EXPLORING MUSIC INDUCED ANXIETY IN VIRTUAL REALITY GAMES: A LITERATURE REVIEW

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Title	
Exploring music induced anxiety in virtual reality games: A literature review	

Subject	Level
Musicology	Bachelor's thesis

Month and year	Number of pages
Spring 2022	16

Abstract

In the growing field of *ludomusicology* (video game music studies), much like in musicology, the study of negative emotions has been long overlooked despite these negative emotions playing a major role in many of the most popular gaming genres. Most notably horror, a genre that often comes with soundtracks and sonic atmospheres that can only be described most aptly as anxiety inducing, has only a handful of studies relating to its distinct style of sound design. It is important to try to understand the mechanisms behind what makes us feel anxious about a video game, and how this kind of virtual anxiety affects us as the player.

In this study I will first shine light on some different views on how we might define anxiety as an emotion, and how exactly it functions within the context of horror games. The main questions I hope to answer are:

- What is anxiety and how it functions in the context of art and media?
- Can music induce anxiety?
- How anxious music works in the context of video games?
- How do we define immersion within the context of video games and how highly immersive VR-technology affects the experience of anxiety?

Depository University of Jyväskylä

Additional information

JYVÄSKYLÄN YLIOPISTO

Tiedekunta Humanistis-yhteiskuntatieteellinen	Laitos Musiikin taiteen ja kulttuurin tutkimuksen laitos
Tekijä Santeri Salmirinne	
Työn nimi **Exploring music induced anxiety in virtual reality games: A literature review**	
Oppiaine Musiikkitiede	Työn laji Kandidaatin tutkielma
Aika Kevät 2022	Sivumäärä 16

Summary

Pelimusiikin tutkimuksen kasvavalla kentällä, kuten musiikkitieteissä negatiivisten tunteiden tutkimusta on pitkään ylenkatsottu siitäkin huolimatta, että näillä negatiiviseksi miellettävillä tunteilla on suurikin rooli suosituimmissa peligenreissä. Erityisesti kauhupelit, joiden äänimaisemia voisi kuvata usein juuri parhaiten sanalla ahdistava, ovat saaneet osakseen vain kourallisen tutkimuksia, jotka keskittyisivät tähän omalaatuiseen äänisunnitteluun. Olisi tärkeää koittaa ymmärtää niitä toimintamekanismeja, jotka saavat meidät ahdistuneeksi videopelissä, ja että miten tämä virtuaalinen ahdistus vaikuttaa meihin pelaajana.

Tässä integroivassa kirjallisuuskatsauksessa esittelen eri näkökulmia siihen, miten voisimme määritellä ahdistuksen tunteena, ja miten se tarkalleen ottaen toimii kauhupelikontekstissa. Kysymykset, joihin toivon tällä tutkimuksella vastaavani ovat:

- Mitä on ahdistus, ja miten se toimii taiteen ja median kontekstissa?
- Voiko musiikki saada aikaan ahdistusta?
- Miten ahdistava musiikki toimii videopeleissä?
- Miten määrittelemme immersion videopelikontekstissa, ja miten vahvasti immersiivinen virtuaalitodellisuusteknologia vaikuttaa ahdistuksen kokemukseen?

Asiasanat ahdistus, musiikki, virtuaalitodellisuus, VR, videopelit, musiikki ja emootiot, negatiiviset tunteet, kauhupelit, immersio, pelimekaniikat
Säilytyspaikka Jyväskylän yliopisto
Muita tietoja

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1 INTRODUCTION

My first memory of video game anxiety comes from the year 2008. I was ten years old when my friend invited me over to play The Elder Scrolls IV: Oblivion (2006). The game had a tutorial which made you crawl through a series of caves and tunnels in order to escape a prison, and that was mostly all I ever got to play myself. It is fair to say that ten-year-old me was afraid of what I was about to come across, but I did not *fear* the caves. I was intrigued by the mysteries and adventures that the immersive fantasy world promised me, while also remaining alert and preparing myself for another giant rat that might jump out any second. The game was way too difficult to fully enjoy for a ten-year-old novice gamer, but it still left a deep impression. The creepy ambiance of the dark caves kept you on your toes, while a loud rhythmic orchestra made your heart pound during battles. This kind of sound design is not unique to the Elder Scrolls series and can be found in practically any game that entertains even slightly similar mechanics and ideas. Some other examples of anxious soundtracking might include the game Amnesia: The Dark Descent (2010), that spawned an entire genre of horror game youtubers in 2011, or the famously difficult Dark Souls series, that have become a game genre in their own right. During 2021 I got the chance to be involved in the creation of a soundtrack for a virtual reality game. What instantly intrigued my mind was how my previous gaming experiences would translate to this more immersive new technology.

Video games have hugely grown in popularity, and for example according to the Official Statistics of Finland, over 55% of Finns ages between 10 to 64 years old played video games at least once per year in 2017. This percentage is four times higher than it was in the beginning of the 1990's and only growing. (OSF, 2017.) Despite the surge in popularity of video games and hence video game studies, for example, KC Collins, a central figure in game audio studies, wrote as recently as 2008 that audio has been in her opinion neglected within the field of game studies (Collins, 2008). More recently game audio has garnered more interest from scholars, for example a more thorough overview on specifically music in video games was done by Donnelly, Gibbons, and Lerner (2014), but systematically and psychologically oriented studies on the subject seem to remain somewhat rare still.

Game audio has been a rather scientifically unexplored area for a long time, that resides in the cross-section of musicology (the study of music) and ludology (the study of games) (Collins, 2008). It deals with a lot of similar issues as the study of early silent film scoring, in which the music was tailored to the movie and had an important role in contextualising the chosen environment (Wierzbicki, 2008). The use of stingers, short musical excerpts that are used to represent a certain emotion or event within the game for example a victory, in both film and video game sound design can even be traced back to the use of leitmotifs of early 1800's opera (Bribitzer-Stull 2015, 8). What is separating video game music from more traditional mediums of musical storytelling is the interactive nature of video games compared to for example a viewing of an opera.

There are plenty of studies focused on horror games, in which fear and anxiety play a key role as a narrative element, and even a game mechanic that guides the player's actions (e.g., Lin, 2017). Horror games in particular are quite popular material in game studies, but for a genre so proficient at using sound design to elicit emotion (especially anxiety and fear), it is surprising that very little studies have actually been done that would explore the difference that music could have for horror games' (or any games' for that matter) ability to make one feel these emotions.

Anxiety is an often-overlooked emotion in game studies, perhaps because of its negative connotation, but many memorable musical excerpts of video games have songs of an anxiety inducing variety, take for example the Shepard tone (e.g., Vernooij et al., 2016) -inspired tune played while running up the endless staircase in Super Mario 64 (Nintendo, 1996), or my formative experience playing the tutorial in TES IV: Oblivion. This could be because fear, and by extension anxiety, has been studied to create perhaps stronger memories of activities than their more positively valenced counterparts (e.g., Izquierdo et al., 2016). The main difference between fear and anxiety is temporal, as fear is something that is experienced currently, while the response to anxiety is more long lasting (MacLeod & Rutherford, 1992). Anxiety also lacks a clear target, as fear of nothing is almost indistinguishable from what could be, by definition, anxiety.

In this study I will first shine light on some different views on how we might define anxiety as an emotion, and how exactly it functions within the context of horror games. The main questions I hope to answer are:

- What is anxiety and how it functions in the context of art and media?
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- How do we define immersion within the context of video games and how highly immersive VR-technology affects the experience of anxiety?

This study is in the form of an integrative literature review (Torraco, 2005), that aims to create an overview on the subject by collecting existing literature on related subjects and combining them. I've gathered literature by mainly using the jyu.finna.fi -search (that has access to databases such as SAGE and EBSCO among others) and google scholar. The material found could be divided roughly into three categories: music, video games and virtual reality, and anxiety. This also shows in the structure of my review, in which both anxiety and virtual reality have their own chapters in which both phenomena are discussed with an emphasis on how it all relates to music and music-related research. In the conclusion-part I will do a brief overview on the subject, and then create a synthesis on all three views.

2   ANXIETY IN ART AND MEDIA

Fear and anxiety are in some contexts defined as two facets of the same phenomenon, a response to a threat, whether imminent or not. Comparing fear and anxiety provides a good viewpoint into what distinct features anxiety has, and an explanation on why I specifically chose anxiety, and not fear, to examine within the context of horror game audio.

In clinical psychology high levels of trait fear, or trait anxiety, have both been commonly mapped under the umbrella term *anxiety disorders*, but neuroscientific studies show that a distinction between the two emotions could and should be made. Macleod & Rutherford (1992) define anxiety neuroscientifically as a heightened state of vigilance in anticipation or response to a threat where danger is not clearly imminent. This differs from fear in the sense that with fear comes a "freeze, fight or flight -reaction" that is the response to a clear and known threat. Another distinction between the two, is the duration of arousal. The heightened state of arousal caused by fear tends to be short lived, while the anxiety response is longer (Davis 1998). (Sylvers et al., 2011.) This view is also supported by the American Psychiatric Association who argue the following:

> *"Obviously, these two states overlap, but they also differ, with fear more often associated with surges of autonomic arousal necessary for fight or flight, thoughts of immediate danger, and escape behaviors, and anxiety more often associated with muscle tension and vigilance in preparation for future danger and cautious or avoidant behaviors."* (American Psychiatric Association, 2016. p.1)

This temporal distinction is also echoed by MacLeod and Rutherford (1992), as according to them fear is something that is experienced currently, while the response to anxiety is more long lasting. Anxiety also lacks a clear target, as fear of *nothing* is almost indistinguishable from what could be, by definition, anxiety.

The difference between anxiety as an emotion, and anxiety as a disorder seems to diagnostically be the frequency in which these anxious emotions are experienced, but the underlying mechanisms remain relatively similar (Banich & Compton, 2018).

Before we start discussing anxiety in other contexts it is important to highlight that there are some differences in whether we discuss for example musical emotions, or emotions in a more universal sense. Sloboda and Juslin (2001) mention two distinct perspectives to musical emotions: (1) the emotions that concern the aesthetic value of music, and (2) the emotions induced and expressed by music. However these two categories are not completely independent, and Sloboda and Juslin argue that finding the connection between the two aspects could be what psychological understanding of music needs. A common problem that the study of musical emotion often runs into, is the fact that, like our current example of anxiety, "emotional reactions are commonly understood in terms of their adaptive functions related to biological survival" (Sloboda & Juslin, 2001, p. 82). Emotional responses to music on the other hand are harder to relate directly to evolutionary survival, and this makes it harder to apply the existing survival-based models on music directly. (Sloboda & Juslin, 2001.) This problematicism is central to this study as well, in answering one of my main goals of finding whether we should discuss anxiety as being expressed or induced by musical content in video games or not.

2.1 Music induced anxiety

Cespedes-Guevara and Eerola (2018) point out that instrumental music is characterised by its inability to specify the object of the emotions it represents. According to for example Kivy (1999) Davies (2003) and Cross (2009) music's ability to represent affective experiences is restricted to the expression of object-less affective states. The fact that anxiety lacks a certain object would imply that the emotions expressed/induced by instrumental music are in fact moods by definition (lacking a clear intentional object). (Cespedes-Guevara & Eerola, 2018.) This loop comes around in the sense that by its very definition, anxiety lacks a clear target. Regardless of if you want to view anxiety as an emotion or as a mood within music, this discussion will rule fear out of this particular study, as music seems to not be able to induce the survival-based emotion of fear without some contextual help.

There have been plenty of studies that have found music itself can induce some emotional responses, for example Panksepp (1995) on the emotional source of "chills", and also on whether video games can induce emotional responses (e.g., Perron and

Schröter, 2016). There is even a study on whether or not virtual reality games can elicit and maybe even induce awe by Quesnel and Riecke (2018). It is worth mentioning that while anxiety is not such a distinctly higher order emotion (LeDoux and Brown, 2017) as Quesnel and Riecke's positively valenced and grandiose example of *awe*, it still works in a lot of similar ways to other emotions. The neurological mechanisms that underlie the fear–anxiety response are well studied, and often used as an example for the processing of emotional information and the role of the amygdala in processing threat-related stimuli (e.g., Banich & Compton, 2018; Aubé et al., 2015). The Aubé (2015) study observed a correlation between the activation of subject-specific amygdala responses to fearful music and vocalizations, but such a connection was not present for faces. Happy and fearful music both were found to cause stronger activation of the anterior *superior temporal gyrus* (STG), a brain region that is especially sensitive to music. What is especially interesting in this study, that this area showed to be in fact more sensitive to emotional intensity rather than emotional valence. They pointed out that similar studies had previously found out that the intensity of emotions correlates with recognition memory enhancement (the ability to identify a previously experienced stimulus or situation as familiar). (Aubé et al., 2015.) This is something I touched upon in the introduction, on how the elements that elicit fear and anxiety often seem to be very memorable. This could be the case for fearful/anxious music as well.

2.2   Music, anxiety, and pleasure

"Anxiety is an emotion characterized by feelings of tension, worried thoughts and physical changes like increased blood pressure. "
(American Psychological Association, 2022)

Anxiety can act as a game mechanic (Lin, 2017) instead of just being part of the overall mood of the game, and it does so by helping us anticipate future events (Bateson et al., 2011). The feelings of tension and increase in the amount of worried thoughts and blood pressure (APA, 2022) point towards a stress-kind-of reaction towards "the unknown future". Van Elferen proposes that one role of music in video games is to help the player navigate (van Elferen, 2016), and the idea that anxiety inducing elements could help the player anticipate future troubles and challenges could make anxiety inducing music a natural and effective guiding element. Similarly, anxiety inducing musical elements could help you feel uneasy about a character or an event,

or creating tension, thus acting as a narrative element, like is the more common use of anxiety inducing music in films.

Musical tension has been studied extensively (e.g., Fredrickson, 1995, 2000; Spangmose et al., 2019) and many argue that tension and release are key components to create meaningful musical structures (e.g., Schoenberg, 1975; Lerdahl, 2001). Release of tension and the fulfilment of anticipated events is linked to dopamine being released in the brain (Salimpoor et al., 2011) and this connection might be very interesting when discussing the appeal of the seemingly tense and anxious nature of horror games. The fact that anxiety makes us more prone to anticipate and predict future events is very interesting, since regarding music, memory and anticipation are studied to have a big role in what makes music pleasurable (van den Bosch et al., 2013). The brain areas that are activated while listening to familiar music are the same ones mediating decision making and retrieving long-term memories (Euston, Gruber, & McNaughton 2012). The fact that we might be able to determine there is something frightening coming up ahead just because the music is suddenly turning more "anxious" is very interesting, since not only does it help us navigate in the game, but it can also awaken our curiosity. We want to know if our schemas about this anxious music are right, since the fulfilment of expectations is indeed linked to the release of dopamine in the brain (Salimpoor et al., 2011; 2015.). I do not mean that anxious music is pleasurable for just creating expectations, but it could make us more inclined to remember previous anxious situations and schemas for those. This claim is also backed up by the previously mentioned study from Aubé and colleagues (2015) who discussed similar reactions reflecting emotional intensity to both happy and fearful music. The use of familiar horror game soundtracking tropes in game design could also mean that the more you play horror games, the better schemas you create for horror game music. Our brains work in a way that we try to predict what's coming, and that functionality has been studied to be what makes musical sounds rewarding to us (Salimpoor et al. 2015), and predicting is a lot easier to do if you have a good idea of what should happen. The familiarity of musical ideas and elements could also help our brain to transform the game-mechanical properties of sound smoothly from game to game.

While anxious and fearful music can be pleasant and pleasurable, it is often the case that horror soundtracks try to at least express displeasure to the listener as well. Known horror tropes, such as dissonant violins, horrid screams, and alien ambiance probably aren't the likeliest of elements to create a hugely successful pop song on their own, not to say that they couldn't be featured in one. The reactions towards aversive music have only recently been getting some attention from music scholars (e.g., Peltola & Vuoskoski, 2022; Merrill, & Ackermann, 2022), and the evidence seems to point towards the fact that while there are some distinct embodied experiences

towards aversive music, the aversiveness of a musical piece also shows itself as "perceived loss of agency and violation of social or moral attitudes and values" (Peltola & Vuoskoski, 2022, p. 172). Merrill and Ackerman (2022) found many types of specific reasons that people disliked certain music for through interviews including object-related causes, such as the music's structure being too unclear or predictable, or too predictable, or that they felt that the performance was off for example. Other typical reasons were subjective, like not being able to relate to the emotions portrayed by the music, and social reasons, like whether the listener thinks the music is accepted as 'good' by their peers or community. The Peltola and Vuoskoski (2022) study also found out that not everybody responds as strongly to aversive music as others. They identified two types of listeners: those who responded very negatively to unpleasant musical sounds, and those who had a more neutral attitude towards them. This is all just to say, that just because music in a video game is seemingly designed to cause displeasure or anxiety, doesn't mean that it cannot be a pleasurable experience to listen to, and that there is a heap of variables in what makes music unpleasant besides the use of negatively valenced themes and elements. This is a point often raised when talking about the appeal of heavy metal music (Thompson et al., 2019; Eerola et al., 2017), and it seems to be, not a question of whether this kind of negatively valenced music can cause pleasure, but *why* it can be pleasurable.

2.3 Anxiety in video games

There are plenty of studies focused on horror games in which fear, and anxiety play a key role as a narrative element, and even a game mechanic that guides the player's actions (e.g., Lin, 2017). When you play a horror game like Amnesia: The Dark Descent (2010), one might feel the emotions of fear and anxiety, both directed towards the main antagonists of the game known as the Gatherers. One key motive in the game is avoiding the Gatherers as much as possible and failing to do so causes unwanted effects or even the loss of the game. The game design uses anxiety inducing elements to help prepare the player to detect and deal with the threat of the Gatherers, very similarly to what Bateson, Brilot, and Nettle (2011) argue to be the function of anxiety on an evolutionary level:

> *"We argue that the function of the human anxiety response, and homologues in other species, is to prepare the individual to detect and deal with threats." (Bateson, Brilot, & Nettle 2011. p. 707)*

One closely related study is one done by Jih-Hsuan Tammy Lin, called "Fear in virtual reality (VR): Fear elements, coping reactions, immediate and next-day fright responses toward a survival horror zombie virtual reality game." Like the title suggests, the study explored players' coping reactions to fear elements in a VR game. The study found that the most common coping strategy to the fear elements presented was in fact *approach*. (Lin 2017.) Interestingly Sylvers et al. (2011) list *approaching* in their article as an experiential characteristic of anxiety rather than fear. In this context the characteristic *approach* is in reference to the defensive direction that the individual takes towards the possible threat. For fear the same response would be *avoidance* of the threat. "Sustained hypervigilance and prolonged hyperarousal while approaching several situations characterises trait anxiety." (Sylvers et. al., 2011.) It would seem logical for horror games to demand this sort of behaviour from the player, since if the player does not want to *approach* the challenge that the game has to offer, the experience won't happen. This can be attributed to the player's role in video games being more comparable to an actor, rather than an audience member (Calleja, 2011). This comparison however seems a bit off, because while the player is indeed responsible for acting in the game their focus is not usually on performance, but rather in experiencing the game themselves.

3   IMMERSIVE VIRTUAL REALITIES AND ANXIETY

As mentioned earlier, video games have one key difference when compared to more traditional media like movies and acted plays in the sense that the player often takes a comparable role to an actor in a play, where they themselves have an active role in how the experience will shape up. The consensus in the field seems to be that players "do not merely consume a pre-established piece of media, but instead are active participants in the creation of their experience" (Calleja, 2011, p. 56). This viewpoint is especially relevant when discussing virtual reality games, where the immersion is said to be even higher compared to a more traditional gaming experience. Some studies (e. g., Lavoie et al., 2021) even claim that theories concerning social anxiety could be considered relevant in this case, as the effect would then be more comparable to a real-life scenario rather than a gaming experience on a regular "2D-screen". So, to discuss if video games can actually induce anxiety comparable to real-life situations, and to see if music has any play in this, it is first important to discuss what the term *immersion* actually means, and how the heightened immersion affects the experience of modern *virtual reality*.

The term virtual reality has been used to refer to many kinds of virtual experiences from video games to some futuristic technology, but in recent years the term has become more and more associated with the technology that is being marketed as VR-headsets. The experience that these headsets provide are often referred to as *high immersion virtual reality*, due to their claims to a more immersive experience when compared to for example watching something on a digital screen. I think that Barret et al. (2021) said it well in the introduction to their study, that modern virtual reality environments use "interfaces that provide sensory immersion through visual and auditory stimuli as well as haptic cues that allow users to navigate as they would in the real world, with the digital setting responding to them." (Barret et al., 2021, p.1) Some commonly found examples of VR-headsets could be the Oculus Quest, or the Valve Index. A typical VR-gaming set has a display that completely blocks all

visual stimuli besides the game or experience itself, stereo headphones or built-in speakers for audio, and two controllers for both hands. The player can move and interact with the game through using the motion sensors that detect the movement of the hands and the head in all three dimensions, as well as using the buttons that can be found on the hand-controllers to move around and interact with the world. In this study, I will mostly be referring to these kinds of VR-headsets when talking about virtual reality in this study.

3.1 Immersion

In video game studies, the term *immersion* is used in a multitude of contexts and there doesn't seem to be a consensus on how exactly it should be defined. In its simplest use within the field, it most often refers to being immersed in a virtual reality, and it is often paired with the term *presence*. According to Calleja (2011) *immersion* specifically has been used regarding a multitude of media before video games, ranging from movies to painting, and within game studies researchers "have used the term *immersion* interchangeably to mean *absorption* or *transportation*" (Calleja, 2011, p. 167). Hence Calleja suggests that a more appropriate metaphor for what is commonly referred to as a mix of both *immersion* and *presence* would be *incorporation,* referring to us incorporating a virtual experience into our reality. He suggests this as a way to get around the issue of confusion surrounding the terms, while also taking into account the fact that even when we are "immersed" and "present" in a virtual reality, we do not suddenly forget everything outside the experience. The reason "we feel that we exist in the game world … is because the metaphor of habitation it provides has a sufficient fit with the experiential gestalts that inform being in everyday life" (p. 168). (Calleja, 2011.) It is important that Calleja uses the word sufficient fit here because immersion is not synonymous with "realism", even though it can often be used in that context for example in game marketing.

Despite the arguments against using *immersion* as a synonym for absorption or transportation by Calleja, the term is still commonly used in the field of game studies (e.g., van Elferen, 2016, Gallacher, 2013). This could be because of its prominent use in video game marketing (Calleja, 2011. p. 25), or just the fact that it is a bit more descriptive as a metaphor compared to incorporation. Funnily enough, the opposite of incorporation would be discorporation meaning to be without a material/physical body. This would fit the immersion-narrative of the game *companies* a lot better in my opinion, as they tend to reference immersion through terms like "leaving your 'current world' for a new virtual one". McGloin, Farrar, & Krcmar (2013) conceptualise immersion as "a feeling of virtual involvement" and they deem it an accurate

description in a context where the user's behaviour is "actually translated into the gaming environment" (McGloin, Farrar, & Krcmar, 2013). This definition seems relevant to my study as well, since McGloin and colleagues in fact studied the connection between immersion, and motion capturing controls, and modern virtual reality technology (like the Oculus Quest for example) very prominently uses motion capture technology on both hands as well as the headset. We should then discuss immersion in terms of different kinds of involvement, all influencing the total *immersivity* of a virtual experience. The multi-layered nature of immersion seems to be one of the things that scholars tend to agree on consistently, evidenced by examples such as the 6-part player involvement model by Calleja (2011), the fusion of Calleja's model (along with some other models of immersion) with the five strategic experiential modules by Mochocki (2021), and the 3-part musical immersion model by van Elferen (2016).

3.2 Musical immersion

At first glance it's hard to believe that music could have a positive effect on player immersion in a virtual reality. It seems irrational that video games that are spending millions on trying to achieve photorealism and life-like motion controls et cetera, are purposefully adding a feature that doesn't *usually* exist in the contexts or prevalence that it does in video games, background music. Jørgensen (2008) however claims that music is key in creating especially emotional involvement in a video game, and when examining the models of immersion listed in the previous chapter, there seem to be many aspects of immersion that overlap with some studied functions and effects of music.

Calleja (2011) divides player *involvement* into six distinct categories: (1) *Kinaesthetic involvement,* meaning movement and physical activities; (2) *spatial involvement* meaning the perception of the surrounding environment; (3) *shared involvement* meaning sharing and communicating experiences, as well as creating relationships; (4) *narrative involvement* referring to involvement in the narrative of the game; (5) *affective involvement* meaning emotional investment and how the player reacts to game play, before and after the game; (6) *Lucid involvement* meaning how the player views their choices in the game in terms of a goal/challenge the game, community, or the player themselves provides. Of these six categories, many overlap with the three categories of game musical immersion outlined by van Elferen's (2016) 3-part ALI -model, consisting of *musical affect*, *musical literacy,* and *musical interaction*.

Musical affect refers to the player's personal engagement in the music regarding memory, emotion, and how much they identify with the music. Van Elferen argues that emotional, affective engagement in music is a key element for musical immersion. Similarly, Calleja (2011) argues that emotional investment/engagement into gameplay is a fundamental element of immersion, and similar properties of involvement are featured in the model under *affective involvement*. Music's role in enhancing emotional involvement in video games is also highlighted by Jørgensen (2008) in her entry to the book *From Pac Man to Pop Music: Interactive Audio in Games and New Media* edited by KC Collins.

Musical literacy refers to how well the player can interpret and understand intended musical meanings and intentions. Van Elferen (2016) here gives the example of associating a low dissonant cello to an approaching danger when watching a horror film. This can be connected to Calleja's (2011) concept of *narrative involvement*, as music in many ways can heighten the meaningfulness of narrative elements, and thus create emotional engagement and weight into narrative elements (Jørgensen, 2008).

Musical interaction refers to the connection between music and the player's actions in the game. Some clear parallels from van Elferen's *musical interaction* can be drawn to Calleja's *kinaesthetic involvement* and McGloin and company's (2013) study on the immersive abilities of motion capture controls for example. The study found that the immersion that game controls provide is largely dependent on the player's actions being projected in the virtual world (McGloin et al., 2013). It would make sense that the player's actions would have an appropriate auditory response in the game world as well.

There is also some other minor overlap in the two models. *Musical interaction, literacy* and *affect* all deal in similar areas of a gameplay experience that form *lucid, kinaesthetic*, and *spatial involvement*. For example, sound design might affect whether the player will be more inclined to stop and wonder the world, or if they feel like the goal is going as fast as possible to the next stage. Some actions might also have an unpleasant sound effect added to deter the player from performing them, and some actions on the other hand might be very pleasant.

So, in a nutshell music alone cannot make a video game immersive, but when a game ranks high in all of the different categories of involvement, the role of music as a game mechanic, and an emotional and narrative tool cannot be overlooked when creating immersive and meaningful virtual experiences.

3.3 Realism or immersion?

"This feels so real!" Those are the words that you might hear someone say when they try playing a game with a VR headset for the first time. It happened to my musicology studying friend too, when she tried playing Half Life: Alyx (Valve Corporation, 2020) for the first time with the Valve Index -headset. She ended up getting spooked by what she thought was but a lifeless corpse, tried hitting it with her hand, and "in real life" smashed her hand on the bookshelf. Now this of course is analogous but still, it raises a good question. How real do we perceive virtual reality to be, if at all?

A recent study has gone as far as to suggest that virtual reality games could cause real-life PTSD (post-traumatic stress disorder) -like effects on players (Lavoie et al., 2021). The paper suggests that "VR's ability to enhance absorption into gameplay, will increase the importance of the gameplay and the subsequent intensity of emotions that are experienced, including negative emotions." (Lavoie et. al., 2021. p. 73.) This effect, when combined with the added emotional involvement that video game soundtracking can provide (Jørgensen, 2008), could make virtual reality games a very potent medium for emotional elicitation especially when compared to some more established counterparts like film, music, and opera, and then if the experience is immersive enough, the subjective experience of the player could be very similar to a real-life scenario. This effect also works the other way, and Diemer et. al (2015) found that being emotionally affected by a game, leads to a higher sense of *presence*, a key component in immersion as listed by Calleja (2011).

Now, while studies such as Lavoie et al. focus on the negative effects, the flipside of the coin is that the immersive nature of VR can make positive experiences more powerful as well, as the involvement in digital games forms a continuous feedback-loop between the player and the game (Calleja, 2011). Wilson and Soranzo have argued that virtual reality can lead to the player exhibiting realistic behaviour (2015), and there seems to be a consensus among scholars that VR-technology has many possible therapeutic applications in simulating real-life scenarios as well. There are plenty of studies using VR to simulate emotional situations and it is being used to treat for example different anxiety disorders (e. g., Kwon et al., 2013; Carl et al., 2019). Despite these real-life simulating applications of VR, not everything works in VR as it does "in real life". One example of this would be the result of a study by Syrjämäki, Isokoski, Surakka, Pasanen & Hietanen (2020) who found out that eye contact specifically failed induce the same levels of physiological arousal in VR as in real life. This would support the obvious-sounding idea that despite the heightened sense of realism that VR offers, there are still plenty of experiences that we can't simulate in VR with the same results as in real life.

4   CONCLUSION

So, how does this all relate to anxiety? Well, anxiety is an emotion, and like we learned earlier the more immersive a virtual experience is, the higher the emotional involvement, and vice versa. Emotional responses to music have been linked to a more pleasurable experience (Salimpoor et al., 2009) as well, so while an anxious musical experience can make feel even more anxious with the help of highly immersive VR, it can also be a more pleasurable experience. Good anxiety-inducing sound design can also help the player anticipate and prepare for threats and navigate the game environment without the need for visual cues for example, thus increasing the immersive potential of the experience in that category of involvement. With the heightened emotional involvement (Calleja, 2011), and the use of VR technology even in therapeutic settings (e. g., Kwon et al., 2013; Carl et al., 2019) in mind, I feel like it has also been appropriate for this review to talk about *induced emotions* instead of *expressed emotions*, especially in this context of highly immersive virtual reality games.

The heightened sense of realism that these highly immersive virtual reality technologies provide also comes with a responsibility, since as the experiences become more and more life-like, the possibility of a game to inflict lasting psychological effects on the player might increase. If a technology can be used in therapy to help with psychological problems, there is good reason to assume it has the power to do the opposite as well, although most commercial VR-experiences still remain well in the domain of fiction and are seen and experienced as such.

The immersive nature of video games opens up plenty of avenues towards the study of emotions and music. The problematicism of applying the often-survival-based psychological emotion theories to a non-survival-based medium like music is alleviated in the context of VR through the evidence that suggests that VR can simulate real-life situations and elicit some emotional responses comparable to real life situations. The fact that music seems to be a natural addition to these VR-environments is in my opinion very much indicative of similar processes and

mechanisms in how music works, and how these other emotional and mental processes work, and this could lead to new studies that aim to further map out the common ground between general emotion theories and musical emotion.

The goal of this review was to highlight some potentially interesting fields of study regarding anxiety and anxiety-inducing virtual reality games. The observations and connections I've made are intended as nothing more than starting points for future research, and many of the areas and potential issues I've discussed are characterised by a lack of peer reviewed studies on the specific subject, although many closely related areas of research are blooming. This review however gives me good confidence that these kinds of interdisciplinary questions can and should be studied in more detail, and that the work has a lot of potential in creating a deeper understanding in the closely related, more mainline fields of musicology, ludology, and psychology as well.

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