectiles also freeze in place, giving the player time to consider their next actions.

Skyrim is a role-playing game where the player controls a character and explores an expansive open world. In the game, the player has characters to interact with, enemies to defeat, stories to uncover, and abilities to learn. The player has the freedom to choose their next objective and is never locked to a linear path.

Table 3. Professional game reviews used as data for each selected game.

Game	Review sources
Superhot	Attack of the Fanboy [18], Game Informer [44], Hardcore Gamer [71], GameCritics.com [55], Destructoid [13], Gamespot [8], IGN [38], Metro News [31], PC Gamer [47], The Escapist [46].
Superhot VR	Attack of the Fanboy [20], Dual Shockers [34], GameCritics.com [69], Game Informer [17], IGN [53], Gaming Nexus [9], Metro News [33], PlayStation Universe [24], SSVAR [50], Video Chums [26].
Skyrim	Destructoid [54], Eurogamer.net [4], GameChronicles [7], GameInformer [45], GameSpy [36], Giant Bomb [49], IGN [37], PC Gamer [16], Video Gamer [5], Wired [48].
Skyrim VR	Attack of the Fanboy [19], CGMagazine [41], Critical Hit [66], Gaming Age [14], Metro News [32], Hardcore Gamer [70], IGN [52], Impulse Gamer [67], Game Informer [21], SSVAR [51].

Table 4. Evaluated games with year released, game genre, and aggregate review score according to Metacritic [30].

Game	Year	Genre	Critic Score	User Score
Superhot	2016	First-person shooter	82% (93 reviews)	7.5 (513 reviews)
Superhot VR	2016	First-person shooter	83% (19 reviews)	7.5 (44 reviews)
Skyrim	2011	Role-playing	94% (32 reviews)	8.2 (10735 reviews)
Skyrim VR	2018	Role-playing	81% (11 reviews)	6.9 (57 reviews)

4 CODING OF GAME REVIEWS

One rater coded the reviews against the GameFlow elements and criteria, with a second rater independently coding 5% of the reviews (2 complete reviews). Following the coding process, the two raters discussed the discrepancies in their coding and the coding was revisited by the first rater. Reviews were coded against the 8 GameFlow elements and the 38 criteria. Any statements in the reviews that did not fit the GameFlow elements and criteria were coded into new categories. The coding and analysis were performed using NVivo 12.

Table 5 shows a summary of the qualitative coding of the professional game reviews, including total number of positive, neutral, and negative comments coded into each GameFlow element for each game. Social Interaction is not included as all games selected are single player games. An additional theme that emerged from the data, Comfort, is also presented. One point of interest is that there were substantially more comments coded into Concentration for the non-VR games (168) than the VR games (38). It is also notable that there were more negative comments for VR games than the non-VR games for Player Skills (31:6), Feedback (10:4), and Immersion (24:12). For Control, the VR games had a similar number of positive (42) and negative (38) comments.

Comfort was a theme that emerged that was not covered by the existing GameFlow elements. Comfort was only present in VR game reviews. More comments were coded into Comfort for *Skyrim VR* (28) than for *Superhot VR* (15). There were also more negative comments (23) for Comfort than positive (18).

Table 5. Total number of positive (+), neutral (/), and negative (-) comments for each game by GameFlow element.

Element	Game	+	/	-
Concentration	Skyrim	107	6	9
	Skyrim VR	15	1	5
	Superhot	28	0	8
	Superhot VR	10	0	6
Challenge	Skyrim	11	2	3
	Skyrim VR	1	1	7
	Superhot	24	0	4
	Superhot VR	12	0	3
Player Skills	Skyrim	34	0	1
	Skyrim VR	23	0	21
	Superhot	48	3	5
	Superhot VR	43	0	10
Control	Skyrim	76	1	9
	Skyrim VR	28	0	28
	Superhot	23	0	4
	Superhot VR	14	1	10
Clear Goals	Skyrim	19	1	2
	Skyrim VR	3	0	0
	Superhot	6	0	0
	Superhot VR	4	0	0
Feedback	Skyrim	10	0	2
	Skyrim VR	11	0	6
	Superhot	2	0	2
	Superhot VR	3	0	4
Immersion	Skyrim	59	0	5
	Skyrim VR	43	0	17
	Superhot	18	1	7
	Superhot VR	33	0	7
Comfort	Skyrim	0	0	0
	Skyrim VR	11	0	17
	Superhot	0	0	0
	Superhot VR	7	2	6

5 ANALYSIS OF GAME REVIEWS

In this section, we report the results of the thematic analysis of the professional game reviews. We present a summary of how each GameFlow element is afforded by the selected games and key points of differentiation between the VR and non-VR versions of each game. Social Interaction is not included as all games selected are single player games. An additional theme that emerged from the data, Comfort, is also presented.

5.1 Concentration

There were no notable differences in affordances for Concentration between the VR versus non-VR games. In *Skyrim*, Concentration is afforded in the form of the amount and variety of content, visuals, non-player character interactions, quality of the game, and the quests. In *Superhot*, Concentration is afforded via the uniqueness of mechanics, the intensity of gameplay, the narrative, the level design, and the presentation of the game. Reviewers noted that *Superhot*'s narrative interrupts gameplay throughout the game, which received mixed reviews. The VR release of the game removed most of the original narrative with reviewers considering what was left to be an unimportant distraction (e.g., "the plot of Superhot VR is thin enough that it often feels quite superfluous" [24], "it would be great to see more narrative woven into the gameplay, or maybe just eliminate it all together - right now what's there feels like a novel distraction" [17]).

5.2 Challenge

There were no notable differences in affordances for Challenge between the VR versus non-VR games. In *Superhot*, Challenge is afforded by the number of active enemies, the weapons they hold, their distance from the player, the environment in which the level occurs, the weapons available to the player, and how the player uses the time flow ability. In *Skyrim*, Challenge is afforded by the level difference between the enemy and player, the abilities enemies possess, the enemy AI, the environment in which the encounter occurs, and the options the player has for an engagement. The *Skyrim VR* reviews mentioned that its implementation breaks some of the mechanics (e.g., "you'll get steered off to the side if you try to aim while your horse is moving" [51]) of the game and that there is a lack of new content for returning players.



Fig. 1. Superhot affords Challenge via enemies, weapons, distance, and environment.

5.3 Player Skills

The key differences in affordances for Player Skills between the VR and non-VR games related to the Player Skills criteria:

- Players should be rewarded appropriately for their effort and skill development.
- Game interfaces and mechanics should be easy to learn and use.

In *Skyrim*, the Player Skills element is afforded through combat, skill progression, story progression, menu design, and the introductory sequence. *Skyrim VR* reviews mentioned that the control system makes learning mechanics more enjoyable (e.g., "it turns out the melee attacks from horseback are really fun" [51]) and that the VR experience rewards players with satisfaction for mastery (e.g., "feels good to actually hold your shield up to block attacks and bash enemies" [51], "no more satisfying feeling than striking an enemy with your sword whilst casually blasting force lighting with your free hand" [67], "seeing a stream of fire shoot from your hands is an empowering feeling" [52]). Reviews also noted that the combat system is intuitive as the player is physically performing the actions (e.g., "using a sword and shield, you grip the Move controllers as if you were holding the items, raising your left hand to block and swinging your right hand is if you were holding a sword" [21]). However, archery combat was perceived to not translate well to VR (e.g., "aim is really only done with your bow hand, which feels less intuitive and natural" [51], "I did find using the bow to be incredibly difficult during my first few hours of exploring" [67], see Figure 2). The user interface elements were also highlighted as not translating well due to their positioning on the VR display (e.g., "one thing I had an issue with was the compass and looking down" [70]).

In *Superhot*, the Player Skills element is afforded through combat mechanics, game progression, and time mechanics. *Superhot VR* reviews mentioned that the throwing mechanic did not translate well to VR (e.g., "I'm sure the developers are loathe to include a simplified point-and-shoot throwing mode since it would break the immersion that the game is built around, but right now the throwing is so frustrating it made me want to quit more than once" [69]). The VR version does not have the playback feature (i.e., plays back an action sequence), which is rewarding for the player. However, physically performing the super-human actions in the VR version is rewarding in itself ("watching trails of bullets whip by your head as you carefully duck and dodge out of harm's way is exhilarating" [26], "more than anything else, Superhot VR makes you feel like a legitimate action movie hero" [34], "in Superhot VR, because you are physically performing these acts yourself, the feeling of satisfaction is that much greater" [24]). Physically performing the actions also makes the combat system more intuitive (e.g., "picking up weapons with the grip handles of the Vive controllers makes a lot of sense" [20]). Reviewers also noted that the hit detection does not always line up with player expectations (e.g., "every once in a while a bullet will come close to your head and still kill you even though it might have seemed like it shouldn't have" [17]) and the progression button is unintuitive in its placement within the game world.

5.4 Control

The key differences in affordances for Controls between the VR and non-VR games related to the Control criteria:

- Players should feel a sense of control over their characters or units and their movements and interactions in the game world.
- Players should not be able to make errors that are detrimental to the game and should be supported in recovering from errors.

In *Skyrim*, Control is afforded by the open world, the content available, the character customisation, and the combat. Reviewers described how they have more control over how they engage in combat scenarios in *Skyrim VR* (e.g., "using the Moves also opens up a whole new dimension in terms of combat, giving players the opportunity to simultaneously attack in two different directions" [67]) and how the VR perspective increases feelings of connectedness to the world (e.g., "I felt more connected to the world than through a flat screen, I didn't feel the urge to try randomly killing villagers or to steal their stuff just for the hell of it - I felt encouraged to hold up my part in the role-playing" [51]). However, they also had expectations around VR increasing control in some aspects of the game, which it did not (e.g., "waving around



Fig. 2. Archery in Skyrim was not perceived to translate well to VR.

the sword feels like a bad Wii game and the bow and arrow barely work half the time" [32]). VR controls were also mentioned to be inaccurate at times, causing frustration (e.g., "when I have to fiddle with the controls or the menus and the whole concept falls apart" [19], "a constant inconvenience is the awkwardness of the controls" [52], "Elder Scrolls' famously terrible combat amplified by imprecise movements from the Move controllers" [41]). Reviewers mentioned that the interface is not well adapted to PC [16], which carries over to VR.

In *Superhot*, Control is afforded by the engagements, the weapons, and the movement. The player feels control due to the time-slowing mechanic and *Superhot VR* further increases this feeling (e.g., "as long as you hold still, you have all the time in the world to decide how to handle the situation ... that feeling of control is empowering" [69]). However, reviewers noted that every motion moves time forward and tracking issues in VR can make the game feel unfair (e.g., "the game is constantly interpreting the slightest twitch as an intended action, or simply imagining movement that you swear you never took" [33]). *Superhot VR* also includes a physical game object as a level progression tool, which reviewers noted can be missed if the player is not facing the right direction (e.g., "I got stuck at the end of a level because I'd looked the wrong way when the direction for what to do next appeared" [69]).

5.5 Clear Goals

There were no notable differences in affordances for Clear Goals between the VR versus non-VR games. In *Skyrim*, the Clear Goals element is afforded by an introductory narrative sequence that sets the overriding narrative and goals for the game, as well as an extensive array of main and side quests throughout the game. Reviewers paid attention to the procedurally generated questions, which gave players a never-ending supply of tasks. *Superhot* does not provide any explicit overriding goals, although the premise of "you're here to kill the red guys" [13] is made clear. *Superhot* provides the player with clear colour coding of objects or short text prompts for immediate objectives.

5.6 Feedback

The key differences in affordances for Feedback between the VR and non-VR games related to the Feedback criteria:

- Players should receive immediate feedback on their actions.

In *Skyrim*, Feedback is afforded by the quest log, health and stamina bars, sounds used to denote successful actions, and text that shows up when a quest is complete or when the player has levelled up. Reviewers mentioned that *Skyrim VR* has satisfying feedback for performing actions such as blocking and archery (e.g., "blocking sword swings and arrows with a shield by physically holding it out in front of you will never not be fun" [66]), but that there is a lack of visceral feedback (e.g., "hitting enemies with melee weapons largely feels like a hit-check rather than a blade slicing into flesh" [51]). The placement of the status bar was also noted as an issue (e.g., "I often found myself straining to find my health bar while running away from an enemy to see how much damage I'd taken" [51]). In *Superhot*, feedback is afforded by sounds for actions, text pop-ups when a level is completed, and visuals. Reviewers noted that in *Superhot VR* there is a noticeable disconnect between the action of grabbing the level progression sign and it shattering (e.g., "that 'next' button comes in the form of a pyramid which asks you to 'grab' it, and then it breaks when you do ... don't ask me to 'grab' something and then have it break into pieces" [17]).

5.7 Immersion

The key differences in affordances for Immersion between the VR and non-VR games related to the Immersion criteria:

- Players should become less self-aware and less worried about everyday life or self.
- Players should feel emotionally involved in the game.
- Players should feel viscerally involved in the game.

In *Skyrim*, Immersion is afforded through the character interactions, the interactions with the environment, the story, and the sound design. Reviewers mention that the *Skyrim VR* player perspective gives the player a deeper sense of involvement ("the actual experience of being in 360° virtual fantasy world is pretty amazing" [41], "creatures looking big on screen is one thing; towering over you is another" [52], "all of the action unfolds through your eyes" [14]) and that deeper emotional attachment is formed while playing the game (e.g., "experiencing *Skyrim* as an actual inhabitant of the world is an experience like no other and truly makes you feel like an epic adventurer" [67]). Although *Skyrim* is mentioned to offer a sense of visceral involvement, *Skyrim VR* is noted to afford increased visceral involvement from "intimate up close" interactions [70].

In *Superhot*, Immersion is afforded through the interactions with the environment, the story, the sound design, and the fast-paced action. Reviewers noted that *Superhot VR* creates an experience where the player is so focused on the game that the rules are expected to transition over to real life (e.g., "I honestly found myself, ever briefly after taking off the headset, feeling like the real world should be slowing down around me as I moved more slowly" [17]). The VR version is mentioned to put the player into the shoes of an action hero who uses their own instincts to overcome challenge and to react to stimuli (e.g., "never in VR have I felt like the sort of action hero that *Superhot VR* has made me" [17], "by tapping into our natural survival instincts, it feels intuitive, it feels natural" [24]). Although the story is removed, the involvement remains high. Visceral involvement is noted to be higher in the VR version, with very real physical reactions (e.g., "very-real quantities of adrenaline still pumping through your veins and the pouring sweat from your brow" [24], "when I finally took off the headset, my hair was matted in sweat and my pulse was pounding" [17]).

5.8 Comfort

Comfort was a theme that emerged from the coding of the professional game reviews that was not covered by the existing GameFlow elements. The concept of Comfort was only present in VR game reviews. Comfort can be described

as how comfortable a player feels while playing a VR game, with respect to physical issues such as play space, body position and movement, and cyber sickness. Comfort is often used as a subheading in professional reviews of VR games.

Skyrim VR affords Comfort by offering different control options to make the experience comfortable to players (e.g., "an option to disable 'realistic shield grip'" [51], "the game's locomotion system, offering both teleporting and free locomotion (controller relative), along with snap-turning and a fair set of options to adjust things as needed" [51]). Reviewers mentioned that some controller options could be nauseating to the players (e.g., "moving around freely is likely to cause at least a degree of nausea in most people" [32], "going without the snap [turning] option resulted in sickness after about an hour" [70]), while alternatives offered a less immersive experience (e.g., "while this can break the immersion, it does help newer users who haven't gained their VR legs acclimatise to free locomotion" [67], "if you can stomach it, I highly recommend smooth movement" [52]). It was noted that although the game does not eliminate the possibility of being nauseated, it does attempt to accommodate it. However, it was observed that nausea was likely to be an issue for most players in *Skyrim VR*, "due to the amount of time needed for grinding and exploration" [70]. The length of the game was mentioned as a general barrier to *Skyrim* as a comfortable VR game (e.g., "while I'm happy to while away the hours playing immense games like this, doing so with headset strapped to your face becomes needlessly tiring" [66], "Skyrim was made to be played sitting down for long stretches of time, which is just not that comfortable in VR" [19]). Reviewers also mentioned that *Skyrim VR* could be played sitting or standing, which is important given the length of the game (e.g., "I was able to play seated when I needed a break - the game automatically calibrates to a standing height, even when you're seated" [51]).

Superhot VR was mentioned to successfully confine its whole experience to a limited play area (e.g., "the game effectively keeps you facing forward toward the cameras to ensure you don't lose tracking" [17], "a standing game that usually doesn't require you to move your feet more than a step in any direction" [53]). To support the player in staying in place, defeated enemies eject their weapons for the player to grab, meaning that the player never has to move (e.g., "the fact that a dying enemy will effectively throw his gun at you ... is a very smart way to keep you from having to move too far" [53]). Although, some reviewers mentioned that having a large play space was preferable (e.g., "the need to dodge is going to take you a step or two in either direction, and you'll be stretching your arms out in desperate reach of weapons flying through the air" [17]).

6 DISCUSSION

Our research aimed to investigate enjoyment in VR games by analysing professional reviews of the VR and non-VR versions of two popular games, *Skyrim* and *Superhot*, using the GameFlow model as a theoretical framework. We found differences in how the elements of Feedback, Control, Immersion, and Player Skills were afforded in the VR and non-VR versions of the games.

We found that **VR affords more control and easier interaction with a more direct connection between physical and virtual movements and actions**. However, the more natural interfacing brings certain player expectations about how the game should feel and respond. The disconnect between actions and expected feedback can be jarring for the player. For example, archery in *Skyrim VR* and throwing in *Superhot VR* did not meet player expectations. Moreover, players had difficulty using these mechanics due to needing additional feedback to accurately perform the actions. Our results suggest that **players need higher veracity feedback in VR games to meet expectations and to feel effective in their actions**.

We also found that **VR games can afford increased emotional and visceral immersion**. Players can physically perform the actions that their character performs, bringing them into the experience. The act of physically performing

Table 6. Proposed new GameFlow element of Comfort and associated criteria.

Comfort: Games should afford players to feel physically comfortable while playing.
Games should afford different players to control their level of comfort.
Games should afford players to feel comfortable in their play space.
Games should afford players to feel comfortable with their body position throughout play.
Games should afford players to feel comfortable with their movements.
Games should afford players to minimise feelings of nausea.

these actions is fun to learn and provides satisfaction when performed correctly. Feelings of mastery at successfully performing actions, particularly if they are extraordinary or super-human, are amplified in VR. The player is no longer controlling a character to perform these actions, they feel as though they are doing it themselves. Emotional investment comes from the perspective of being the character and seeing through their eyes and the sheer impact of experiencing the world at-scale (e.g., life size dragons in *Skyrim VR*). This perspective and scale gives players a greater sense of presence and connection to the world, resulting in a greater impetus to act their part and an increased sense of consequence and responsibility for their actions.

We found that **increased immersion often comes at the cost of a loss of sense of control for players**. Reviewers felt limited in their abilities to freely move around both VR games, which impacted exploration in the open-world game *Skyrim VR*, but also reduced overall sense of control and continuity in *Superhot VR*. Reviewers were also critical of perceived inaccuracies in movement detection, particularly when it resulted in game outcomes that felt unfair (e.g., unintended movement in *Superhot VR*). Compromises were also made in player control as a result of limited input mechanisms (e.g., players choosing between turning during combat or two-handed wielding in *Skyrim VR*). The VR controllers or the control mappings were often found to not sufficiently accommodate the desired or required actions.

Comfort was identified to be a key enabler or inhibitor of player enjoyment in VR games. We propose that Comfort could be added to GameFlow as an additional element when designing or evaluating VR games. Comfort can present a direct barrier to playing, or becoming involved in, a VR experience, with a stand-out example being cyber sickness. There are also considerations related to size of the play space and how it is used, whether the player must stand for the duration of the game, and how they move their body. We defined Comfort as how comfortable a player feels while playing a VR game, with respect to physical issues such as play space, body position and movement, and cyber sickness. It is important to consider and support differences between players. Providing players with some level of control over their experience, even if it is choosing between immersion and comfort, is important to accommodate the needs of different players. We propose an additional GameFlow element of Comfort, as defined in Table 6, for use with XR and other games that blend the physical and virtual worlds.

A final point of interest that was identified in the professional reviews was that **VR games, even complete and extensive games like *Skyrim VR*, can feel “more like a tech demo than a full experience”** [17]. This perception warrants further investigation to fully understand, but it could relate to the experience feeling incomplete (e.g., lacking feedback) rather than the game being incomplete. Most reviews treated the VR games as an expansion or extension of the original games and limited their reviews to only the differences. Figure 3 illustrates the difference in focus between the reviews for *Skyrim* and *Skyrim VR*, in the form of word clouds for each set of reviews. The *Skyrim* reviews focused on the gameplay and narrative, whereas the *Skyrim VR* reviews focused more on the control system.

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