Pursuing pleasure through fear:

Can being scared in the virtual world make you happier in real life?

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Abstract. Fear is considered a valuable emotion, evolved to provide protection and incentive to escape from potential danger. However, modern humans strive to create narratives that purposely provoke thrill and distress. But why is it that we actually enjoy emotions that are supposed to be unpleasant? This study aims to explore the mechanisms involved in the generation of fear and fear-related euphoria through new media applications. Arousal is hypothesized to be one of these fundamental mechanisms. The excitation transfer theory states that once a person is physiologically aroused due to an excitatory event, this arousal persists after its termination and can facilitate a subsequent elicited emotion in an additive manner. Accordingly, physiological arousal due to horror gameplay in Virtual Reality (VR) as opposed to conventional desktop play is inspected. To fulfill this study's requirements, a horror computer game was created. Subsequent to the horror game, the participants' laughter response during a tongue-twister session is compared between the two conditions. A total of 46 individuals participated in the current study. Throughout the experimental practice, arousal-related data derived from skin conductance measures where gathered. Furthermore, self-report data referring to perceived arousal and valence before the onset of the experiment, after the gameplay and subsequent to the laughter session were collected. Results indicate that VR is indeed a more fitting medium for arousal generation and negative valence induction as opposed on a conventional monitor. Despite that, no significant difference in arousal and valence was found between the two conditions during the laughter session. Results suggest that while VR horror-gameplay is more intense than desktop gameplay, it doesn't necessarily facilitate subsequent positive emotions to a greater extent.

1 Introduction

"*For as long as we've gathered by campfires, humans have always loved a good scare*". (Kerr, 2015)

Emotions have been evolving for millennia as adaptive functions serving the well-being of the organism. However, humans as master-toolmakers have created novel avenues through which they could manipulate those archaic functions and use them in perplexing and obscure ways. But why is it that we actually enjoy emotions that are supposed to be unpleasant? Can it be because the experience of intensely good and intensely bad emotions is not that different in respect to their underlying mechanisms?

Fear is in the center of emotion research since its birth and is regarded by a plethora of researchers as one of the basic human emotions (e.g., Ekman, Ellsworth & Friesen, 1972; Izard, 1992, Plutchik, 1980). That is partly because fear is considered as a valuable emotion, evolved to provide protection and incentive to escape from potential danger (Bowlby, 1973). But since fear, even though beneficial, is associated with harmful experiences, why is it that humans actively seek it? From folk tales to roller-coasters, horror games and haunted attractions, humans have created cultural channels made to provoke thrill and distress. Deeply rooted in the heart of tradition and entertainment, there is evidently something about it that accommodates pleasure.

Excitation transfer theory provides a plausible explanation. Architected by Dolf Zillmann in 1966, this theory proposes that if one is physiologically aroused - through the experience of an emotional event or by non emotional means such as exercise - and afterward is placed in an emotion-provoking situation, the arousal experienced in the first condition will transfer to the subsequent one and amplify the associated emotional experience (Zillmann, 1983). That is because the experienced arousal briefly persists after the termination of the excitation-eliciting event and can promote the intensity of a shortly following one. When such residual arousal occurs along with an emotional event, the *misattribution effect* takes place. In this, "the search for the cause for perceived bodily changes ends as soon as an appropriate probable cause is found" (Reisenzein, 1983). Therefore, the residual excitation is thought to work in an additive fashion with stimulation from a subsequent emotional event (Cummins, 2017). An important aspect of this theory is that the occurring arousal is not positive or negative in nature and thus, can facilitate emotions that are traditionally thought to be opposite. Along these lines, the notion that positive affect (PA) and negative affect (NA) constitute two bipolar opposites is considered obsolete as it "provides a parsimonious fit to existing data" (Russel, Carroll, 1999).

In this study, the efficacy of emerging, interactive media in the application of excitation transfer theory is examined. In particular, the utility of Virtual Reality (VR) gameplay as opposed to conventional desktop play in the generation of fear and therefore, the generation of arousal is inspected. Subsequently, the facilitation of the induced arousal to a following non-media related positive emotion is studied. Since excitation transfer is a well-researched topic with robust findings that promote its validity (Cantor, Zillmann, & Bryant, 1975; Meston & Frohlich, 2003; Jeong, Bohil, & Biocca, 2011), this research does not aim at testing its efficacy. Instead, following a multidisciplinary approach, immersive media and emotion research are recruited intending to shed light upon the paradox of fear enjoyment.

Although films and music are often used as emotion-eliciting stimuli in emotion research, one has to wonder if VR is similarly or even additively effective. In a recent study (Estupiñán, Francisco et al, 2014), VR is found to be a fitting method for emotional response enhancement, especially arousal and valence. To further consideration, videogames and horror can substantially complement each other since many of the classic horror elements lend themselves well to this interactive medium (Rouse, 2009). By combining the two, one can suggest that a VR horror game would be even more successful in fear generation compared to a traditional desktop approach. Since more intense fear correlates positively to enhanced arousal, it is expected that VR will be more efficient on the application of the excitation transfer theory. This encourages further research on the topic and inspires exploration towards a relatively uncharted territory.

While the general public looks at horror games and films with suspicion, the broad appeal of the genre appears opposing to such concerns. Literature does present instances where horror content negatively affects specific demographic groups (Ballon & Leszcz, 2007; Nemeth, Scheres et al, 2015), however, not much has been found in relation to virtual fear and its real-life impact. Many anxious individuals seem to find comfort in horror content since it provides distraction from constant concerns (Zakarin & Puranik, 2017; Moss, 2017) and other testimonies point out the soothing effects of horror during a period of grief (Fletcher, 2018). In a more general view, the above present an interesting pattern: not only the way we feel dictates our choice towards horror content but also, fearful virtual narratives shape our real life. Therefore, it seems compelling to wonder whether playing a horror videogame would be able to reinforce a subsequent real-life positive affect within a controlled environment.

Accordingly, an experimental setup was designed to test the above question. For this, a horror game was created following the inquiries of the present study. This game was developed to equally serve both VR and desktop gameplay. This provided the opportunity for VR and more traditional technologies to be studied in opposition based on their abilities to generate arousal and NA. Accompanying the above, a real-life interaction was conceptualized intending to generate laughter and ultimately, examine the effectiveness of excitation transfer amidst the virtual and the real world. Throughout the experiment, psycho-physiological and self-report measures were acquired from the participants. Pursuing the direction of interest, this study was performed with the following research question and hypotheses in mind:

Can a negative affect, experienced in virtual reality, promote a subsequent real-life positive affect?

H1: Participants will report experiencing more NA in VR compared to desktop play. Psycho-physiological measures will indicate increased emotional arousal in VR.
H2: Participants that played the game in VR will report feeling more pleasant and aroused during the laughter session. Psycho-physiological measures will indicate increased emotional arousal after the VR gameplay.

The remainder of this paper is organized in four distinct sections. Section 2 goes through the theoretical foundation that helped support the conceptualization and implementation of the current study. Section 3 describes the design, methods and tools that were used in the experimental sessions. Section 4 demonstrates the obtained results and the analysis methods while section 5 provides a discussion of the conclusions and future research.

2 Theoretical Foundation

The following section will review important elements of scientific literature that were incremental in the development of the current study. Following a multidisciplinary approach, emotion science, media studies and media psychology are recruited to outline a fundamental understanding of the discussed subject.

2.1 Emotions

In order to understand fear as well as pleasure, a more general understanding of emotion and its mechanisms appears necessary. Four predominant theories attempt to explain emotion while each, views the matter from a different angle. Charles Darwin (1873) and Paul Ekman (Ekman & Friesen, 1971) conducted research on facial expressions and concluded that emotions must be adaptive functions that all humans share in a universal scale. On the other hand, James Averill (1980) argued that emotions are socially constructed within each culture, serving its specific needs. For William James, the experience of emotion prerequisites the experience of "bodily changes" that are directly initiated by the perception of an emotion-eliciting stimulus (James, 1884), while Magda Arnold (1969) and Stanley Schachter (Schachter & Singer, 1963) emphasized the role of cognitive mechanisms that take place before and after such physiological arousal. Today, emotions are considered as "complex programs of actions triggered by the presence of certain stimuli, external to the body or from within the body" (Damasio, 2011) and all the above statements appear as valuable pieces of a puzzle that in conjunction might reveal a clearer view on what an emotion actually is.

While the sequence in which the emotional experience occurs is still under discourse, all accepted theories agree that physiological changes must be an integral part of such process. As William James put it more than a century ago: "*Emotion dissociated from all bodily feeling is inconceivable*" (James, 1890). The responses of the autonomic nervous system are actually quite specific, with different patterns of activation characterizing different emotional states (Purves & Williams, 2001). However, these autonomic patterns even though distinct, can resemble each other quite a lot and their distinction is often inaccurate when testing multiple individuals. Nevertheless, biological indicators that propose an emotional experience do not necessarily suggest the "feeling of emotion" or reveal its subjective interpretation. In this, other cognitive processes are at play and for the most part, they are opaque to the researcher's eye (Fox, 2008).

The excitation transfer theory relies both on physiological responses and cognitive mechanisms that must be meticulously coordinated; they are both fundamental parts that operate in equilibrium. First, an excitatory stimulus must generate sufficient physiological arousal as to initiate the sequential process. This arousal will persist for no more than five minutes after the completion of the first excitatory stimulus (Cummins, 2017). Therefore, the second emotional stimulus must begin within this time-window (Figure 1). However, if this second stimulus takes place too soon after the initial one, the misattribution of arousal to the second emotional event will not occur. For this, the individual must omit the original excitatory source and actively inspect the environment for a probable cause to his/her arousal. When a fitting explanation is presented -second stimulus-, the individual will attribute the felt arousal to the following event. With the help of this residual arousal, this final event and its emotional imprint will be experienced more intensely.

Excitation transfer has been extensively studied within the media psychology and advertising fields (Jeong, Bohil, & Biocca, 2011; Cummins & Nutting, 2012). Nonetheless, contemporary research has mostly focused on efficient product placement or the negative behavioral effects that media content and games might present subsequent to their experience (Jeong, Bohil & Biocca, 2011; Perse, 2000; Adachi & Willoughby, 2011;

Arriaga, Esteves et al, 2006). A general bias towards the consumeristic and negative effects of excitation transfer theory dominates most modern research that in truth, has grown relatively stagnant.

A quick look into the literature, evidently reveals that emotions are complex structures that can occur or be manipulated by both bottom up and top down mechanisms. Hence, one's bodily states can influence or initiate an emotional experience. Yet, higher-order cognitive processes can generate and direct emotion likewise.

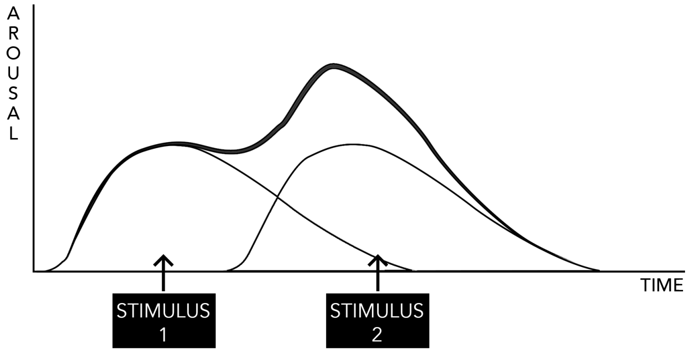

Figure 1: Time course of excitatory activity.

2.2 Fear & Pleasure

Pleasure and fear are both basic adaptive functions that can be found across the animal kingdom (Panksepp, 2011). The first serves as a protector while the second accommodates reward directed exploration, reproduction and social/maternal bonding. Nevertheless, pleasure is an umbrella term that describes various distinct states and interactions. One can feel pleasure during the consumption of tasty food, listening to music, social interaction etc. While this list can be quite long, one can identify distinct behavioral expressions that correspond to each pleasing experience. Laughter, is one of those expressions. Although laughter is a very common social signal amongst humans, similar behavioral patterns and vocalizations have been registered amongst a small number of mammals like apes and rats (Panksepp & Burgdorf, 2003; BBC, 2009). In all its diverse forms, laughter *usually* communicates pleasure and might be one of the most distinct expressions of delight. Karl Pfeifer (1994) opposites this notion suggesting that "laughter does not have to have pleasure as its causal antecedent" and that it can be imitative, nervous, hysterical, physiogenic etc. Nevertheless, when laughter is accompanied with a positive affective state, then it must be its expression. This study is concerned with *mirthful laughter* that only occurs under pleasant and humorous situations.

While pleasure can be a demanding research subject -mainly because of its diverse forms and expressions- fear is a well-studied emotion that attracts a lot of scientific interest. From normal fear to traumas and phobias the scientific community has put effort to delimit its sources and expressions. When one is afraid the autonomic nervous system shifts to its sympathetic mode -more commonly called fight or flight-. The amygdala becomes highly activated and releases chemicals that prepare the body to fight danger or escape it. Respiration and heart rate accelerates along with blood pressure that directs blood to the skeletal muscles and away from the intestines. Finally, perspiration increases and cognitive controls subside (Ops, 2016).

The whole body is aroused under fear conditions however, this is the case with laughter too. "Laughter is a whole-body experience" (Evans, 2018). The limbic system within the brain, including the amygdala and the hippocampus is activated when we attend to a funny joke. Then this activation is passed on to the motor region that in turn sends signals to the body and produces the physical reaction of laughter. In this, the facial muscles contract along with the abdomen and respiratory muscles. The heart rate and respiration accelerate and becomes irregular (Karthikeyan, 2017) while cognitive controls recede (Evans, 2018). Evidently, the human body experiences both laughter and fear in a similar, intense manner.

Both fear and pleasure have been consistently considered as core dimensions of emotion (Kringelbach & Berridge, 2017; Ekman, Ellsworth & Friesen, 1972; Izard, 1992, Plutchik, 1980) and while the first would be intuitively thought as a negative state and the second as a positive one, it is evidently not as simple. Research suggests that people do experience pleasant and unpleasant emotions at the same time, experiencing the world through more complex structures (Russell & Carroll, 1999;). While one could look into psychology, philosophy (Bloom, 2011) or neuroscience (Shaw, Bramham et al, 2005) to shed a light upon this paradox, looking into our everyday experiences might provide an even more comprehensible guide to our subjective states.

2.3 Horror

Horror, an "immensely resilient" (Carroll, 1990) genre has profoundly arisen in popularity over the last decades. From novels, to films, theatrical plays, attractions and videogames, people dedicate time and money to be voluntarily scared. Carroll (1990), studying the horror genre as a "transmedia" phenomenon referred to it as a "paradox of the heart". With that he meant that the mere existence of horror is quite paradoxical therefore, there must be something about it that we greatly enjoy and that makes it so widespread across media and cultures.

Defined by its intention of causing the physical reactions associated with fear, the horror genre is described as a "body genre" (Williams, 1991). Progressing further on this idea, Perron (2009) referred to horror games as an "extended body genre". In agreement, Rouse (2009) proposed that this additive relationship between horror and games is due to the interactive nature of the later. Recently, due to the availability of the VR medium to the wider public, the conjunction of horror and immersive technologies has generated both concerns and enthusiasm amongst the scientific community (Crecente, 2017). As Tanya Krzywinska put it "horror is one of the few genres that VR really suits" and Sergio Hidalgo added that "the horror genre is built on immersion". Yet "when the headset is on, there is seemingly no escape" (May, 2016).

2.4 Immersive & Real

Modern people live their day-to-day lives on the verge between physical and digital. We manufactured parallel realms where digital media act as real-life actors. With a large portion of our cognitive resources dedicated to that, one has to wonder whether the border between physical and virtual has been blurred beyond perception.

The term immersion and spatial presence are often used to describe that almost real-life experience accompanied with vivid emotions occurring within a virtual world. Videogames, offer an enhanced state of spatial presence and that is because of their interactive nature. Spatial presence or immersion occurs when "media contents are perceived as "real" in the sense that media users experience a sensation of being spatially located in the mediated environment." (Wissmath, Weibel, & Groner, 2009) When a narrative -in this case a videogame- is immersive enough, the user feels that he/she is "there" in the virtual world and his/her choices and emotions make sense in the context of the imaginary rather than the real (Madigan, 2012). Lynch and Martins (2015) argue that videogames' interactive elements are possible because of an enhanced state of presence. Therefore, a closed loop might occur between interaction and immersion.

Wirth et al (2007) have grouped that characteristics of games that facilitate immersion into two categories: richness and consistency. *Richness* describes a) the multiple senses that the game engages, b) the completeness of the sensory information, c) the amount of cognitive resources that are demanded and d) the engagement that the narrative attracts. *Consistency* refers to a) the congruity of the visual cues within the game, b) the consistency of the elements' behavior, c) the coherent presentation of the game world and d) the interactivity that it offers. With the above in mind, immersion does not only regard the design and narration of a videogame but also the medium through which is it experienced. In this, VR has a vantage point since it can engage the user's senses to a larger completion, exclude real-world intrusions to the virtual world and ultimately, occupy more cognitive resources. In agreement Jiménez et al (2018) suggest that "VR has the potential to elicit strong emotions in players", however, "there is a lack of comparative studies offering empirical evidence" (Jiménez, James, Maureira et al, 2018).

Research in the field of media psychology is actively trying to determine what immersion really is, how and why it occurs. In the meantime, game developers and technology makers are on an arms-race with real-life qualia; the more real the better. While advantages in technology offer increasingly engaging virtual interactions one has to wonder the impact that this might have on traditional, non-mediated real-life interactions.

3 Design, methods and tools

At the onset of each experimental cycle, each participant was requested to complete a short survey. In this, age, gender and previous VR exposure were inquired. Additively, smoking habits and coffee consumption within the last three hours were specified by the participants. These last data, when paired with the psychophysiological measures would help identify outlying results (Berntson, Cacioppo & Tassinary, 2017; Braithwaite, Watson et al, 2013). Subsequently, participants were asked to indicate their current, perceived emotional state within a 9x9 valence-arousal affective grid (Russell, Weiss & Mendelsohn, 1989). A short tutorial was previously provided confirming that each individual was adequately informed and understood the purposes and usage of the presented grid. Subsequently, each participant played a -VR or desktop- horror game that was specifically developed for the current study. After the gameplay session, participants were once more asked to indicate their during-the-game emotional state on the valence-arousal grid. Afterwards, a three-minute intermission between the gameplay session and the successive laughter session occurred. In this, participants involved in casual conversation with the author prompting distraction from the in-game impressions and aiming at the actuation of the misattribution effect in the following session. Thereafter, each participant participated in a laughter session in which he/she was asked to audibly and with increasing speed, read a set of tongue-twister rhymes interchangeably with the author. Following that, participants were asked to once more indicate their current emotional state on the valence-arousal grid. At end of the experimental cycle a single-question survey on horror game/film appreciation was completed by each participant. Throughout the length of the experiment, the participants' electrodermal activity (EDA) was recorded as a useful indicator of the sympathetic system's activity and in extend, an index of arousal. A schematic that outlines the testing environment and experimental setup can be found in Figure 2.

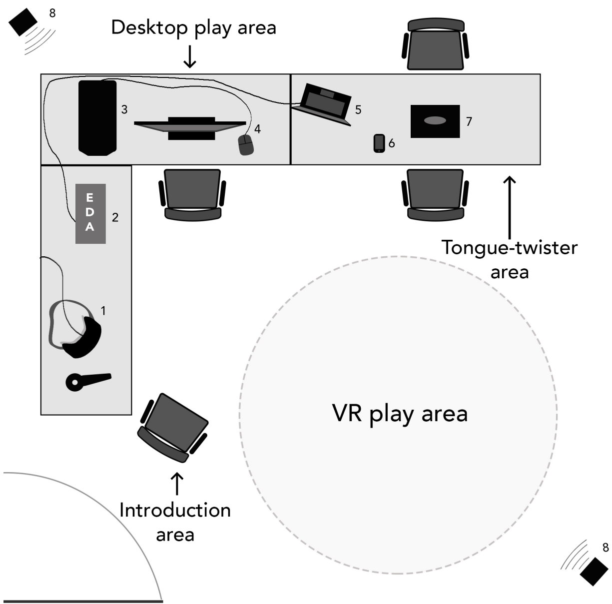

Figure 2: Schematic of the testing environment and setup.

1) VR headset and controller, 2) Biopac EDA sensor, 3) Gaming computer, 4) Screen and mouse used in the Desktop condition, 5) Laptop receiving EDA data from sensor, 6) Mobile device used for the surveys, 7) Vault containing the tongue-twisters for the laughter session, 8) Laser room-scale sensors used in the VR condition

3.1 Virtual staging and game design

"Terror… is rather identified with the more imaginative and subtle anticipatory dread. It relies more on the unease of the unseen. The most common time of terror... is night, a great absence of light and therefore a great time of uncertainty"
(Rockett, 1988)

Engagement is essential to a cohesive game experience. To facilitate the needs of the present study the game experience had to be kept short, succinct and intuitive but nevertheless, engaging. Therefore, the game's narrative was presented through environmental story-telling (Jenkins, 2004) (Figure 3.b) as well as visual and auditory hints. The player is gradually informed about the game's objectives through the use of textual on-screen messages (Figure 3.a, 3.c, 3.e, 3.f) and illuminated environmental guides (Figure 3.d, 3.e, 3.g). Originally, auditory directions were considered but were quickly disposed as they evoked attentional distraction and prompted technical obstacles. The designed VR experience has minimal interaction and a low level of task difficulty allowing for an analogous gameplay amongst diverse age and social groups. All in-game events were carefully timed, seemingly directly interacting with the player but in reality, the participant is unable to change the course of events. In that manner, all participants have an almost identical virtual experience and therefore, a standardized experimental design could be established. As a reference, a video recording of a full-length gameplay[1] is included in this paper.

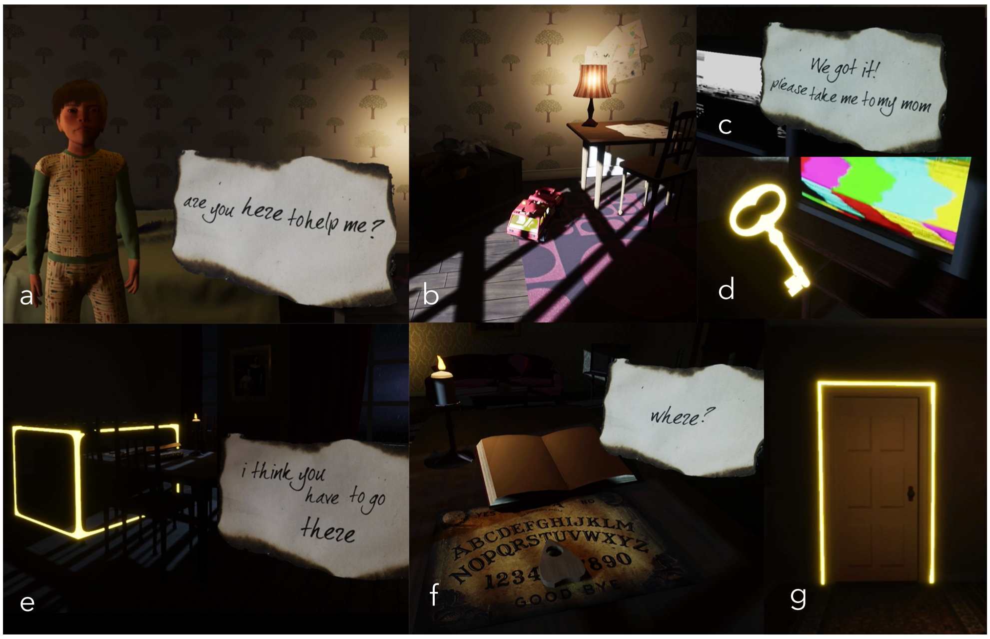

Figure 3: Example of in-game narrative elements from the players point of view.

a) Introduction to the character, b) Example of narrative elements in the child's room, c) Example of a guiding message, d) Illuminated view of the key, e) Guiding message combined with illuminated guides, f) Textual message combined with interactive visual cues, g) Illuminated guides indicate which room has to be accessed

It must be noted that the developed game did not intend to terrify the participants as this would be redundant for the objectives of this study and could potentially be harmful to some individuals. Instead, the game intended to moderately induce fear and distress. VR games are commonly found to be relatively arousing suggesting that the medium itself is stimulating (Estupiñán, Francisco et al, 2014). Consequently, the designed virtual experience did not need to be intensely agitating. Instead, the medium's ability to generate arousal was used and emotional valence was directed. Therefore, the experience had to

[1] Full-game video walkthrough can be viewed here : https://vimeo.com/283280697

maintain and augment stressful emotional states as to facilitate excitation transfer to a subsequent event. The desired misattribution of arousal would only be effective if the initial stimulating event was sufficiently arousing but not as exciting and memorable as to destruct the participant from the subsequent emotion-provoking task (Zillmann, 1983). The participant should not be aware of the excitation source and therefore the designed virtual experience did not need to be too intense.

Aiming to an intense game experience, sound was deemed as an essential element. Since the current game was designed as such as to cause fear through the suggestion of threat, relevant, well-designed sound could greatly contribute to an immersive experience. All in-game sound was explicitly created for this study by Giuliano Anzani and Kyriakos Charalampides. In-game narrative elements and events were used as a reference for the sound design process and programming. In a further attempt to approach a more realistic experience, each in-game element has its own dedicated three-dimensional sound. As an effect, the sound loudness and panning corresponds to the positioning of the player relative to the virtual sound-source as well as the distance between them.

Recent research has revealed that high-pitched, nonlinear sounds are perceived as the most arousing. This is hypothesized to be an adaptive feature since “humans, and many non-human animals, produce and respond to harsh, unpredictable, nonlinear sounds when alarmed”. This is thought to occur “because these are produced when acoustic production systems (vocal cords and syrinxes) are overblown in stressful, dangerous situations” (Blumstein, Bryant & Kaye, 2012). The same study supports that noise and low-pitched sounds are perceived as material of negative valence. In-game sonic elements were used in correspondence to the above findings. The environmental sound utilizes noise-like structures (Figure 4.a), low-pitch sonic material (Figure 4.b) as well as sudden, high-pitch sounds (Figure 4.c). This was hypothesized to set the participant’s perceived valence to a negative point and maintain a moderate arousal level. Additionally, most in-game events

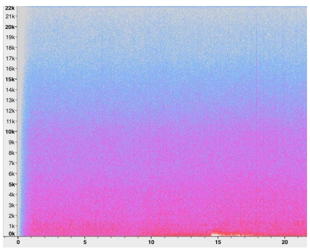

Figure 4.a: Rain sound spectrogram.

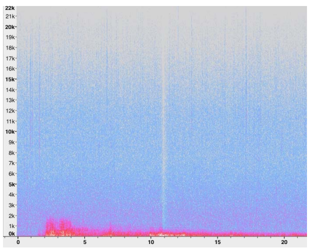

Figure 4.b: Thunder sound spectrogram.

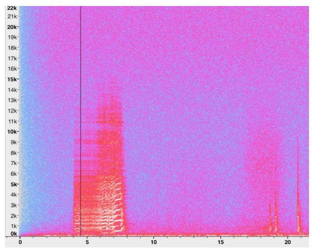

Figure 4.c: Opening door sound spectrogram.

Time is indicated in the X axis and the Y axis indicates the sound frequency. Warmer colors represent higher concentration of energy within the spectrum while colder colors represent lower concentration of energy within the spectrum.

produce sudden, high-pitched sounds allowing for a more concise control over the arousal levels during game-play.

As humans are diurnal creatures, “darkness is a phylogenetically pertinent aversive context” (Mühlberger, Wieser & Pauli, 2008) that when combined with the suggestion of unseen threat can aid to a successful horror experience. Research validates this notion revealing that dark virtual environments can increase anxiety and distress when participants are subjected to stressful conditions (Toet, Welie & Houtkamp, 2009; Mühlberger, Wieser & Pauli, 2008). Emanating from this idea, the present virtual experience takes place during a dark stormy night in an old creaking house. The light conditions are generally quite low and the environment’s illuminating points are placed accordingly to assist spatial perception and direct attention to important elements and events. To stress this idea further, the game concludes to one and half minute of absolute darkness where only disturbing sonic elements are available to the player.

The experience is spatially distributed in three consecutive rooms and a hallway connecting all three of them (Figure 5). Since the game is situated in a haunted house, the environmental design and in-game events were greatly inspired by historic horror films such as “The exorcist” (Friedkin, 1973), “The shining” (Kubrick, 1980) and “Poltergeist” (Hooper, Spielberg & Grais, 1982). Fear induction has been pursued by many and it is only logical to rely on established methods derived from examples that were proven successful in this task. Due to the popularity of the above films it is believed that participants will be familiar with, at least, some of them or other media instances that resemble them. Therefore, inference to these structures could instantaneously generate the appropriate mood and clearly set the emotional framework in which the game is designed to operate. Additionally, it is proposed that a carefully insinuating environmental design can

Figure 5: Top view of the game's layout.

a) Children's bedroom, b) Corridor, c) Living room, d) Mother's bedroom

generate "contextual fear" (Fox, 2008, p. 104) summoning the participants' episodic memory of previous exposure to similar horror films or games.

At the game's onset the player is situated into an old-fashioned children's bedroom (Figure 6.a). Initially, the player has no virtual body and is unable to move. Compelled to observe from a third person point of view, the player witnesses a young boy sleeping. Closely thereafter the boy wakes up and walks towards the player. The boy walks through the player and from this moment on the player possesses the boy's body. If the player looks downward a young child's body is to be found directly corresponding to the his/her position, rotation and input commands. Now the player has a virtual body and can move and explore the space. A full-body virtual mirror can be found within the player's proximity and field of view. This aims to prompt the participant's feeling of embodiment and to crystallize the assumed in-game identity. This part of the game is substantial as it allows a period of familiarization with the medium, the environment and the character as well as establishes the player's virtual self. Previous research has reported that participants exhibit behavioral changes that correspond to the identity of their virtual personas (Yee & Bailenson, 2007; Siebelink, van der Putten & Kaptein, 2015). Based on the above, it is anticipated that undertaking the persona of a young frightened child will adjust accordingly the players' in-game behavior and possibly intensify the fearfulness towards the experienced events.

The goal of the game is revealed during the first phase. In this, the player learns that his/her mission is to help the child reach his mother's room. However, in order to do so the key to the master-bedroom door has to be acquired. All in-game directions are supposedly derived from the child itself allowing for a better acquaintance with the character. In addition to that, before the onset of the game each participant received scripted directions in a verbal format assuring for a better in-game goal-orientation and a steeper learning curve. Immediately following the first communication with the character, inanimate objects within the room vitalize. Connotations and symbolisms derived from popular culture are used. Events such as a rocking chair moving without a person sitting on it or a carillon suddenly coming to life are included. The player continues on following the textual directions while proceeding within the environment.

After proceeding through the main corridor, the player reaches the living-room area where the key is to be collected. In this, the situation escalates as the lights self-destruct, crawling shadows appear and an old television projects distressful audiovisual material. Thereafter, the player has to once more proceed through the hallway which appears to be incrementally covered by dark roots (Figure 6.b). In the final room the mother is to be found but when the player reaches her, all lights turn off and the mother disappears so the player is completely left by his own devices. An old radio turns on changing between radio stations and static signals. These are the game's final moments. In this, the player is left in

Figure 6: In-game impressions from the players point of view.

a) View of the character in the children's bedroom, b) View of the corridor, c) Ouija session in the living room, d) View of the corridor covered in roots

absolute darkness and except from two vaguely lit windows, nothing else can be seen.

Suspense and fear of the unknown are extensively summoned within the game. Disposition theory suggests that "a necessary condition for suspense is that the viewer witnesses the conflicting forces ... without being able to intervene in the goings-on" (Zillmann & Vorderer, 2008). Inspired by this, all in-game interactions are directed corresponding to the player's positioning within the virtual environment, however, once they are initiated the user cannot influence their ongoing progress.

To test the game in line with this study's incentives, VR media had to be studied next to non-VR media. Therefore, two experimental conditions were realized. In the first condition, the game was played in VR and in the second condition, the game was played in traditional, desktop format. For the VR condition, the VIVE head mounted display (HTC, 2011) was used accompanied with one of the system's controllers. In the desktop condition, a simple 24" display monitor and a mouse were used. The game's design remained identical and the movement controls were programmed in a similar way in both conditions. In both VR and desktop format, the navigation controls only required the usage of the participant's dominant hand dismissing the non-dominant hand for the sensor placement. In the VR condition, participants could proceed forward by facing towards the desired direction and pressing the trigger on the handheld controller. In the desktop condition, the players could navigate by pressing the left mouse button. The game was developed using the Unreal engine (Epic Games, 2017) and FMOD studio (Firelight Technologies Pty Ltd, 2018) and all visual and sonic material was explicitly created for this use.

3.2 From fear to laughter

The induction of PA within laboratory settings can be quite demanding. Since laughter was the PA to be pursued, diverse methods for its induction were considered. Such methods include amongst others role-playing, taboo, verbal jokes etc. Through this process, a list of methodological prerequisites was created allowing for a more structured investigation of the available laughter induction techniques (Table 1).

The chosen method should be considered humorous by most age and social groups.
The chosen method should be moderately amusing and arousing allowing for excitation transfer to facilitate its intensity.
The included material should not be considered inappropriate or offensive by the participating individuals.
The chosen method should promote social interaction.
The chosen method should not be too obvious in regard to its intentions.
The chosen method should not include and kind of digital media or technological means; it should be a completely real-life event.

Table 1: Methodological prerequisites for the laughter induction technique.

Following the above requirements, a short game-like episode was created to further aid interaction and cooperation. Gary McKeown et al (2013) studied various social interactions directed towards laughter manifestations concluding that one of the most successful in this particular task was tongue-twister rhymes. That is because, tongue-twisters are inherently funny due to their non-semantic, phonetic hilariousness. Furthermore, when such are audibly read in an interactive setup are not only found entertaining to the performer but also to the audience. Likewise, when they are performed interchangeably between two or more people each individual has the opportunity to laugh with the other as well as with him/herself. This actively reduces awkwardness by sharing the experience. Along this path, a session of tongue-twister readings shortly followed the gameplay in each experiment. In this, the participant as well as the author had to pick a folded piece of paper from a vault. Afterwards, each had to audibly read the piece of text that was included within the chosen paper. The reading speed was raised in every round and after three rounds the process was repeated with a new piece of paper. Some examples of the included material can be found in Table 2.

For they'll beat a tattoo at twenty to two A rat-tat-tat-Tat-tat-tat-Tat-tat-tat-too And the dragon will come when he hears the drum, At a minute or two to two today At a minute or two to two.	Silly Sally swift shooed seven silly sheep The seven silly sheep Silly Sally shooed shilly-shallied south. These sheep shouldn't sleep in a shack; Sheep should sleep in a shed.
I wish to wish the wish you wish but if you wish the witch wishes I wont wish the wish you wish to wish.	How many cans can a canner can if a canner can can cans? Well, a canner can can as many cans as a canner can can if a canner can can cans!
A certain young fellow named Beebee Wished to marry a lady called Phoebe "But" he said "I must see what the minister's fee be before Phoebe be Phoebe Beebee"	A tutor who tooted the flute tried to tutor two tooters to toot. Said the two to the tutor "Is it tougher to toot or to tutor two tooters to toot?".

Table 2: Example of tongue-twister rhymes used in the laughter sessions.

3.3 Electrodermal Activity and self-report measures

Since arousal is a substantial element in the operation of excitation transfer theory, an objective, somatic indicator of arousal was deemed necessary. Electrodermal activity (skin conductivity) is a strong indicator of the sympathetic system's operation and therefore arousal (Fox, 2008, p. 104). Accordingly, an EDA sensor was used to monitor the participants' sympathetic responses throughout the course of each experimental session.

The EDA measurements were conducted using the Biopac MP150 data acquisition system connected to a portable computer through Ethernet communication. The received data were displayed and analyzed in the Acqknowledge software which was provided coupled to the hardware unit. (Biopac Systems, Inc., Santa Barbara, CA). The EDA-specific hardware and software systems were generously provided by the Social sciences faculty, Leiden University. The EDA channel sample rate was set on 1.00 kHz while the data acquisition sample rate was set on 2000 samples/second with a gain of x1000.

Two dry electrodes were bipolarly placed on each participant's non-dominant palm on the thenar and hypothenar eminence respectively. The electrodes remained placed for eight to ten minutes prior to the beginning of the experimental session assuring for adequate conductivity to the participants' skin. Consequently, any diversity in the baseline skin conductivity levels (SCL) amongst the users is assumed to occur due to individual or circumstantial physiological and psychological differences or even, habitual smoking. Additionally, SCL can vary within the same participant based on the current psychological state or mood, prior to measurement caffeine consumption, room temperature as well as a plethora of affecting variables (Berntson, Cacioppo & Tassinary, 2017; Braithwaite, Watson et al, 2013). The baseline recording per participant was completed within a two to five minutes period. The onset and finish of the four individual sessions per participant - Baseline, Gameplay, Intermission and Laughter- were demarcated within the dataset in real time using a dedicated key. Each experimental session provided two sets of EDA signals: the tonic EDA signal that generally describes the more slow-paced changes of the skin's conductivity over time and the phasic EDA signal that describes event-specific reactions.

Additional self-report measures were deemed necessary for the identification of the participants' perceived emotional states in every session. Therefore, participants were requested to demarcate their current emotional state within a valence-arousal affect grid before the onset of the experiment, after the gameplay and at the end of the experimental cycle. The affect grid (Figure 7.b) closely resembles the proposed format by Russell, Weiss and Mendelsohn (1989) in their original study. Before the completion of the task, each participant was given a short tutorial on how to appropriately use the matrix assuring that its purpose and functionality was clear. Before the onset of the experiment, an additional survey was distributed to the participants requesting for gender, age, previous VR exposure, smoking habits and recent caffeine consumption specifications. After the final session (tongue-twister rhymes) an additional single-question survey on horror game/film appreciation was completed. All the self-report and survey modules were delivered in a mobile application format (Figure 7.a & 7.b). This allowed for an automatic and structured

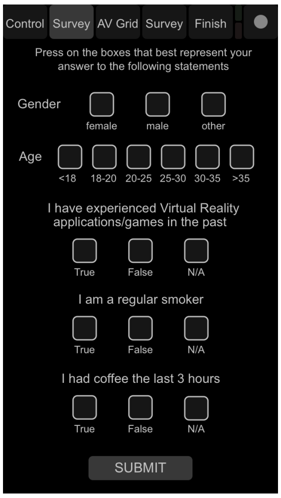

Figure 7.a: Mobile survey

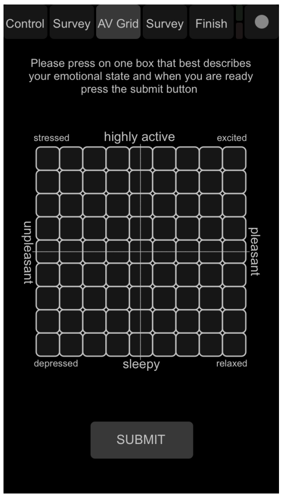

Figure 7.b: Mobile affective grid

Interface of the developed mobile application used to gather demographic and self-report valence and arousal data. The application was presented on a tough-screen mobile devise. When completing the survey, participants were asked to tap on the appropriate check box and then tap on the submit button. Then, the affective grid would appear on the screen. Participants were asked to tap on the box that best represented their current affective state and then tap on the submit button. Then, the screen refreshed erasing the previous selection. This process was carried three sequential times on baseline, after the gameplay and after the laughter session.

data registry as well as granted an extra level of convenience within a lengthy and convoluted experimental setup. The mobile interface was created with the TouchOSC application (Hexler, 2018) while the data receiver and registry system were created in Max MSP (Cycling 74, 2018).

4 Results

A total of 46 individuals participated in the current experiment. 27 played the game in VR and 19 in desktop format. Most participants were students in the Leiden University's Science Faculty. Four individual sessions can be identified within the course of each experiment: preparation/baseline, gameplay, intermission and laughter sessions. EDA data were derived for the four individual sessions while self-reported valence and arousal data were gathered only for three of them (baseline, gameplay and laughter sessions). In the following section, the gathered subjective and psychophysiological data are to be analyzed.

4.1 EDA analysis

Analysis was conducted in the tonic EDA mean scores per session, the tonic EDA maximum scores per session as well as the phasic EDA maximum scores per session. However, due to the nature of the current experimental design, average EDA scores and phasic EDA maximum scores were deemed inappropriate for analysis. That is to say that, session times -especially during the gameplay and laughter sessions- varied a lot per participant therefore, analyzing the average tonic EDA scores could conclude to misleading results. Analysis on the phasic EDA signal was deemed unnecessary, since the experimental design does not rely on specific arousing stimuli rather than sessions of multiple indistinct events.

The participants in both conditions responded with incrementing EDA scores across the sequential sessions. It was anticipated that the VR condition would result to higher arousal scores compared to the Desktop condition. Along these lines, the results indeed show higher average scores across the VR condition (Figure 8). Additionally, the revealed pattern in the VR group's tonic EDA scores accurately matches excitation transfer hypothesis' observations: arousal raises considerably during the first excitatory event, then it recedes to a lower level during the intermission while still remaining significantly higher compared to the baseline and finally, it raises again during the laughter sessions exceeding the original peak. However, in the Desktop tonic EDA measures a somewhat different pattern is observed. In this, the arousal levels are persistently incrementing even during the intermission stage.

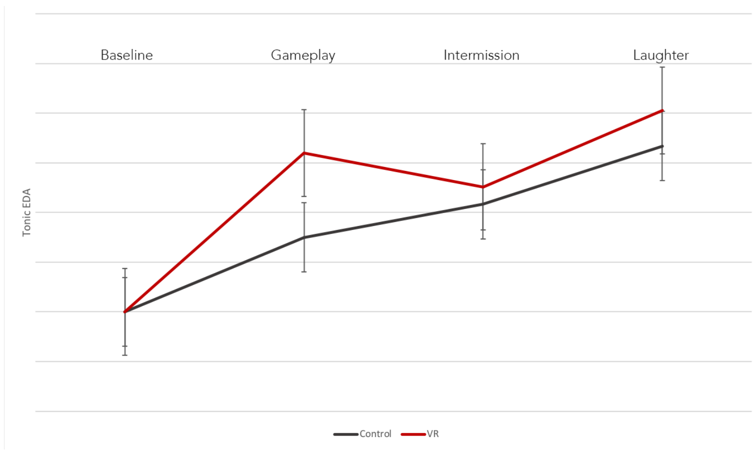

Figure 8: Average maximum tonic EDA scores amongst groups during baseline, gameplay, intermission and laughter sessions. The scores were normalized based on the baseline readings of each participant.

A t-Test in the tonic EDA maximum scores during the gameplay sessions between the Desktop and VR groups revealed a significant difference in the signal (P = 0.044, t =

2.015) indicating that VR is indeed a more appropriate medium for arousal generation compared to desktop. However, an analogous comparison between the tonic EDA maximum scores during the laughter session did not expose any such significant results (P = 0.378, t = 2.034). Additional analysis examining the difference in tonic EDA maximum scores between baseline and laughter sessions, revealed a significant increment for the VR group (P = 0.022, t = 1.674) but not for the Control group (P = 0.071, t = 1.688). Therefore, although the signal difference between the two groups during the laughter session did not show any significant divergence, a comparison of the baseline to the laughter scores in each group did indicate a significant effect in the VR condition.

Further Anova analysis conducted in both VR and Control groups' tonic EDA maximum scores did not reveal any significant between-sessions variation -Baseline, Gameplay, Intermission and Laughter sessions- suggesting that the found between-sessions differences might be due to in-group variation and individual differences. The above results invite for further examination and pose the question whether this broad in-group variation would be as evident in a larger participant sample.

4.2 Self-report data analysis

a. Valence-specific self-report data

The gathered valence self-report data indicated that participants were indeed in a less positive emotional state during the horror gameplay when compared to their baseline as well as the laughter sessions (Figure 9). Despite that, a t-Test analysis revealed that the valence decline during gameplay compared to the self-reported baseline was only significant for the VR group (P = 0.027, t = 1.674 for the VR group and P = 0.073, t = 1.688 for the Desktop group). Additional analysis comparing the self-reported baseline scores to the laughter scores revealed significant increment only in the Desktop group (P = 0.088, t = 1.674 for the VR group and P = 0.036, t = 1.688 for the Desktop group). Nonetheless, very significant valence increase ($P < 0{,}005$) was observed between the gameplay and laughter sessions in both groups. Further Anova analysis reported significant between-sessions variance in both groups (P = 0.014, F = 4.479 > Fcrit = 3.113 for the VR group and P = 0.036, F = 6.193 > Fcrit = 3.158 for the Desktop group) indicating that the observed between-sessions score differences can be attributed to the sessions themselves and not to in-group variance. Nevertheless, analysis conducted on the self-reported valence scores during the gameplay and laughter sessions between the VR and Desktop groups did not present any significant effect. However, significant observations were gathered in the between-sessions analysis in each group.

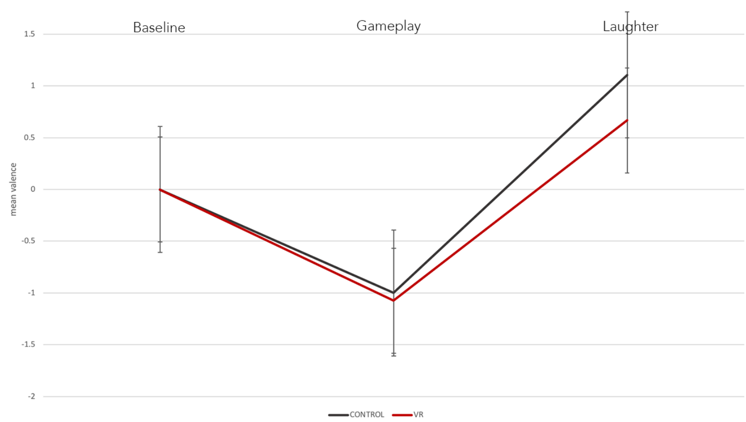

Figure 9: Average self-report valence scores between VR and Desktop groups. The scores were normalized based on the reported baseline scores of each participant.

b. Arousal-specific self-report data

Self-Reported arousal data are congruent with the results derived from the EDA analysis. On average, participants in both conditions reported feeling more aroused during the gameplay compared to their baseline and incrementally more aroused during the laughter session (Figure 10). Significant difference between baseline and gameplay self-report arousal scores was only found in the Desktop group ($P = 0.002$, $t = 1.688$). Additional analysis on the self-report arousal scores during the gameplay compared to the laughter session presented significant increment only in the VR group ($P = 0.047$, $t = 1.674$ for the VR group and $P = 0.346$, $t = 1.688$ for the Desktop group) while a significant effect between the baseline and laughter sessions was revealed only in the Desktop group ($P < 0.001$, $t = 1.688$). An Anova analysis conducted in both groups indicated that the between-sessions variance was only significant in the Desktop group ($P = 0.001$, $F = 7.604 > Fcrit = 3.168$). The above indicate that the results regarding self-reported arousal obtained from the VR group might be due to in-group variance rather than between-sessions variance. Additional comparison in self-reported arousal during the gameplay and laughter sessions did not reveal any significant difference between the groups deeming further research necessary.

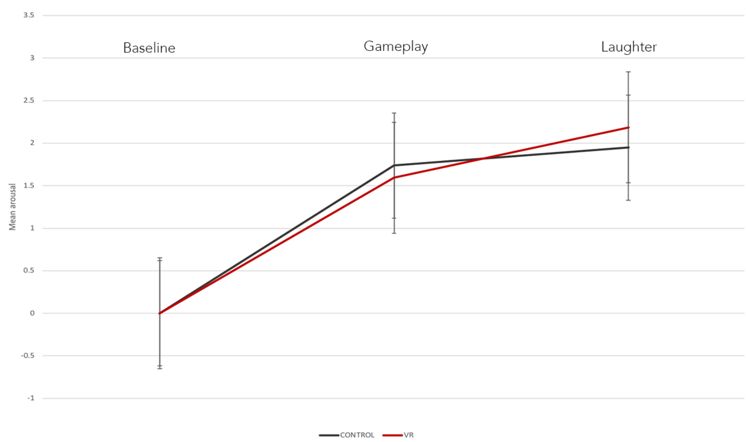

Figure 10: Average self-report arousal scores between VR and Desktop groups. The scores were normalized based on the reported baseline scores of each participant.

4.3 Further analysis and data exploration

Further data exploration was conducted aiming to a better comprehension of the population variance and to the identification of possible in-group clusters. A first analysis was directed towards the self-reported valence measures as, within the dataset, two major population bodies were identified based on their baseline valence reports. It was observed that amongst both conditions the majority of the participants reported a pleasant emotional state during baseline (63% in the Desktop group and 52% in the VR group). Accordingly, the participants were divided in two groups: Valence-positive and Valence-negative. Both categories describe the participants' self-reported valence during baseline. Anova analysis on the Valence-positive (Vp) groups in both conditions presented very significant between-sessions variance ($P = 0.014$, $F = 4.866 > Fcrit = 3.315$ for the Vp Control group and $P < 0.005$, $F = 9.801 > Fcrit = 3.284$ for the Vp VR group) while no significant between-sessions variance was found in the Valence-negative (Vn) groups in both conditions. The above indicate that previous results indicating between-sessions variance in the self-report valence data might be due to the Vp groups' performance in both VR and Control conditions.

Additional exploration on the Vp and Vn populations in both groups revealed a double dissociation effect amongst sessions (Figure 11.a & 11.b). To illustrate, the Vp groups in both conditions demonstrated a greater valence decline during gameplay ($P < 0.005$ in both groups) and did not surpass the self-reported baseline during the laughter session. Conversely, the Vn groups did not present any significant valence decline during gameplay ($P > 0.1$ in both conditions) however, very significant increase was observed during the laughter session compared to baseline (P < 0.005, t = 1.782 in the Desktop group and P = 0.012, t = 1.710 in the VR group). The above results might indicate that the self-reported valence amongst sessions is very much dependent on each participant's perceived baseline valence. An analogous analysis based on the self-reported arousal scores during baseline in both conditions (Low-aroused individuals and Highly-aroused individuals) did not present similar behaviors.

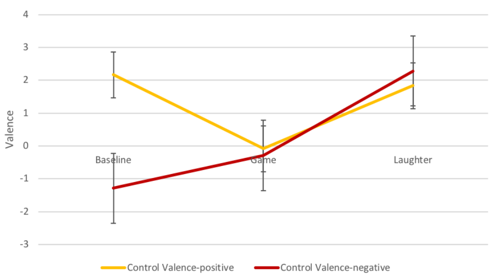

Figure 11.a: Scores between valence groups in Desktop condition

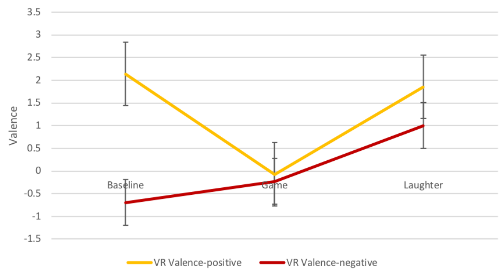

Figure 11.b: Scores between valence groups in VR condition

On further analysis, a general but not significant preference towards the horror genre was observed in the male population compared to the female population. Nonetheless, most participants reported an overall dislike towards horror film and games. Additionally, participants that reported aversion towards the horror genre revealed the most significant valence decline during gameplay in the VR condition (P = 0.020, t = 1.724) and the most significant increase in valence during the laughter session (P < 0.001, t = 1.724). Anova analysis run on this group indicates that these results are not due to in-group variance but are relevant to the individual sessions (P = 0.003, F = 7.005 > Fcrit = 3.315). Nevertheless, no significant results were obtained by other groups based on their horror preference.

Further analysis on demographic data did not reveal any significant effect in the self-reported valence and arousal. In addition, a comparison between the participants' age, gender and EDA scores did not indicate any apparent correlations. Anova tests conducted on age and gender groups in regard to their EDA scores presented great in-group variance indicating once more, that a bigger participant sample is needed for future research. Additional correlations between previous to the experiment VR exposure and self-report as well as EDA measures did not reveal any significant results.

Although habitual smokers presented higher average baseline EDA scores these relations were not supported by any statistical significance. Similar results were obtained by individuals that reported consuming coffee at most three hours before the experiment. Such inconclusive results might be due to individual baseline variance. Previous to the experiment measurements could have provided more reliable references to each participant's idle skin-conductance scores.

5 Conclusions and Discussion

The excitation transfer theory describes two distinct variables as prerequisites for its completion: arousal and valence. Along these lines, the current study hypothesized that participants while involving in VR horror gameplay will experience an arousal increase as well as a decrease on their perceived emotional valence. Additionally, it was assumed that once a short intermission followed and afterwards participants involved in a humorous session, they would experience an even greater arousal boost and a valence increment. To test the study's research question, two experimental conditions were tested: VR and Desktop gameplay. The VR condition succeeded in presenting the expected results only in the EDA measures. The above confirm the findings of Estupiñán et al (2014) accepting the view that VR is indeed a powerful tool for arousal generation. Self-reported valence and arousal did not indicate any such divergence between the VR and Desktop conditions. Subsequently, it can be concluded that only one of the two prerequisites of excitation transfer theory were met in VR compared to Desktop play.

Although results suggest that when the developed horror game was played in VR it was perceived as more disturbing and arousing than when played in a traditional desktop setup, the difference between the two conditions was not statistically significant. Along these lines, recent research suggests that people do not necessarily find horror games scarier when played in VR rather than in desktop format the first time that they are experienced. However, sequential game sessions are found to be more disturbing in VR than in desktop format (Jiménez, James, Maureira et al, 2018). The above indicate that additional pilot studies involving the same participants within the same conditions might have provided a stronger effect in valence decline between the VR and Desktop conditions.

It was observed that participants did not perceive the tongue-twister session as funnier after the VR gameplay. Conversely, slightly higher but not significant valence scores were obtained from the Desktop group rather than the VR group during the laughter session. Nonetheless, in both conditions no significant valence increment was found between the baseline and the laughter sessions. This could suggest that the misattribution effect did not operate appropriately or that substantial confines were evident in the laughter induction session. The arousal response over time as described by theory was accurately manifested within the objective data but the expected valence deviation between the baseline and the laughter session did not occur in the VR group. Research claims that VR is a fitting tool for episodic memory enhancement (e.g., Repetto, Serino, Macedonia et al, 2016; Holt, 2017), suggesting that it might be more memorable than traditional desktop exposure. Such results might explain why the misattribution of arousal during the laughter sessions failed to operate in the VR condition.

It is considered that further optimizations could have been applied on the last parts of the experiment's delivery. Optimally, a confederate would perform the final tongue-twister session along with the participants but in the current design, the author took upon this role. This might have played a role on the outcome of the present study. Moreover, a pilot study dedicated to the evaluation of the laughter induction method could have been substantially helpful for the PA affect evaluation. Optimally, previous measures of the activity's perceived valence would have been obtained and used in a comparative manner to the collected data. That is to say that, the current analysis considered the self-reported valence baseline as an appropriate, corresponding measure in the laughter session's valence analysis; an assumption that might have been misleading. The used method for PA induction might not be adequately entertaining and therefore, "excitation transfer" might have operated while remained unnoticed. Finally, the significant in-group variation observed within the population sample grants for future research with a greater number of participants. This could eliminate the apparent individual differences and provide more definite results.

This study attempted to examine the efficacy of Virtual Reality as a fitting tool for the implementation and study of the excitation transfer theory. The obtained results indicate that VR is not more efficient in this task compared to traditional desktop gameplay. This might be due to the enduring impression of VR experiences that result to the interception of the misattribution effect. In addition, the efficiency of the second stimulus' delivery is still under discourse. Hence, pilot studies examining each stimulus in isolation might provide more reliable comparative measures. Future research aims to explore this idea. Further analysis on the obtained data revealed that the perceived valence of a specific stimulus might be dependent on one's perceived valence before the experience of the stimulus. These observed behavioral patterns grant further research that might help determine whether this is a concrete and consistently occurring effect.

Future investigations will not only aim to clarify various confines of the present study but also to shed a light upon diverse interactions that might be enhanced by residual arousal produced in VR. Such applications might include arousal enhanced pain studies that might help research on pain and its mechanisms or modified versions of VR cognitive behavioral therapy that offers the possibility of helping phobic individuals cope with their fears using VR. In this, researchers can use the VR induced arousal to direct and enhance the users' focus on behavioral treatment methods not only in VR but also after the VR exposure. Other uses of VR arousal enhancement techniques might involve affect augmentation in VR and in subsequent non-VR interactions as well as group bonding applications. In agreement with preceding literature, it was found that VR is a powerful tool for arousal enhancement. Therefore, if the VR experience and subsequent interactions share similar semantic outlines, both virtual and non-virtual experiences might become more memorable and meaningful with the aid of VR arousal enhancement techniques.

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