Formalising suspense from immersive environments

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Abstract. Survival horror video-games have acquired great acceptance in recent years. Immersion, ease of play, virtual reality gadgets and emotional intensity have helped to popularise them. Famous *youtubers* still perform their videos based on these games, counting millions of viewers even if the design of them is very similar in terms of atmosphere, limited actions and mapping. Usually conceived as suspense-evoking threatening environments to explore and escape, this similarity may lead to think about automatising the generation of products of this genre. In this paper, suspense definitions are reviewed from the view of emotional effects. Further, we propose a formula relating suspense to dimensions valence, arousal and dominance. Finally, we present an experiment that supports its application for a horror game.

Keywords: suspense, emotions, survival horror, video-games

1 Introduction

Popularity of games based on horror and suspense has boomed in recent years. Both 2014 and 2015 were defined by critics as "a great year for horror games" [52] and "the year of horror games" [38]. The amount of games of this genre offered in Steam has almost triplicated from 2008 (3.65%) to 2015 (8.49%)[3]. Most followed *youtubers* have used this sort of games to induct their fame, what has helped to the expansion of the genre. From the list of twenty more followed *youtubers*[4] [70], half of them dedicated to video-games have based or are basing its slide-shows on fear and frights[5], counting about 84 millions of subscribers. In addition to this, recent simple engines and tools have influenced video-games new developers. Thereby, a thousand of non-professional products have been

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[3] Information obtained from the list of offered games of Steam store web site [66].
[4] Excluding Vevo channels.
[5] Eight out of twenty of the most followed *youtubers* play and comment video-games. The half of them, pewdeepie (first position), elrubiusOMG (5), JuegaGerman (17) and Markiplier (19) usually play horror and suspense games.

released for the community in recent years, and many of them have been played by mentioned *youtubers* in their videos.

Amplified by our then-current fascination with the possibilities of virtual reality environments (VR) [4, p. 2], new technologies as Oculus Rift, Samsumg Gear VR or Google Cardboard diffuse even further the genre. Immersion is mainly oriented to a first person environment, where the game can create virtual spaces in which the player performs an actor [60, p. 80] that engage the player psychologically [64, p. 176]. For example, in *3D Monster Maze* (survivor First-Person Shooter precedent and probably the first 3D game [7, p. 30]), the walker is supposed to go and can preview the route to take. From a first-person point of view, player is forced to navigate in order to learn what the structure of space is and to make a mental map of it [18, p. 75]. Beyond mere fun, the aim of these games is that players experiment just the same sensations of fear and anxiety that the character performed would feel. This type of paradigm is used to generate increasing engaging *out-of-the-body* and body substitution illusions [56, p. 1]. In this way, the genres naturally adapted to virtual reality are simulators, FPS and the sub-genre of first-person horror and suspense survivor adventures (mostly FPSs with limited use of weapons and aim, or even without options to attack, as it happens in games like *Outlast*). These applications require a high level of immersion while they try to produce a "sense of presence" [5, p. 37] by means of monopolising the own senses [11, p. 60].

Despite this increasing popularity, horror and suspense games are not usually among the best games of each year, and barely a few of them have been elected among the main games that *you-may-not-miss*[6] [1, 22, 28, 21]. Only *Doom*, *BioShock*, *Resident Evil 4*, *Silent Hill 2* and *The Last of Us* are mentioned, and not in every list. Nevertheless, in the memory of many players remains titles like *Slender*, *Fatal Frame*, *Dead Space*, *Five Nights at Freddy's*, *Alan Wake* or aforenamed *Outlast* as fundamental games in the history of the interactive entertainment.

However, although a difference is observed between the successful acceptation of horror and suspense video-games, and users and reviewers ratings, we may see that their offer keeps increasing, videos where people play them get a lot of audience, VR new technologies perfectly fit them in terms of immersion and many titles become part of the collective knowledge.

Consistent with this acceptation of a wide community of gamers and YouTube viewers, experiments in video-games industry conclude that players prefer suspenseful games, finding them more enjoyable than non-suspenseful ones [31, p. 31]. Results support the assumption that suspense is a driver of video-game enjoyment [p. 29], even for people who dislike horror and suspense genre in literature or movies. Since the relationship between gamer and game is fundamentally different from that between a film viewer and a film, it may be expected that films and video-games excel at generating different types of emotions [20, p. 13].

Elements that influence these preferences have been broadly studied. Atmosphere plays a fundamental role in terms of illumination, sound and aesthetic to provide a different environment for expressing a way to see the world. Quite

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[6] Sources: Metacritic, GamesRadar+, IGN and Game Rankings.

frequently the simulated environment influences more than the game argument, relegating it to a second plane. Unlike narrative and drama, its essence lays on a basic assumption: change is possible. It does not deal with what happened or is happening, but with what may happen [19, p. 233].

For example, *Slender: The Eight Pages* successfully represents the simplest way to illustrate this idea. The player is situated in the woods with the objective of collecting eight pages of paper scattered randomly around ten areas while avoiding being captured by the Slender Man, an invincible faceless creature who passively stalks his targets until they mentally break down and disappear [65, p. 45–46]. Whilst video-games differ from cinema in their digital origin and their interactive and typically immersive environments, the premise of creating fear for a player within the survival horror game genre can be attributed to the confrontation with grotesque, non-human-like beings, and in this, is no different from horror cinema [62, p. 4]: lighting alternates between illuminated places and a complete darkness, and the character has only the help of a lantern to see while moving around open landscapes or inside of labyrinthine buildings; encounters are not the same when the player cannot clearly see the enemy or the surrounding environment; player is embarked upon a lengthy exploration in a hostile environment [45, p. 133]. In this context, the fact that elements to search are pages, pictures or coins is secondary: the game is uniquely based on the environment and making the player jump, as it is not possible to predict the scare nor barely defend from threats. Both, environment and sudden attacks contributes to the emotional immersion: in a 3D environment, antagonists can appear from all directions [67, p. 100]. Further, this context of uncertain outcome led to greater enjoyment, and this effect is mediated by suspense [2, p. 1].

This model of primitive mechanisms based on threat of jump scares, feeling of vulnerability and immersed on an evocative atmosphere are common in many modern horror and suspense games[7]. In this manner, the importance of this style of video-game is remarkable, as much as to be worthy of having their own sub-genre in the survival horror classification.

The concept of this sub-genre is so simple that products could be candidate to be generated by computer. We propose that the threat of jump scares, feeling of vulnerability and atmosphere can be created by automatic mappings and plot generators, taking into account an external configuration about each particular aesthetic concept. However, none remarkable initiative has been released to this respect: excepting the discrete Zeoworks Horror Game Creator & HD Free Indie Games (a Kickstarter project released in September of 2014), existing tools often used to develop horror-games are conceived for generic games design[8].

Aiming to get this automation, in this paper we put forward a criteria to measure a game aesthetic. Actions are fixed and limited, map generation is a

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[7] For example, *Amnesia: the Dark Descent*, *Outlast*, *Affected* (developed for Oculus Rift), *Insanidade*, *Mental Hospital*, *Layers of Fear*, *P.T.*, *Doors of Silence* or *Kraven Manor*, originals and sequels, in their cases. All of them were developed from 2010.

[8] Even if Unity 3D is nowadays a popular tool to develop survival horror games, it is not specifically oriented for it. Released assets neither cover automatic generation.

solved enough issue [10, 59, 27] and growing sophistication of artificial intelligence programming techniques has contributed greatly to adding variation in enemies behaviour [20, p. 26]. However, beyond its natural creative conception, there is a lack of a formal model of suspense which may help to generate and predict the atmosphere scope based on its emotional effects. In fact, although several authors have discussed scenarios in which video-games generate emotions, little attention has been paid to a detailed understanding of the emotions in question [p. 13]. Finding a quantitative relation between suspense and emotions would allow to generate suspense environments from rated emotional terms dictionaries.

To prove this, in Section 2, we briefly resume the environment's elements that may influence player's emotions. Further, in Section 3 we analyse different definitions of suspense, associating them with the emotional dimensions and proposing a formula that relates suspense to emotions in Section 4. Finally, Section 5 and Section 6 are intended to discuss the proposal and conclude this paper, respectively.

2 Background

As we referred above, atmospheric elements provide emotion to an environment by means of aspects as illumination, sound, and aesthetic. For reasons of space restrictions, the aim of this section is not giving a broad bibliography about the subject, but suggesting the influence of the environment in fear and suspense.

The meaning that persons attribute to environments implies both perceptual cognitive meaning and affective meaning [54, p. 311]. To blend both aspects, Oliveira & Chambel (2008) affirms that interactive environments combine diverse symbol systems, such as pictures, texts, music and narration that often engage the viewer cognitively and emotionally, and have a great potential in the promotion of emotional experiences [43, p. 16]. They cite Norman (2004) [42] when affirming that rounded shapes, smooth and symmetrical objects, and rhythmic beats, are some of the interface characteristics that also induce positive states; while sudden, unexpected loud sounds or bright lights, darkness, looming and sharp objects, empty and flat terrain induce negative emotional states [p. 18]. Smith (1999) asseverates that fear makes us notice dark shadows, mysterious noises and sudden movements and thus provides more possibly frightening cues [57, p. 114]. Van & Gareth (2012) support this view. To them, it is more common for players to experience a startle suspense in response to games with fictional worlds because the atmosphere that triggers the anticipation is more easily created through fictional clues. This is the case in games with portray dark alleys and scary-looking monsters that can jump out at us unexpectedly. Atmosphere effects as dark/foggy and the music/soundscape are continuously suspenseful [67, p. 100]. Perron (2012) sustains a similar opinion about the fog and darkness as used to hide what is not depicted. Player does not see very far, so is always scared to run into something awful [47, p. 27].

According to Callahan (1999), lighting in a digital scene aims to enhance mood, atmosphere and drama [8, p. 1]. Concretely, Niedenthal (2005) describes

evocative lighting (as opposed to functional lighting), which allows the designer to manipulate the qualities of light (colour, shadow and lighting direction) to influence players' emotions and behaviour during the game [41, p. 225], by the evocation of suspense, dread, comfort or ecstatic abandon [p. 229]. However, on the contrary that popular belief, Toet *et al.* (2009) defend that player' emotions in desktop virtual environments are not influenced by day / night alternation, contrary to darkness in the real world and immersive environments [63, p. 369]. To refine this affirmation, Houtkamp (2012) found evidences that a virtual environment is considered less pleasant and more unpleasant by the simulated nighttime lighting conditions, but not more arousing [26, p. 160]. At the same time, weather conditions, especially blue sky and bright colours versus grey sky and dull colours, had a positive impact on the appraisal of the area [p. 158].

Analysis made by Joosten *et al.* (2012) reveal that the use of colours is a suitable method for game designers to elicit specific emotional responses from players, in particular from novice players: colour red evokes a highly-aroused, negative emotional response, while colour yellow evokes a positive emotional response, being these results significantly different from the emotional responses measured for other colours [30, p. 76]. To Pandey *et al.* (2009), colors can influence emotion as much as provoke physical reactions. They are generally associated with two types of emotions: on the one side, the warm, active and exciting qualities of red, orange and yellow; on the other, the passive qualities of blue, violet and green. Human responses are for example 12% faster than normal under red lighting. Different experiments also showed that warm colors like red are better attention-catchers than cool colors such as green or blue [44, p. 9].

To Shilling & Krebs (2002), auditory interface should be considered an essential component to virtual environments that adds ambience, emotion, and a sense of presence [55, p. 1]. Additionally, Rosenblum (2004) affirms that music can direct the emotional messages received during play and highlight important game changes [53, p. 36]. Toprac & Abdel-Meguid (2010) suggest that the best sound design for causing fear are well-timed high volume sound effects with the accompanying visual element [64, p. 186]. Hayward (2009) defends that abstract music sets a general dramatic tone of what is to follow [24, p. 29]. Wei *et al.* (2012) affirm that ambient sound helps to define the environment and shape the emotional tenor of the progress through the game space [69, p. 11]. Nevertheless, despite the bibliography indicates the influence of sound, Vachiratamporn *et al.* (2015) report that there is no research on survival horror games that investigates player affective responses to it as a continuous experience and analyses the player affective states transition during the gameplays [65, p. 45].

3   Analysis of the concept

Our studies support the relation among horror/suspense, environment and emotions, where environment affects the player in terms of emotions which, at the same time, influences suspense. In Section 2 we have illustrated the emotional effects caused by the environment. Our hypothesis is based on the existence of a

quantitative way to measure suspense in terms of these emotions. To support it, in this Section we analyse different suspense definitions with the aim to extract emotional dimensions (*valence*, *arousal* and *dominance*) from them.

Emotional *valence* describes the extent to which something cause a positive or a negative emotion [13, p. 79]. In terms of a story, an element has a negative valence when it pushes towards a negative outcome. Suspense increases while the negative outcome probability [29, p. 107, 137] and the negative valence effect of the environment features increase [20, p. 19].

The second dimension is *arousal*, referring the intensity of the emotion [13, p. 79]. This dimension seems to have a similar effect on the audience that the pattern found in negative valence, ranging from calm to exciting [35, p. 82].

Finally, the third dimension, variously called *dominance*, *control* or *power*, reflects the degree of control an individual feels over a specific stimulus and extends from out of control to in control. [39, p. 888]

The American Heritage Dictionary of the English Language [14] defines suspense as "anxiety or apprehension resulting from an uncertain, undecided, or mysterious situation". Meanwhile, *Collins English Dictionary* [49] conceives suspense as "mental uncertainty; anxiety" and "excitement felt at the approach of the climax". In turn, *Random House Kernerman Webster's College Dictionary* [36] interprets it as "a state of mental uncertainty, as in awaiting a decision or outcome, accompanied by anxiety or excitement". For on-line *Macmillan Dictionary* [37], suspense is defined as "excitement or worry that you feel when you are waiting to find out what has happened or what will happen". *Oxford Dictionary of English* [61] does as "A state or feeling of excited or anxious uncertainty about what may happen". *Cambridge Dictionaries Online* [48] defines suspense as "the feeling of excitement that you have when you are waiting for something to happen". For *Larousse French Dictionary* [34], it is "moment of a film or a literary work in which the action takes the viewer, listener or reader in the anxious expectation of what will happen" and "situation or event which is expected with a very lively worry". Finally, *Dictionary of Spanish Language* [17] provides as definition "impatient or anxious expectation about the development of an action or event, especially in a motion picture, a play or a story"-

From the point of view of the affective theories, Zillmann (1980) proposes that "suspense is conceived of as the experience of uncertainty regarding the outcome of a potential hostile confrontation" [71, p. 135]. Therefore, Carroll (1984) specifies that suspense implies two logically opposed outcomes: "one is morally correct but unlikely and the other is evil and likely" [12, p. 72]. In their works about suspense in films, de Wied *et al.* provide another view describing (film) suspense as "an anticipatory emotion, initiated by an event which sets up anticipations about a forthcoming (harmful) outcome event for one of the main characters" [15, p. 325]. Again Zillmann (1991) writes about the experience of suspense as "an affective reaction that characteristically derives from respondents' acute, fearful apprehension about deplorable events that threaten the liked protagonists" [72, p. 282]. From the field of literature, Gerrig & Bernardo (1994) affirm "readers feel suspense when led them to believe that the quantity

or quality of paths through the hero's problem space has become diminished" [23, p. 460]. To Bryant *et al.* (1994) "suspense is viewed, on its simplest terms, as a high degree of certainty of a negative outcome" [6, p. 326]. Caplin & Leahy (1997) defines suspense as "the pleasure experienced immediately prior to the anticipated resolution of uncertainty, and posit that it is positively related (up to a point) to the amount that is at stake on the outcome of an event" [9, p. 73]. Similarly, Knight & McKnight (1999) refer that "suspense relies upon the audience's strong sense of uncertainty about how events will play out" [32, p. 108]. And, accordingly, Vorderer *et al.* (2001) defend that "in a typical drama situation, when the character's failure becomes likely, they may even feel empathetic stress, a rather negative emotional experience better known as suspense" [68, p. 344]. Somanchi (2003) writes "suspense involves emotional responses and arises from a cognitive state of uncertainty of outcome and anticipation of misfortune" [58, p. 1]. To Alwitt (2002), "suspense due to the unfolding of events within the narrative is based on the viewer's uncertainty about the outcomes of those events" [3, p. 36]. Finally, to Perron (2004), "the more the chances of succeeding are slim, the more the presentation is suspenseful" [45, p. 134].

Once revised all the definitions, we decompose them in their significant lexical components related to emotional dimensions, that we show in Table 1.

Emotional dimension	Terms and occurrences
valence	worry (3), apprehension (1), hostile outcome (1), harmful outcome (1), evil (likely) outcome (1), fearful outcome (1), negative outcome (1), negative experience (1), threaten (1)
arousal	excitement (4), anxiety (4), climax (1), stress (1)
dominance	uncertain (8), expectation (3), waiting (3), impatient (1), failure (1), slim success (1)

Table 1. Emotional dimensions (and occurrences) found in suspense conceptualisations

We may observe the idea of (negative or low) valence expressed by terms: *worry*, *apprehension*, *hostile / harmful / evil / fearful / negative outcome*, *negative experience* and *threaten*, as non-pleasuring feelings. Respecting to arousal, *excitement*, *anxiety*, *climax* or *stress* seem strongly related to emotional intensity [25, p. 69]. All of them are the result of a feeling of worry, nervousness, or unease, and relevant for fearfulness [51, p. 2], being this higher when someone is exposed to suspense than in a neutral not specific situation. According to this, suspense is a factor implied in the increment of arousal, supporting the idea of the impact of game-play is based on the states of arousal of the gamer [46, p. 3]. Finally, we rely on the idea that *uncertainty*, *expectation*, *waiting*, *impatient*, *failure* and *slim success* (even other terms like *worry*, which we have applied to valence) denote a need of control [40, p. 6] and, consequently, suspense is related to a lack of dominance. The structure of horror games is based on *out-of-control* experience [33, p. 207].

4 Proposal

Based on our preliminary study (explained above), in terms of valence, arousal and dominance, we consider that the lower valence, higher arousal and lower dominance concepts, the more suspense is evoked to players. In contrast, elements with high valence, low arousal and high dominance help to decrease the suspense. According to this hypothesis, we define three groups of concepts: suspense enhancer, suspense reducer and neutral, where neutral concepts do not influence the suspense level of the environment. Our general formula to measure the level of suspense of a concept is given by the factor ψ in Equation 1.

$$= f(V, A, D) = \frac{\triangle^{-1}V + \triangle A + \triangle^{-1}D}{\triangle_\vee V + \triangle_\vee A + \triangle_\vee D} \tag{1}$$

where V, A and D represent respectively *valence*, *arousal* and *dominance*. Operator $\triangle$ obtains the difference between the value and lowest possible value in the measuring scale, operator $\triangle^{-1}$ obtains the difference between highest possible value and the current value of the dimension, and, $\triangle_\vee$, the difference between highest and lowest possible values in the scale. Thus, Equation 1 gets the highest value when the lowest valence, highest arousal and lowest dominance. We consider a concept around $\psi = 0.5$ as neutral in terms of suspense, $\psi \in (0.5, 1.0]$ as suspense enhancer and $\psi \in [0.0, 0.5)$ as suspense reducer. The level of influence depends on how closer is the value of ψ to the limits of each range.

5 Discussion

To experimentally test Formula 1, we have performed a first experiment comparing suspense ratings to the values of ψ obtained from Spanish version of Affective Norms for English Words (ANEW) [50]. Fifteen participants were asked to score the evoked suspense of six elements that we introduced in a suspenseful situation, ranging from 1 to 9. Elements where obtained from the video-game *Outlast*: a corpse ($\psi = 0.8295$), vomit ($\psi = 0.7468$), dirt ($\psi = 0.6315$), a computer ($\psi = 0.4704$), a diploma ($\psi = 0.4014$) and a bed ($\psi = 0.3264$). Results aim to support our hypothesis, existing a clear correlation between reported suspense and Formula 1 applied to emotional dimensions obtained from ANEW ($r = 0.8196$, $p < 0.05$).

However, we are working on a broader experiment taking into account other demographic and atmospheric influential variables. For example, our first experiment has not included elements as colours, meteorology or day time. It neither studies characters' and participants' features. Moreover, we need to test other video-games as much as the story in which the scene occurs. The reason is that, even if the bibliography supports the effects of the environment in suspense, this effect is nuanced by the particular plot: a corpse on the floor has not the same connotation in the context of a mental hospital that in a zombie story or a Sherlock Holmes' case. Besides, the effect of object perceived as influencing the plot (the corpse in a zombie game) versus just decorative or explicative object has to be taken into account [16].

6   Conclusions

In this paper, we propose a formula to relate suspense evoked by a environment to the emotional effects of the environment's elements. In order to formalise it, several definitions of suspense has been analysed and compared with the emotional dimensions valence, arousal and dominance. Suspense conceptions were reviewed from classical definitions and the field of narrative.

To test the practical result of our formula, we have performed an experiment that shows a significant relation. In any case, we are working on a new experiment that consider aspects regarding demographic information and influence of the elements in the story. Confirming this effect, our proposal aims to be a background to help to automatise the generation of survival horror environments.

Acknowledgements

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