GAMEPLAY & INTERACTIVITY

Contents [hide]

1 GAMEPLAY & INTERACTIVITY
2 Introduction
  2.1 Definitions
3 Gameplay considerations
  3.1 (1) Difficulty
  3.2 (2) Reward systems
  3.3 (3) Failure
4 Interactivity restrictions
  4.1 Headsets
  4.2 Controllers
5 Gaze control considerations
  5.1 (1) Providing feedback to users
  5.2 (2) Guiding user attention
6 Gameplay and interactivity › Calm
  6.1 A passive approach
  6.2 The use of casual gameplay components

6.3 Subtle physical movement
7 Gameplay and interactivity › Energy
7.1 A passive approach
7.2 Dynamic movement mechanics
7.3 Symbolism
8 Gameplay and interactivity › Pain relief
8.1 The importance of interactivity
8.2 Gameplay intensity
8.3 Expansive physical movement
9 Gameplay and interactivity › Awe
9.1 Awe-inspiring user interactions
9.2 Interaction mechanics – flight
10 References

Introduction

The interactive nature of VR will continue to be a standout feature which enhances the sense of presence, engagement and enjoyment an experience can provide. Even so, passive VR experiences with no obvious form of gameplay or participation can still effectively induce cognitive and emotional states. They encourage users to take better notice of surrounding audio/visual stimulation; features which are easily overlooked when engaged in demanding tasks in VR. As such, interactivity and gameplay are not essential to all experiences within the Liminal VR platform.

The following sections looking at considerations for gameplay and gaze control, as well as restrictions for interactivity, outline factors significant to all categories of the platform. The final sections include research evidence and examples relevant to specific categories.

Definitions

The following definitions are purposed to reflect design factors appropriate for the Liminal VR platform.

Interactivity: The physical input which enables participation and the extent to which a user has influence over a virtual environment.

Gameplay: The incorporation of goals or objectives which define how users should interact.

For VR (virtual reality) to contain gameplay features, users must be able to interact and control elements of virtual environments which enable them to win or lose. In contrast, interactive experiences don't require any gameplay components to function. User interactions can simply exist as joyful novel actions, as opposed to functions which help to complete goals or missions.

Gameplay considerations

(1) Difficulty

Core to the platform is the importance of designing gameplay features for a broad range of skill levels. The profile of users looking for cognitive and emotional changes through VR extends past the typical game-savvy groups to include a broad range of ages, abilities and experience levels with VR and video games.

Regardless of the intended psychological outcome, all gameplay features should be fun, easy to learn and require no previous video game expertise to play. The recommended difficulty levels for each category are outlined in the quick start guides.

Balancing difficulty with user skill levels

Due to the broad range of potential user ability levels using the experiences on the platform, imbalances between difficulty and user skill levels will be an issue. Various techniques should be considered when addressing imbalances (Table 1).

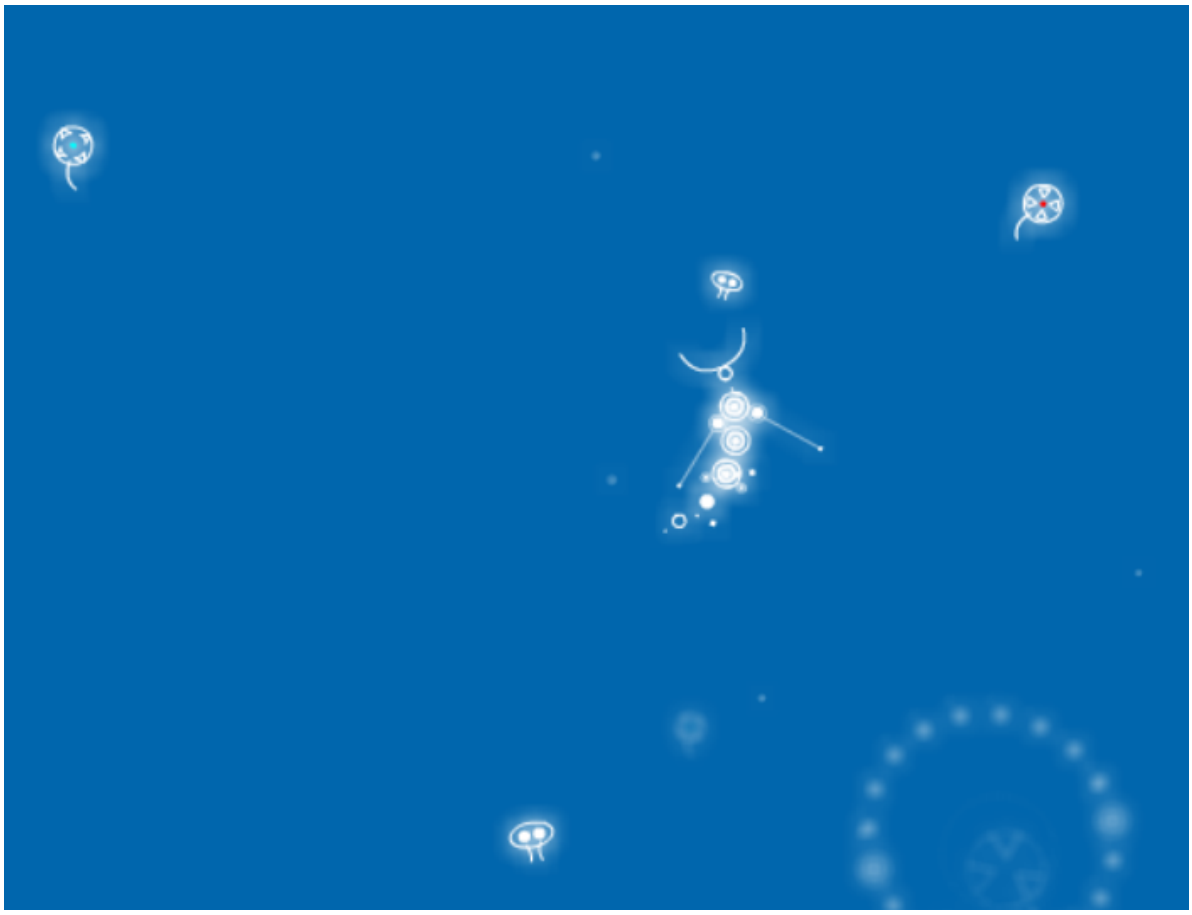
Technique	Implementation
User instructions	Guidance and feedback is essential across all categories, ensuring that users have relatively equal starting points
Gradually increasing difficulty	Combined with user instructions, beginner/practice trials will ensure users understand the basic mechanics of the gameplay before progressing
Player difficulty level chosen at the beginning	Users are given a variety of game modes, appealing to different skill levels and providing additional motivation to re-play
Dynamic difficulty adjustments	Implementation of a programming model to assess user performance and modify difficulty levels accordingly
Player led difficulty adjustments	Players are given direct in-game control over when and how difficulty is adjusted (see fl0w below)

Table 1: Techniques to balance difficulty with user skill levels

Player led difficulty adjustments in fl0w (Chen, 2007)

In fl0w, players control a flying creature with the aim to navigate and grow larger whilst eating other creatures. Whilst progressing through the game, players can eat red creatures (top right) to make the game harder or eat green creatures (top left) to make the game easier. Otherwise, users can choose to ignore the coloured creatures if they are happy with the difficulty level.

This an example of an interactive method for adjusting difficulty levels without interrupting the user experience. Users can rapidly increase or decrease the difficulty of the experience to suit their skills.



fl0w: choose between red or green to change difficulty

(2) Reward systems

The sense of achievement and progression that accompanies rewarding gameplay experiences serves as one amongst several key motivations to play. Both performance-

based and intrinsic reward systems can be used to such effect, but a focus towards either one will impact the psychological outcomes of gameplay.

VR is a unique medium which provides users with novel, interesting gameplay features and therefore the act of participation should always provide a sense of satisfaction and enjoyment, regardless of any performance-based rewards.

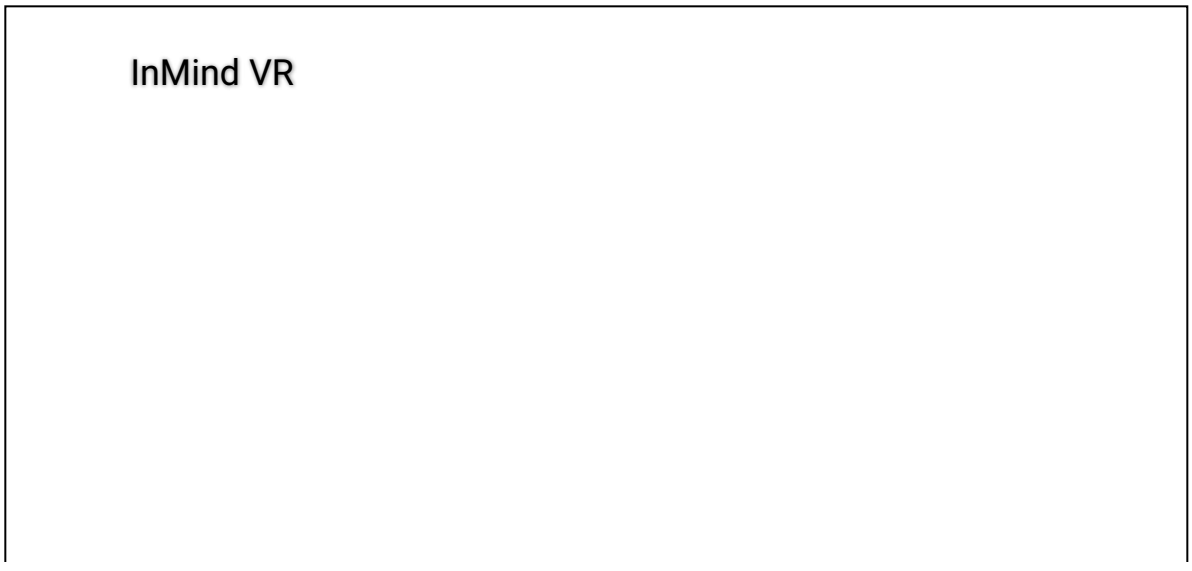
Performance-based rewards

The Liminal VR platform supports the use of in-game rewards to accompany user performance and provide enhanced engagement and motivation to play. The typical examples for performance-based rewards include points and achievement-based features or progression from one 'level' or 'stage' to the next.

Please note: The platform does not currently support the use of tracked user data from prior sessions (e.g. new personal high scores) or provide comparisons with other users on the platform in the form of leader boards etc.

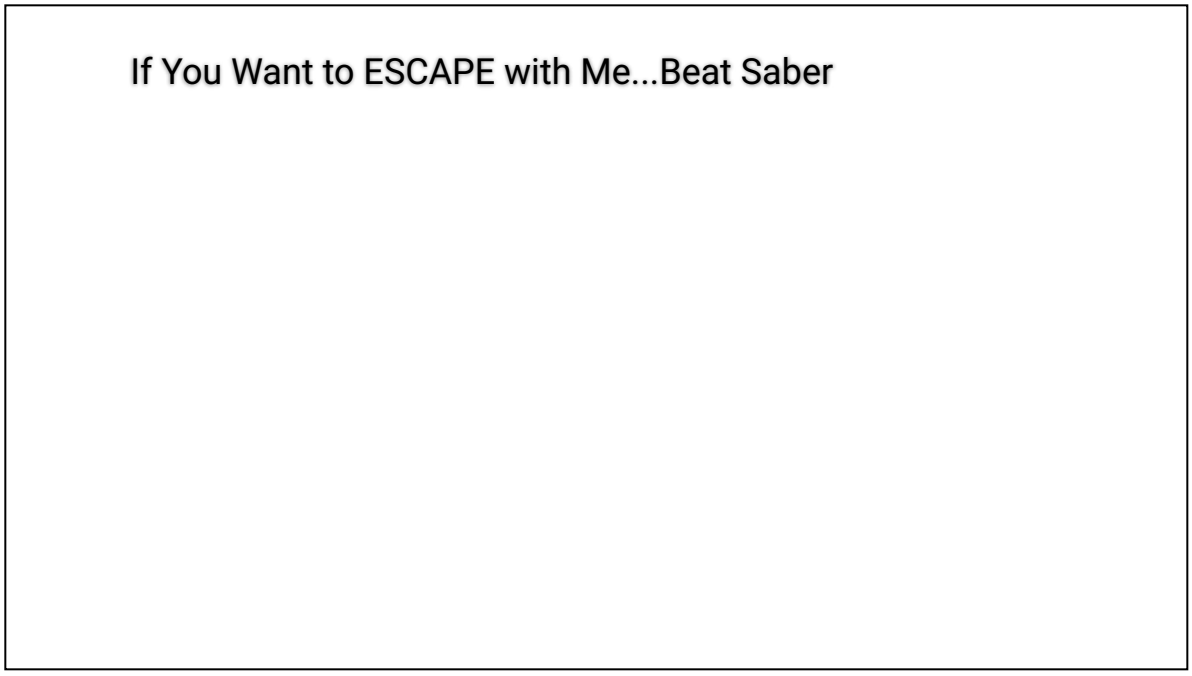
These forms of rewards can embody a major part of the gameplay experience, to the extent where they become the only motivation to play. Importantly this quest for success is a highly reinforcing and arousing component of gameplay (Nakamura, Csikszentmihalyi, Snyder & Lopez, 2002) which can be detrimental to inducing calm and relaxation.

Performance-based rewards are well suited to pain relief experiences where they can greatly enhance engagement and provide a more effective form of distraction from pain. The VR game InMind adopts a performance-based rewards system in which players receive a combined star/out of 50 rating related to their shooting accuracy. Amin (2016) assessed the analgesic effects of playing InMind for 10 minutes in participants who were currently experiencing physical pain. The engaging gameplay and immersive nature of the game corresponded with significant reductions in the pain intensity reported by participants during and after playing the game.



InMind (Nival)

Energy experiences may also benfit from the use of performance-based rewards. For example Beat Saber' adopts a combo system showing each string of successful hits to encourage players to maintain a high level of intensity and accuracy.



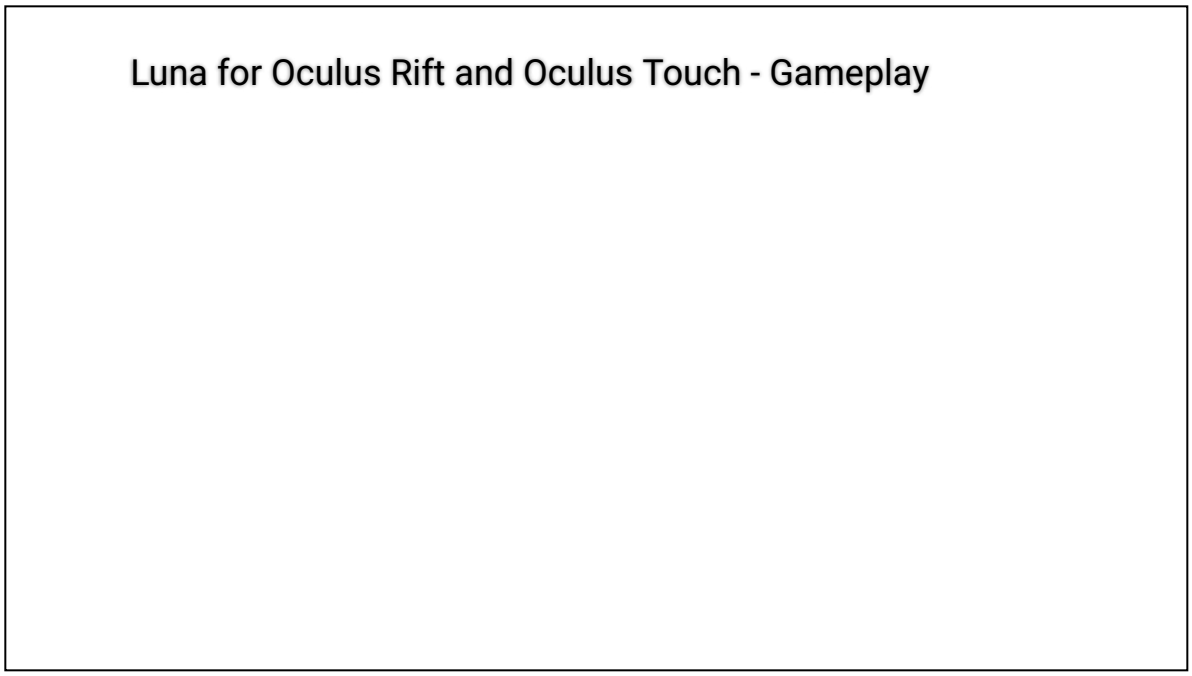
Beater Saber (Hyperbolic Magnetism)

Intrinsic rewards

Intrinsic rewards are intangible and subjective to each user when they feel a sense of enjoyment and satisfaction whilst participating in a task. So instead of interacting for the sakes of receiving points or recognition, players engage with a VR experience because of the stimulating experiences it provides. Whilst every VR experience should be intrinsically rewarding, performance-based rewards are not always necessary.

The VR game 'Luna' involves a series of unique gameplay components with no obvious form of rewards. Progressive steps within the puzzles are made to feel gentle and satisfying, encouraging enjoyment in the simple act of moving the puzzle pieces. Where performance is rewarded, for example during puzzle tasks, users are rewarded with pleasant sensations such as sound effects and visual displays of completion as the star constellations 'become' the intended object.

Luna is a great example of gameplay elements which have been implemented to provide intrinsic value in a calming environment.



Luna (Funomena)

In Liminal's energy experience 'Ion' the gameplay features are symbolic, centred around a core goal of absorbing energy crystals and using the generated power to activate the surrounding energy balls. There are no performance-based rewards involved. Instead, users are rewarded as their participation in the experience leads to increased levels of intensity and excitement. Powering up the energy balls through stages leads to continuous surges in the power of the rising platform before reaching the final explosive stage of the experience.

Ion: rising platform

Ion: final phase

(3) Failure

The potential for failure will determine to some degree the level of engagement achieved in VR experiences which employ demanding gameplay features. It's often what inspires us to try harder, learn and use different tactics to succeed.

The consequences of failure – minimising frustration

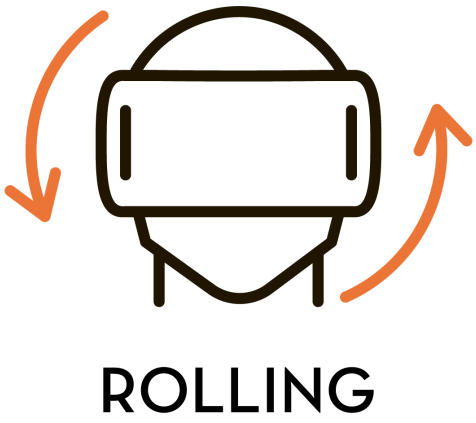
Core to all experiences on the platform is that they remain fun and enjoyable. More failure in a game is unsurprisingly related to greater feelings of frustration. To minimise frustration the consequences related to failure should be minimised. That is to avoid any ‘game over’ or ‘you lose’ type scenarios and focus on enabling users to play seamlessly without interruptions.

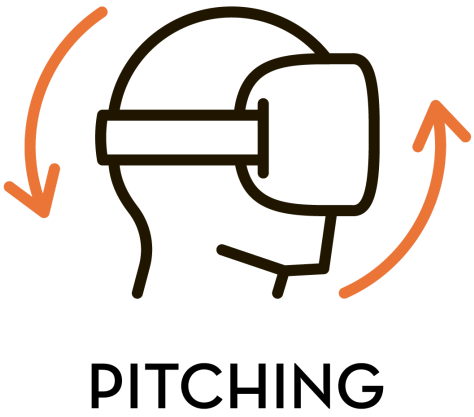
Interactivity restrictions

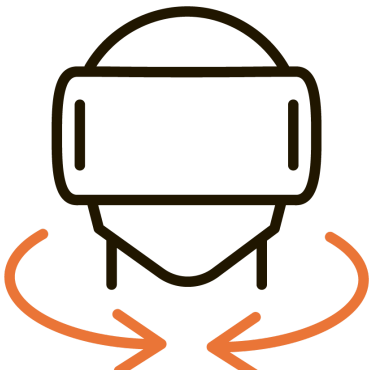
Within mobile VR there are restrictions to consider which determine the types of interactions available.

Headsets

In many HMDs, movement is restricted to three degrees of freedom: rolling, pitching and yawing. Essentially users are limited to static rotation-based movements, as opposed to positional tracking which allows a person to physically move around in a virtual space.







(Andrew Lucas Studios, “A quick guide to Degrees of Freedom in Virtual Reality”, n.d.)

In the absence of positional tracking, movement is enabled through controller input (e.g. teleportation) or the pre-determined motion patterns of the experience. Users still have a 360° field of view to explore which can incorporate gaze-based interactions.

Controllers

The only noticeable difference between the three currently available controllers (for Google Daydream, Gear VR and Oculus Go) which will have an impact on interactivity is the trigger on the back side of the Gear VR and Oculus Go controllers. This provides an additional physical input not offered by the Daydream.

Each controller has 3 degrees of freedom and a trackpad which enables both swipe and click options.

Controller tracking

The controllers for Google Daydream View, Samsung Gear VR and Oculus Go have no positional tracking and are limited to 360° rotational tracking. They work best for ‘point-and-click’ type interactions.

Movement is tracked from left-right and up-down but does not detect forwards and backwards motions. The controllers work poorly as a representation of a person’s arm as the ability to reach out and grab something in most mobile VR is currently limited. The act of gathering up energy crystals in Ion takes advantage of a proximity-based mechanism to attract objects within range whilst pressing the trackpad.

Gaze control considerations

The implementation of gaze control features can contribute to a more immersive VR experience, particularly when compared to purely controller-based input methods (Lee, Kim, Jeon & Kim, 2016). Most importantly, they offer a unique mechanism for interactions which provide enhanced enjoyment and interest when implemented appropriately.

(1) Providing feedback to users

Gaze control relies on the provision of feedback to inform users of the whereabouts of their shifting focal point.

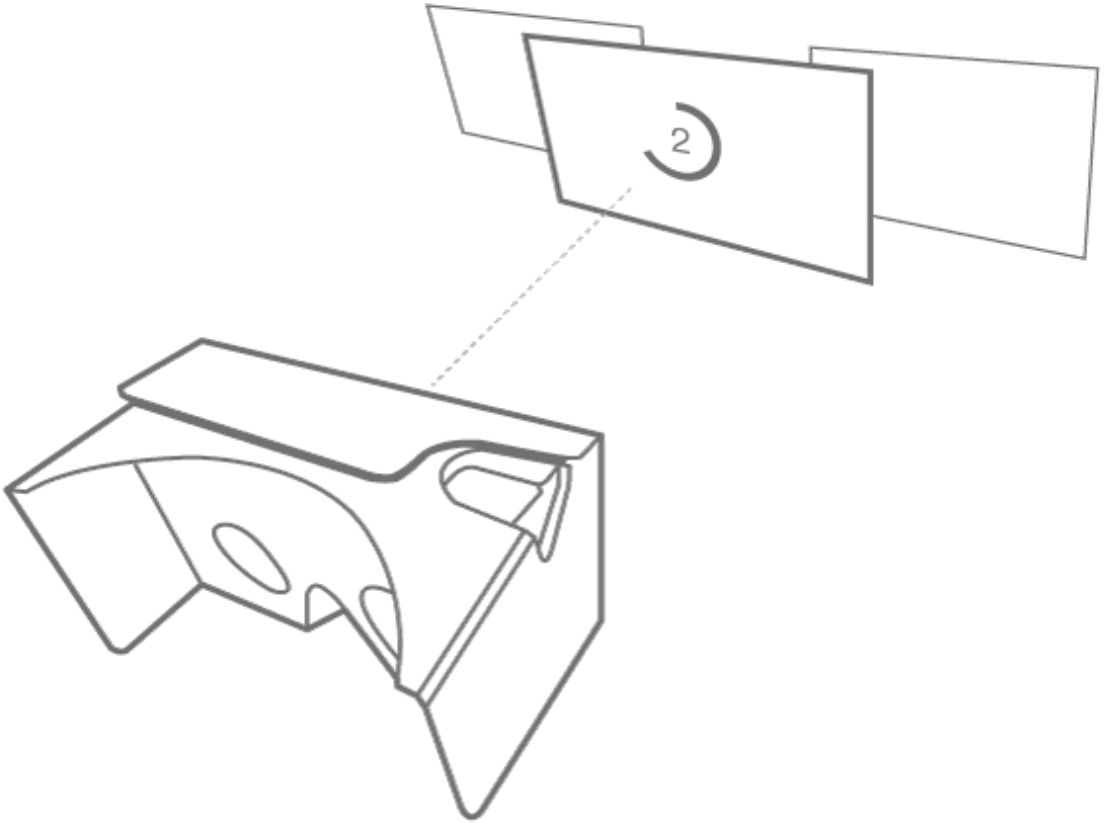
Problems with accuracy

When using gaze control as an interaction method, the lack of eye tracking makes it difficult to accurately select objects or aim at specific locations. A central reticle informs users of their changing focal point as they shift their gaze. This has been implemented in Liminal's 'Splat!' to enable accurate paint firing and show the current colour of the paint balls.

Use of reticle in **Splat!**

Whilst making selections

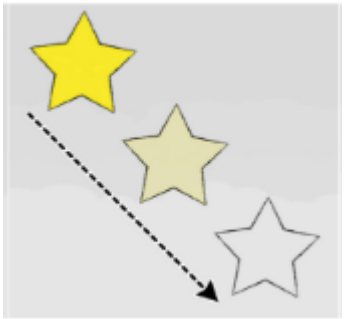
Feedback is also required when gaze control is used for object selection purposes. As gaze is centred on an intended object, a set time frame can be implemented where users must hold their gaze before the interaction is initiated.



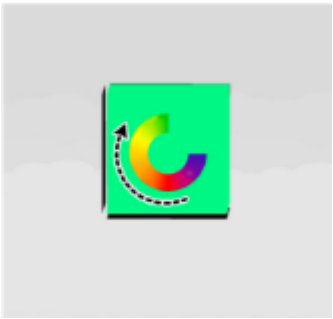
(Viro Media, “Designing for Mobile VR”, n.d.)

Kim, Leon, Jeon and Kim (2017) compared user ratings of three different feedback mechanisms for gaze-selection: transparency, circular sliders and sound. They found pros and cons to each method as outlined in the descriptions below.

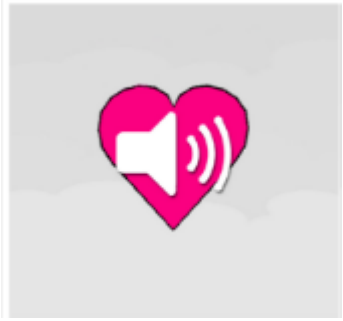
Transparency



Circular slider



Sound



Three different feedback mechanisms for making selections through gaze control

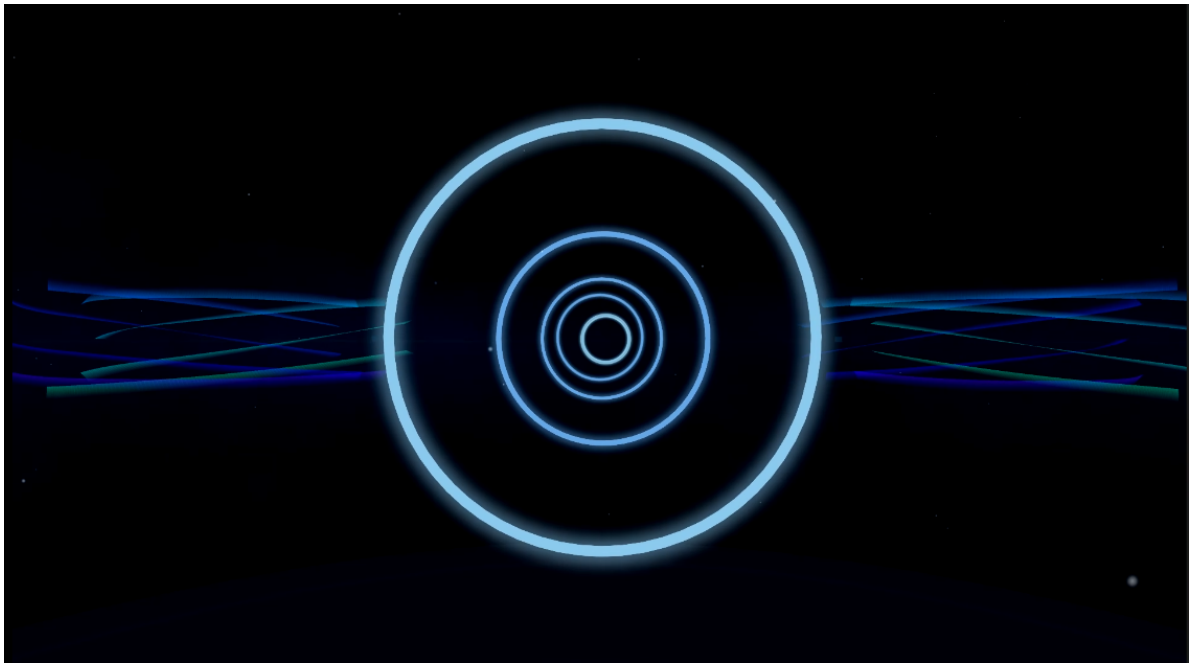
Transparency: Object becomes increasingly transparent whilst selection is being made. Rated highly interesting and immersive. The object itself provides means of feedback without distracting from the experience. Colour changes or animations could also be used for the same purpose.

Circular slider: Slider pops up showing quick progression before selection is made. Rated as the most convenient, the slider provides the most accurate means of feedback. However, the addition of the slider was rated as low immersion as it distracts away from the experience.

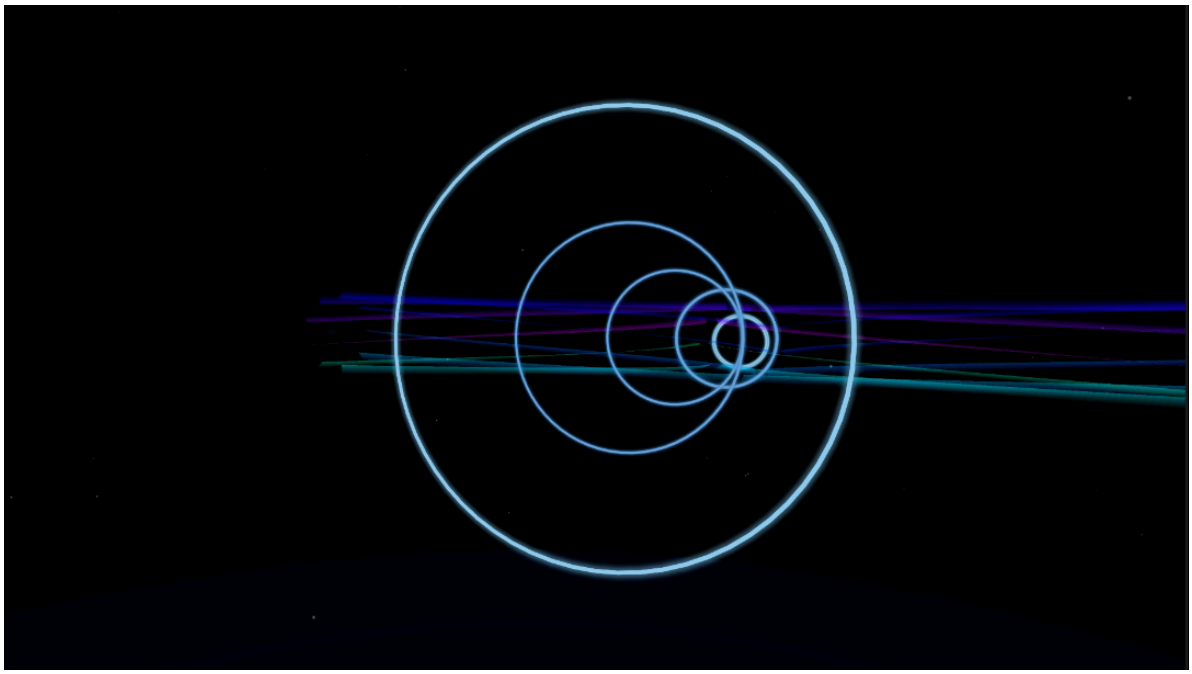
Sound: A sound is delivered to signify that an object is being selected. Rated as the most satisfying of the feedback mechanisms, also rated highly for immersion. Different sounds can be implemented reflective of different objects. Accuracy can be an issue if there are competing noises in the soundscape.

(2) Guiding user attention

Gaze-based tracking can also be used as a method to direct user attention towards desired locations. For example, in Ripple Effect users are instructed to keep the rings aligned and stay focused on a central breathing visualisation. Changes in focal point will misalign the rings or ‘ripples’ and draw focus away from the breathing guidance.



Ripple Effect: Fixed gaze, rings alligned

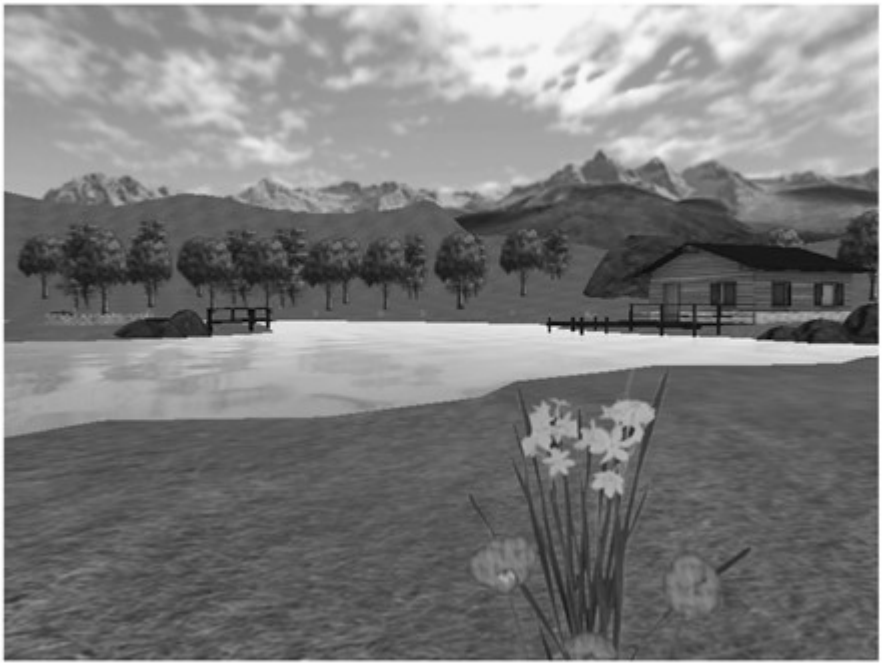


Ripple Effect: Gaze moved away from fixation point

Gameplay and interactivity › Calm

A passive approach

Passive VR is often well suited for deep relaxation purposes, allowing a more complete appreciation of the surrounding audio and visual effects. Gorini et al. (2009) introduced participants to ‘Green Valley’, a non-interactive VR experience depicting a mountain landscape around a calm lake alongside relaxing music and soft sounds (birdsongs, flowing water etc). Participants were given the impression of walking around the lake where they would observe nature and virtually sit on a comfortable deck chair. Overall reductions in heart rate and improved emotion ratings were evident of the relaxing effects of a passive approach. This serves as one amongst many examples where a passive approach to VR works well to engender calm.



Example screenshot taken from Green Valley (Gorini et al., 2009)

The use of casual gameplay components

Casual video games (CVG’s) provide an ideal model for when gameplay components are implemented within calm experiences. That is, when defined as being fun, quick to access and easy to learn whilst requiring no previous video game skills, expertise, or regular time commitment to play (Casual games association, 2007). Numerous studies have demonstrated the calming effects of playing casual video games (Table 2).

Authors	Findings
Whitbourne, Ellenberg, & Akimoto (2013)	Stress relief found to be one of the most common perceived benefits associated with CVG playing
Kappil (2015)	Implementing Tetris playing into daily lives of participants over a two-week period significantly reduced subjective stress ratings
Russoniello, O'Brien and Parks (2009)	One 20-minute period of playing either Bejewelled 2 or Peggle caused significant reductions in heart rate and improved mood ratings. Bejewelled 2 was also associated with changes in heart rate variability reflective of the relaxation response and meditative state identified by Peng et al. (2004)

Table 2: Three example investigations demonstrating the relationship between casual video games and stress relief/relaxation

Peggle (left) and **Bejewelled 2** (right): Casual video games used by Russoniello, O'Brien and Parks (2009) to enhance relaxation in participants.

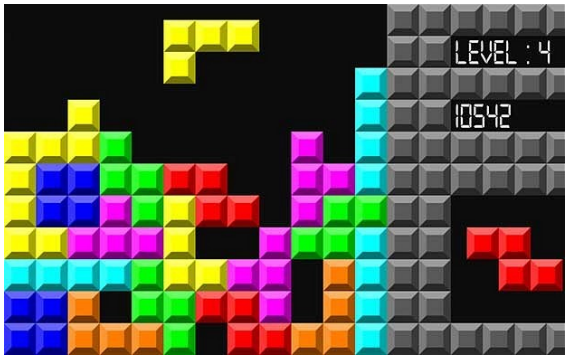
Casual video games and cognitive load

Part of the reason behind the calming effects of CVG's is their ability to amplify cognitive load (mental strain) in a way that remains both simple and fun, thus keeping arousal to a minimum. In doing so this provides a means of distraction from stress and negative thoughts.

Quite often CVG's rely on the spatial perception of objects and our ability to organise and rearrange their position to meet a purpose. This action places strain on our visuo-spatial working memory and is thought to interfere with stress inducing memories or thoughts (Stickgold, James & Hobson, 2000). In support, Holmes, James, Coode-Bate and Deeprose (2009) found that playing Tetris competed for working memory resources and inhibited memory recall performance.

There are other elements of Tetris also geared towards causing a higher cognitive load. Players must concentrate on positioning the current piece whilst simultaneously planning the following move with knowledge of what the next piece will be. This contributes to the 'split attention effect', when a task is performed which requires the division of attention, the strain on working memory increases (Chandler & Sweller, 1992).

The aspects of CVG's which enhance cognitive load are vital when implementing casual gameplay into calm VR experiences.



Tetris

Subtle physical movement

The most simplistic interactions involve slow, subtle movements with the body, head and/or controller. This level of input ensures arousal levels remain low to avoid over-stimulation and maintain a calm and relaxed state.

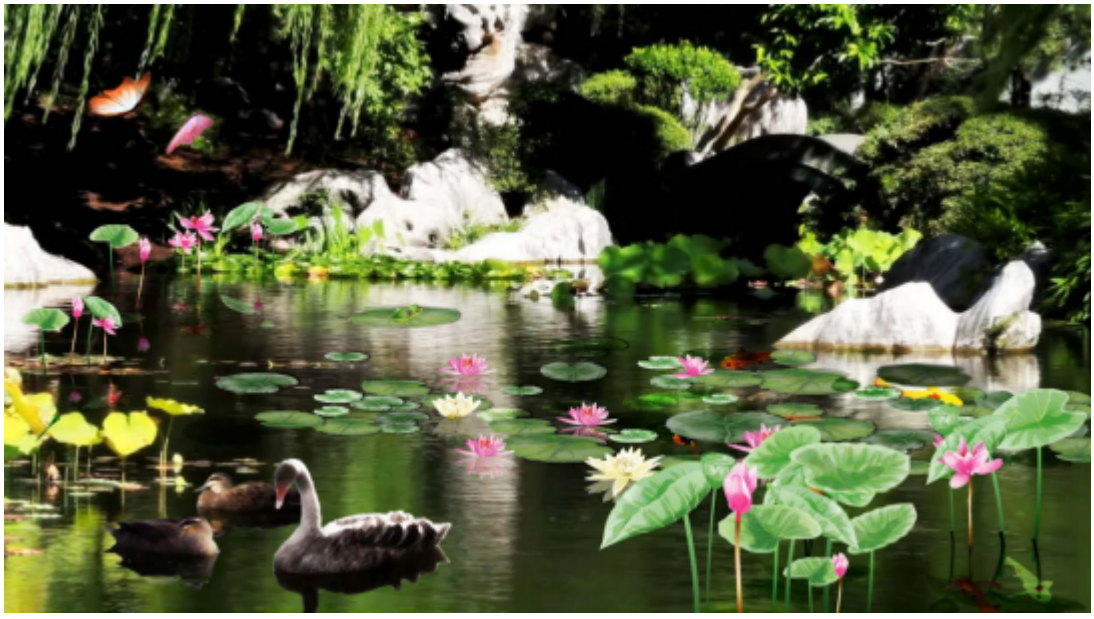
Examples from interactive art installations

Interactive art installations are multimedia artworks which combine therapeutic images, colour and sounds with basic interactive components affording both positive distraction and empowerment (Cooper, 2006). There are no gameplay components involved, rather users choose to animate virtual objects or animals as they please, offering an assortment of interesting and relaxing stimulation.

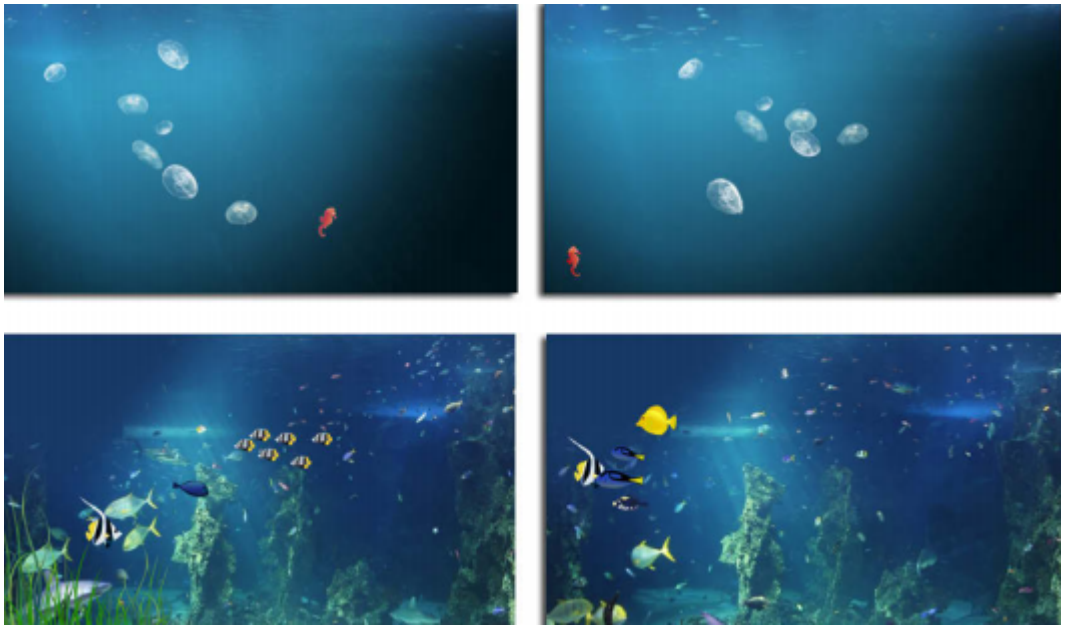
Chen (2011) created a portfolio of interactive art installations with a primary objective to engender relaxation and stress relief. Each theme presents various animations which users can choose to interact with using a simple click or press. Point and click or gaze-based selections within a limited field of view offer very subtle input methods.

Different themes and interactive elements created by Chen (2011):

Forest theme animations: Growing ferns, mushrooms popping up, growing flowers, waterdrops falling on leaves



Garden theme animations: Flying dragonfly, ducks and swans swimming, butterflies flying, frog jumping, waterlilies and lotus flower shrinking



Marine theme animations: Fish swimming and skipping stones and transforming clouds when viewed from the surface

Gameplay and interactivity › Energy

A passive approach

The VR experience ‘Apex’ from Arjan van Meerteen (House of Secrets) demonstrates an awe-inspiring level of intensity achievable without gameplay or interaction of any kind. Apex implements a powerful combination of visual effects and music for an energising viewing experience. The takeaway message here is that gameplay and/or interactive components are not necessary to produce an invigorating energy experience.

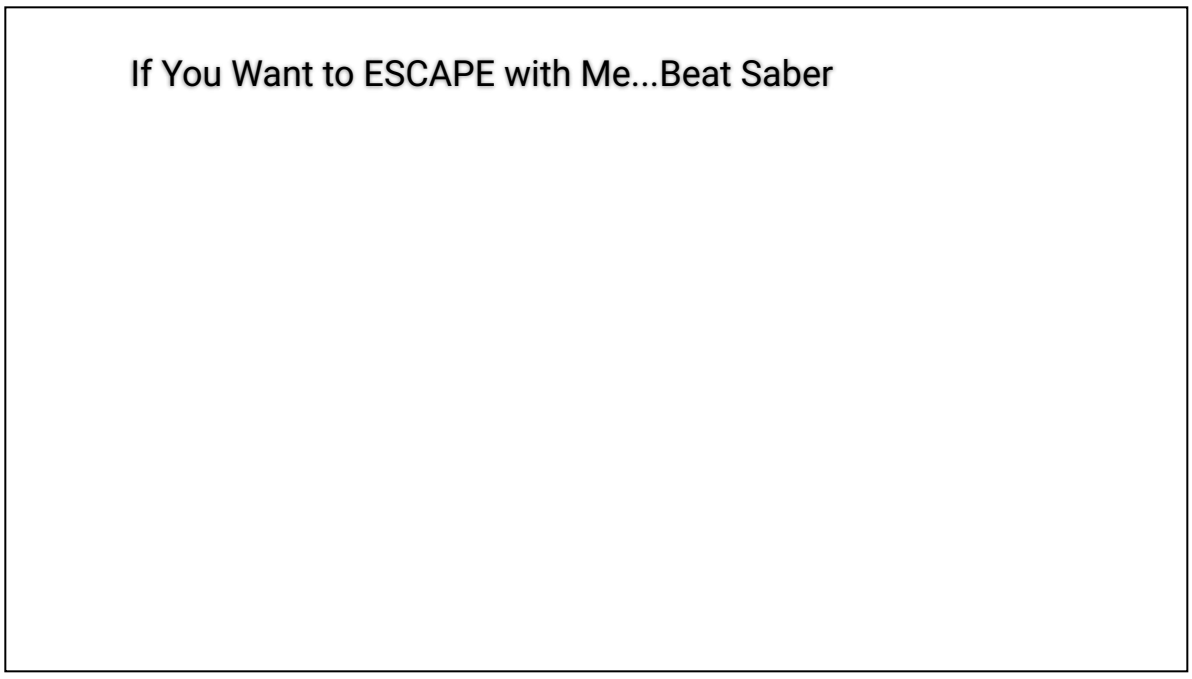
It's the End-times in APEX VR ~ Oculus Rift Virtual Reality Krazz...

Apex. To avoid spoilers, your first watch is highly recommended in VR. Available for download on Steam.

Dynamic movement mechanics

When interactions become fast paced and incorporate large scale physical inputs surrounding the user they instantly become more exciting. Our bodies respond and rise to the challenge of a more stimulating experience. This provides obvious advantages when increasing arousal for an energy experience, although limitations must be implemented to prevent fatigue.

The VR game Beat Saber takes full advantage of dynamic, alternating movement patterns to produce a highly stimulating and exhilarating experience.



Beater Saber (Hyperbolic Magnetism)

Symbolism

Interactions which symbolise an accumulation or growing surge of energy can serve as a powerful tool to enhance the energy response from VR.

In Ion, interactions are used to enable a sense of agency and control within the environment. The act of gathering up particles is a symbolic gesture as it leads to a continuous cycle of energy gathering. Powering up the energy 'balls' leads to a powered surge in the platform before landing in the final stage of the experience. In the final phase, the release of energy crystals into the sun (a prototypical symbol of energy) results in a series of explosions and expansion of the sun.

Gameplay and interactivity › Pain relief

The importance of interactivity

Interactions in VR have a major impact on the magnitude of pain relief an experience will provide. Wender et al. (2009) compared the analgesic effects of Snow World when subjects used an interactive compared to a passive version of the experience. Interactive components were enabled through a trackball which could be used to adjust viewing direction and shoot objects whilst traversing through a canyon. The non-interactive group did not have access to the trackball. Users of the interactive version of Snow World showed 75% greater reduction in pain unpleasantness and 74% more reduction in pain intensity than users of the passive version. The findings replicate that of prior investigations (Dahlquist et al., 2007), highlighting the necessity of interactions within pain relief experiences.

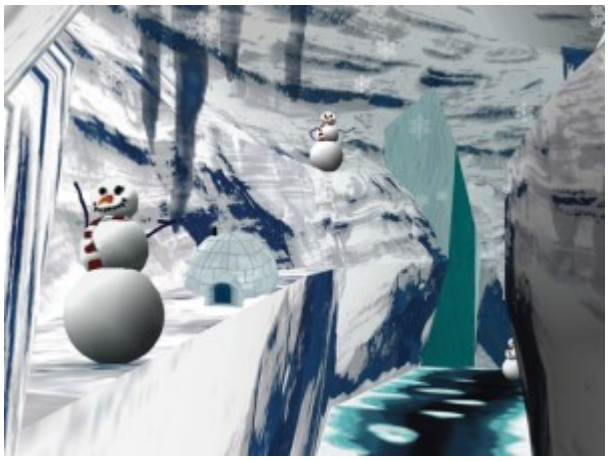
Gameplay intensity

Demanding gameplay for pain relief

Demanding gameplay can be characterised by games with depth and a complex set of objectives which require the recruitment of skills and often problem-solving abilities to succeed. VR games are renowned for their analgesic effects due to their ability to immerse players in engaging gameplay activities which successfully compete for our attention.

In a meta-analysis of pain relief studies using VR, Kenney and Milling (2016) compared the effectiveness of studies which used VR experiences developed for pain relief purposes (e.g. Snow World) vs. those which used 3D commercial games played in VR (e.g. Sonic and the secret rings). Although all the VR interventions were effective, the authors found no difference in pain relief produced by studies which used dedicated pain relief experiences compared to those which used commercial games played in VR. The fact that games created for entertainment purposes can produce analgesic effects comparable to

dedicated pain relief experiences highlights the significance of using demanding and fun gameplay features.



Snow World: Example VR pain relief experience developed at the University of Washington and now used extensively for the treatment of pain and assessment of the analgesic effects of VR in a multitude of studies

Sonic and the secret rings: Example commercial game set up to play in VR in a study by Sil et al. (2014). Created solely for entertainment purposes

Expansive physical movement

A recent series of investigations suggests that interactions become more effective for pain relief when they involve increased movement by the user. In one study, Czub and Piskorz (2014) compared the analgesic effects of a VR experience comparing interactions

conducted with a computer mouse (small movement) vs. bodily movements with a Microsoft Kinect sensor (large movement). Participants in the study showed a greater deal of tolerance to pain during the large movement interaction condition.

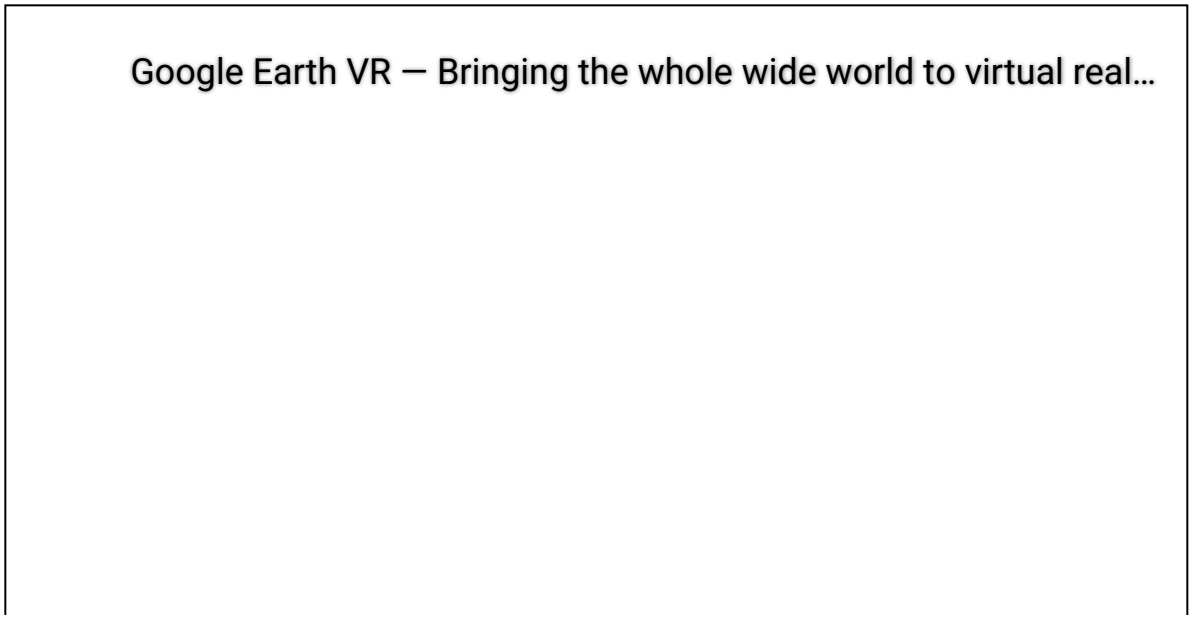
In another study, Czub and Piskorz (2017) found that decreased mouse sensitivity, corresponding with increased body movements to steer a VR game, was related to greater reductions in pain intensity compared to the high sensitivity mouse condition. The findings from these investigations suggest the use of interactions involving a larger range of motion for enhanced analgesic effects

Gameplay and interactivity › Awe

Awe-inspiring user interactions

Interactions within VR challenge our conception of what's possible and empower us to do extraordinary things. It is these types of interactions, those which instill a sense of power and control over our surroundings that induce a sense of awe. For example, in the final phase of Ion users shoot energy crystals into the sun, this in turn ignites an explosion similar to a coronal mass injection.

Google Earth VR provides awe-inspiring interaction capabilities which simulate flying and provide the ability to pick and choose desired locations to explore around the globe. This challenges every pre-existing schema we've had related to travel and exploration so much so that it's hard not to awe at your new-found abilities.

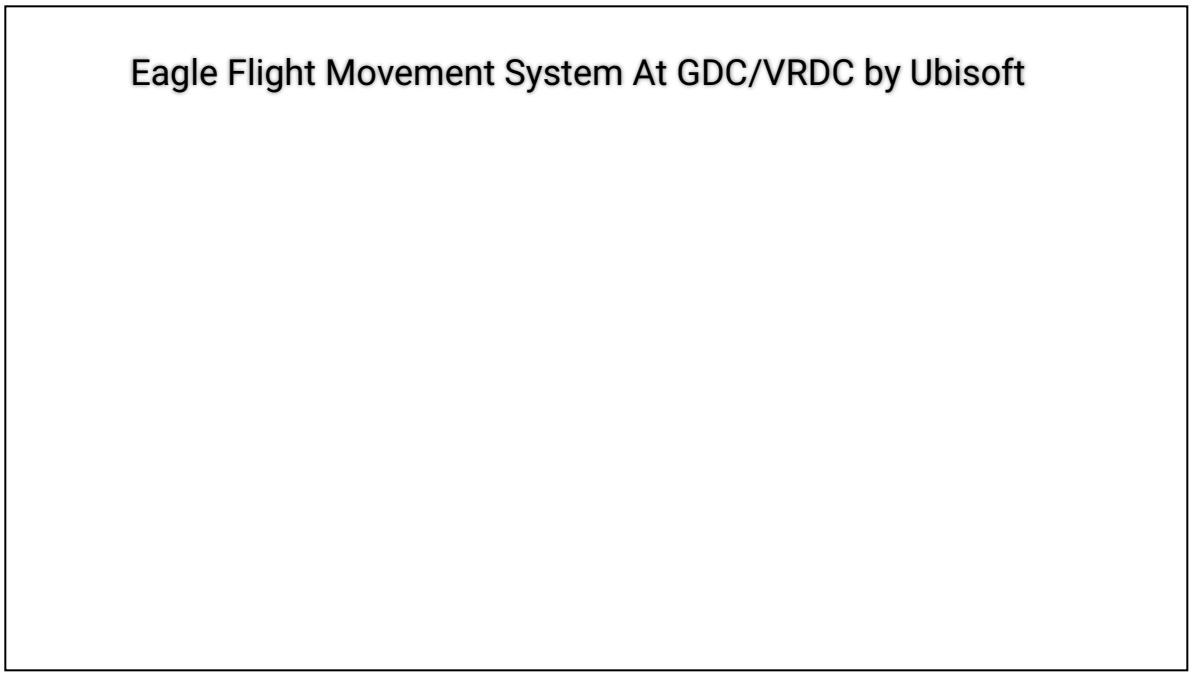


Google Earth VR

Quesnel & Riecke (2017) studied the effectiveness of Google Earth VR as a stimulus to induce awe. They found that 20 minutes of interacting with the experience was indeed effective at eliciting awe. The findings were evidenced by a large proportion of participants displaying goose bumps (40.3%) and reporting a high intensity for feelings of awe (79.7) on a scale of 1 to 100.

Interaction mechanics – flight

The use of flight for navigation purposes relies on a straightforward yet engaging interaction mechanic to enable control over direction and height. Head rotation methods may prove to be a highly engaging method for flight controls. See example from Eagle Flight.



Head-controlled flight movement in ‘Eagle Flight’ (Ubisoft)

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