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JENS KJELDGAARD-CHRISTIANSEN AND MATHIAS CLASEN
Aarhus University

Threat simulation in virtual limbo: An evolutionary approach to horror video games

ABSTRACT

Why would anyone want to play a game designed to scare them? We argue that an alliance between evolutionary theory and game studies can shed light on the forms and psychological functions of horror video games. Horror games invite players to simulate prototypical fear scenarios of uncertainty and danger. These scenarios challenge players to adaptively assess and negotiate their dangers. While horror games thereby instil negative emotion, they also entice players with stimulating challenges of fearful coping. Players who brave these challenges expand their emotional and behavioural repertoire and experience a sense of mastery, explaining the genre's paradoxical appeal. We end by illustrating our evolutionary approach through an in-depth analysis of Playdead's puzzle-horror game Limbo.

KEYWORDS

horror
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Introduction

Imagine this: you are a little boy, lost somewhere deep in the woods at night. You do not know how you got there or how to get out. All you know is that your sister is out there, somewhere, possibly in great danger. You have to find her.

The ambiance is alive with animal calls, the flutter of branches and bushes and a welter of noises that you cannot quite make out. Flailing about to make some sort of headway, you rush past foot-high mounds of decomposing meat – once living things, now organic breeding grounds for the flies. Somewhere in the distance you see skulking silhouettes that look human. They see you – see you see them – and quickly scatter among the trees. You move on, scouring for any trace of the woods' furtive inhabitants. Clearing a hill, you fix your gaze on a large tree trunk with three heavy boughs that seem to be *hanging* from the tree rather than projecting out of it. As you move closer, the boughs lift over your head as if from a powerful gust of wind. Instead of falling again, however, they steady themselves, like snakes making ready to strike. But they are not snakes, much less branches. They are the multijointed, spiked legs of a colossal spider, whose body completely enfolds the tree's copious trunk. Suddenly, the monster thrusts one of its readied members forward to skewer you alive. Whether you will manage to dodge it and survive the encounter is now entirely on your focus and reflexes.

As a real experience, this scenario would be positively terrifying. No sane person would want to be in the boy's shoes. As an imaginative exercise, however, the scenario is harmless but intensely stimulating. People pay good money to experience virtual danger of this kind when they watch a horror film or play a horror video game, such as *Limbo* (Playdead, 2010), from which the scenario is taken. Why would they do that? The philosopher Noël Carroll (1990) labelled this difficult question *the paradox of horror* and distinguished it from the so-called paradox of tragedy with which aestheticians have grappled for centuries (Smuts 2009). Carroll proposed that the genre's appeal comes from its presenting the audience with impossible monsters (like the giant spider) and deep mysteries (how did it, and *I*, get here?) that grab and hold our attention. We are inquisitive beings, and horror serves up intriguing mysteries for us to solve.

In this article, we extend to video games an alternative but abutting solution to the paradox of horror that is grounded in the evolutionary and cognitive psychology of horrific entertainment (Clasen 2017). This line of research has shed light on horror in literature and film by showing it to be crucially dependent on evolved mental architecture. We dread reptiles and reptile-like monsters, in real life or on the big screen, because they have preyed upon us throughout our mammalian evolutionary history; we fear the dark, whether real or fictional, because it limits our access to information about our surroundings, thereby allowing predators and hostile conspecifics to creep up on us unnoticed; and we recoil at the sight of a zombie because this lumbering horror staple is simultaneously a rabid predator and an oozing vector of disease (Clasen 2012). These phobic pressure points make sense as a function of what mammalian, defanged and disease-prone hominids have ancestrally had good reasons to avoid (Öhman and Mineka 2001; Clasen et al. 2018). They find their way into so many of our scary stories because they reliably and cross-culturally elicit fear – they do what the genre needs them to do (Clasen 2017; Davis and Javor 2004). We aim to extend these insights to horror in video games, using the popular puzzle-horror game *Limbo* to illustrate our

points. Horror games, including *Limbo*, represent a virtual repository of evolutionarily rooted scares. These scares combine and interact to produce imaginatively compelling experiences of being alone in the dark, surrounded and hunted by hostile agents. The paradoxical appeal of such experiences, as we will argue, is one of attaining adaptive mastery over dangerous and uncertain environments.

Ours is not the first attempt to investigate video games from an evolutionary perspective. Evolutionary social scientists have for some time advanced functional accounts of video game genres ranging from the high-profile, controversial first-person shooter games to 'casual' mobile games (e.g. Ferguson 2010; Mendenhall et al. 2010). Like these theorists, we are convinced that evolutionary theory can shed light on the forms and functions of video games, including horror games. However, we believe that previous efforts have erred in neglecting pertinent insights of contemporary game studies, and that they therefore represent a missed opportunity for scholarly cross-pollination. Of course, the feeling may be mutual. Mendenhall et al. (2010: 306) observe that evolutionary theory is 'conspicuously absent' in game studies. They overstate their case (see Grodal 2003 for an example of evolutionary theory being applied to video games), but we agree that the explanatory potential of evolutionary theory represents an underused resource for the humanistic study of video games.

For their part, evolutionary social scientific theorists of video games have largely failed to consider the phenomenology of gameplay. They reduce the scope of their research to themes that appear in the game, such as conflict or family life, before explaining how these themes relate to human evolution. (However, see Breuer et al. [2018] for a recent example of more ambitious scholarship.) But if video games manage to do anything to us, they do so through the structured, embodied and temporally extended experience of gameplay, and not merely through representing themes of human evolutionary history. The concept of a dangerous predator is not very scary, but a simulated encounter with its in-the-flesh instantiation certainly is – especially, perhaps, if that encounter is prefigured with cues to danger and suffered from an involved first-person perspective, as in many modern horror games (Pinchbeck 2009). These are hypotheses that can only be explored through careful attention to the experiences that games afford players. In this article, therefore, we want to bring the evolutionary psychology of fear and game studies into closer dialogue. Our discussion will engage with but also move beyond the semantics of horror video games, beyond the beasts, revenants and (oversize) creepy-crawlies that inhabit the genre. Horror video games allow for kinds of enactive and embodied experience that traditional narrative media do not (Perron 2005), and we will attempt to elucidate these formal features in evolutionary terms.

Our functional thesis breaks into two substantial claims: horror video games (1) rely on ancestral threats to fulfil their affective promise, and (2) present virtual environments that challenge players to cope with such threats. Horror video games are thus danger-simulation devices in a very real sense: they feature psychologically deep-seated scares and instil methods for dealing with them, including behavioural coping strategies and emotional self-regulation. This adaptive *qua* survival-promoting quality explains the genre's paradoxical appeal.

In the next two sections, we will build this conception of the genre by arguing that horror games adaptively simulate what Panksepp and Biven,

in their seminal work, *Neuroevolutionary Origins of Human Emotions* (2012), term *prototypical fear sequences*: ancestrally prevalent situations of danger and uncertainty. We will then flesh out and illustrate our points in an evolutionary analysis of *Limbo*.

Video games, horror and evolution

Popular video games typically invite a simulative experience (Aarseth 2004; Brill et al. 2018). They challenge players to reach goals in a virtual environment that is phenomenally marked off from the real world by its self-referential rules and narrative horizon (Juul 2005). This interactive mode of engagement represents a substantial breach with traditional narrative media in offering players interactive, 'egocentric' experiences, that is, experiences that unfold through and around the player's own actions (Gaut 2010). Of course, that is also true of *horror* video games.

Horror literature and film rely on third-person and often empathy-mediated 'witness emotions' of fearful concern for central characters (Tan and Frijda 1999). By contrast, videoludic horror, because it is simulative in nature, prototypically evokes the first-person experience of surviving in a dangerous world (Perron 2005). It confronts resource-starved players with immediate physical threats, such as a ravenous predator, and challenges them to cope. Panksepp and Biven (2012: 177) label this a 'prototypical' fear scenario: the kind of scenario to which the human fear system originally evolved to respond adaptively and to which it is therefore most sensitive. Prototypical fear scenarios involve humans *assessing* and *negotiating* physical threats in the form of hostile agents. These two basic classes of experience, we propose, correspond to two dominant modes of horror gameplay.

What characterizes threat assessment and threat negotiation, and how are these coping activities simulated in horror video games?

Threat assessment

Humans who feel threatened are motivated to assess the threat in order to either avoid it completely or prepare for it optimally (Barrett 2005; Woody and Szechtman 2011). They do so by vigilantly scanning their environment for cues to danger: ill-intentioned conspecifics may chatter loudly enough among themselves to be heard, for example, and a feline predator may give away its location by scaring nearby wildlife into uproarious flight. False positives are likely because the anxious organism is in a state of heightened psychophysiological responsivity, enabling it to quickly identify, but also to misidentify, a potential threat. Despite this potential for error, we do well to expect the worst because, on the off-chance that the worst is indeed the case, the consequence of inaction could be fatal (Barrett 2005; Haselton and Buss 2000). *Better safe than sorry*.

The adaptive problem of threat assessment looms large in the horror video-game genre, including the popular survival-horror games such as *Amnesia: The Dark Descent* (Frictional Games, 2010) and *Silent Hill 2* (Konami, 2001). The player of these games explores a dangerous setting to discover what menacing forces occupy it and what kinds of threat these forces represent. Some games focus sharply on this aspect of the prototypical horror scenario. In the point-and-click adventure-horror game *Tormentum – Dark Sorrow* (OhNoo Studio, 2015), for instance, the player navigates a Gigeresque environment of great uncertainty and manifest danger. The game features lots of discovery and

puzzle-solving in its elaborate fictional world, putting a premium on sensory acuity, but it does not require players to contend dynamically with the hostile agents that the world surely contains through either fight or flight. (The point-and-click gameplay, of course, would not lend itself well to that kind of scenario, emphasizing that the form of horror games and the experience of horror gameplay cannot be understood in analytic isolation from each other.)

Threat negotiation

Not all threats can be pre-empted with information and foresight – thus comes threat negotiation. Some must be fled or fought in a real-time encounter. The human fear system is prepared for this contingency and rapidly prepares the organism to cope (Lang et al. 2000; Marks and Nesse 1994; Öhman and Mineka 2001). Clasen provides a summary:

The heart rate goes up and glucose is released into the bloodstream for an instant energy fix [...]. Blood is diverted from the digestive system – irrelevant when you're facing a predator or an oncoming boulder – to the large muscle groups [...]. Pupils dilate to take in as much visual information as possible [...]. Attention is sharply focused on the threat.
(2017: 26)

An autonomic cascade primes the organism for situations of immediate, physical danger that motivate either evasive or aggressive *action*, or, in rare circumstances, tonic immobility in response to a concrete and immediate threat. In horror games, dynamic threat negotiation describes the player's experience of dealing with simulated threats of comparable urgency. An example would be the player's experience of the adrenaline-pumped chase sequences in *Outlast* (Red Barrels, 2013), in which homicidal maniacs must be outrun in a secluded asylum.

The gameplay of *Outlast* is divided rather cleanly into sections of paradigmatic threat assessment (stealthy exploration) and threat negotiation (chase sequences). Shifts between these two modes are marked at several levels in the game's design space. Musically, the sudden shift from anxious threat assessment to fearful, dynamic threat negotiation is signalled by musical stingers (sharp, loud notes), whose intensity conveys the prudence of a mad dash to safety. *Outlast's* gameplay shifts in chase sequences, too, in accordance with the heightened dramatic circumstances in which players find themselves. Instead of the deliberate button presses that mediate the player's movement during stealthy exploration, the chase sequences call for dynamically coordinated controls to implement the player's split-second decisions about how best to escape.

The vital adaptive pursuits of threat assessment and negotiation are what fear is essentially about, what it motivates and is motivated by. Hence, it is not surprising that horror video games should facilitate these experiences (Clasen 2017; Clasen and Kjeldgaard-Christiansen 2016; Lynch 2018). As many theorists of the genre have noted, horror video games can be roughly divided into two modes, or intensities, of gameplay, to which individual games assign different weightings (e.g. Nacke et al. 2016; Perron 2005; Toprac and Abdel-Meguid 2011). Survival-horror games accentuate threat assessment: these games are about traversing dangerous environments while evading their dangers, and about building an atmosphere of vulnerability and anxious tension that prompts the player to stay vigilant. By contrast, action-horror

games, such as *Dead Space* (EA Redwood Shores, 2008), accentuate threat negotiation. These games stage dynamic confrontations with dangerous antagonists in combat and chase sequences. They focus on the actionable fear of an immediate threat. Of course, the two modes of gameplay may coexist within a single game, as they do in *Outlast*. They may also shade into one another at the conceptual fringe. The point is only that the two modes are assigned different weightings in individual games according to the kind of coping experience that the game aims to foster. (See Perron's [2005] discussion on 'horror' vs. 'terror' for a somewhat similar argument.)

The signatures of these two basic modes, we propose, emerge at different levels of analysis in the horror genre. For example, they instantiate in a specifically horrific frame what Grodal (2003) terms the fundamental gameplay activities of *explorative* and *dynamic coping*. The former, signified by the player's flashlight and monster-sensitive radio in *Silent Hill 2*, is about slow-paced and careful exploration of the gameworld. The latter, signified by the advanced weaponry available to the player in *Dead Space*, is about overcoming an immediate challenge. Also, and as already mentioned, the twin poles are respectively typified in the broad genre configurations of survival- and action-horror, as well as in the general affective categories of anxiety and fear. They even emerge at the level of production geography (Picard 2009): threat assessment, as embodied in the experience of survival-horror, is frequently associated with Eastern horror game developers. Threat negotiation, as embodied in the experience of action-horror, is associated with western developers.

Horror video games, then, are organized around the quintessentially adaptive pursuits of threat assessment and threat negotiation. From the perspective of the player, these pursuits involve appraising and fighting or fleeing threats to one's (avatar's) life. (Of course, horror games can be organized around other themes as well, but that would normally warrant an additional genre tag, such as with a puzzle-horror game.) Recognition of the fact that horror video games stage evolutionarily resonant, prototypical fear scenarios for their *players* almost forces the question of the genre's paradoxical appeal upon the analyst. The dubious selling proposition of finding oneself *Alone in the Dark* (Infogrames, 1992) or *Left 4 Dead* (Valve South, 2008) is, if anything, more puzzling than the appeal of witnessing others so afflicted.

The appeal of virtual danger

Building on Clasen's (2017) adaptationist perspective on horror, we argue that the appeal of horror video games rests on their capacity to provide safe experience with prototypical fear scenarios. Our roaming, social, omnivorous species has faced many and varied dangers over evolutionary time, and it is adaptive (and therefore enjoyable) for us to obtain information about which threats are out there and how best to negotiate them. Humans have exchanged such information for millennia through the telling of scary stories (Clasen 2017; Sugiyama 2001). Because stories of danger and its avoidance transmit survival-relevant information, they capture our attention and stick in memory, as shown by research on adaptive cognitive biases (e.g. Nairne and Pandeirada 2016). Video games are not merely digitized stories, however. Unlike its non-interactive counterparts, the modern horror video game offers an involved experience that centres on the self. The medium lets players simulate danger – not the abstract slow burn of a carcinogenic cigarette, but the blazing fear of being preyed upon – and practice effective coping.

This argument derives its functional logic from what the play theorist Brian Sutton-Smith, in his influential *The Ambiguity of Play* ([1997] 2009), termed the pervasive 'progression rhetoric' of play. Sutton-Smith noted that many play theorists made much of the putative adaptive benefits of play, to the extent that it was 'the most popular play explanation among many animal theorists' (2009: 30). Though not entirely dismissive of this perspective, he identified problems with the literature and concluded that the broad functional claims that had been made about play lacked sufficient empirical evidence. The years following the publication of *The Ambiguity of Play*, however, saw continued interest in the topic of the adaptive benefits of play across, especially, the mammalian species. These inquiries produced a wealth of evidence for the adaptive functions of human and animal play (e.g. Burghardt 2014; Spinka et al. 2001; Steen and Owens 2001), including simulative play in humans (Vorderer et al. 2006). Across different animal taxa, play behaviours recapitulate aspects of adaptive adult behaviours. It is no coincidence that humans, with our vast behavioural repertoire, exhibit the most varied and creative forms of play of any species (Vorderer et al. 2006). As for the adaptive benefits of horror gameplay specifically, the limited available evidence indicates that players may learn to cope with fear through playing horror video games. Repeated exposure makes the gameplay experience more enjoyable and less scary. In addition, it whets the appetite for more intense forms of horrific experience against which to test one's resolve (Andrade and Cohen 2007; Vachiratamporn et al. 2015). Players seem continually to push against their fears by graduating the experience so as to be scary without being horrifying to the point of forcing disengagement.

As already noted, horror games are not frightening because they feature ancestral dangers. Rather, the games are frightening because they afford players involved *experiences* of ancestral danger. The same type of argument elucidates the player's motivation for horrific gameplay. Horror games are not engaging merely because they feature scary scenarios (who would buy a game that offered nothing but a series of thematically unrelated startles?), but because they make such scares the core of a complete simulative system that promises a sustained, ego-focused challenge of threat assessment and threat negotiation. Juul (2013) points out that something like the paradox of horror applies to most challenging games. Players may fail time and time again and thus come to experience abiding negative emotion. However, the game always holds out the promise of a final resolution, or at least of the attainment of desirable goal-states, such as a public top score or an in-game unlock. You are supposed to be able to do well at a game, to *beat it*, and players know that. The implicit promise of a surmountable challenge motivates players to power through negative emotion such as frustration (Malone and Lepper 1987). They come to construe diverse gameplay obstacles and antagonists as stimulating challenges to overcome. Mastery, and in particular adaptive mastery, can be its own motivation (Aunger and Curtis 2013).

The promise of a fair challenge structures all aspects of horror gameplay and helps explain why the notion of a fear-based entertainment simulator is not a contradiction in terms. Within mere minutes of gameplay, players will normally know what they are supposed to do because the game telegraphs its goals as well as their moments of completion. This teleological inscription can often simply be read off at the level of narrative setup ('escape the haunted mansion'), but, as Gee (2003: 109) points out, it may also be gleaned at different levels of game design. In a 2D horror game like *Limbo*, for example, the perspective frames the player's sustained effort to move the avatar

rightward. Based simply on the perspective and the avatar's orientation within it, the player knows that he or she is being challenged to reach some as yet unseen goal to the far right, and to contend effectively with the dangers that lurk between the avatar's starting position and the implied desired end state. To a seasoned player, one fully versed in the unforgiving 2D-platformers of the early 1990s, for instance, this implicit ludic signifier reads like an open challenge: 'can you do it, despite the perils ahead?'. Adventurous individuals will know the real-life counterpart of this challenge, as well as its motivating force. It aptly begins: 'I dare you...'

Supporting this interpretation, Lynch and Martins (2015) found that the personality trait of sensation seeking (a preference for highly arousing and oftentimes dangerous experiences) predicted liking of horror video games. More recently, Clasen et al. (2018) found that, from a battery of standard personality measures, sensation seeking was the most predictive of horror media enjoyment. The quintessentially adaptive challenge of horror is nothing if not intensely stimulating. That is why studies have found that the negative emotions associated with horror are complemented by positive emotions such as anticipation, bravery and joy (Andrade and Cohen 2007; Clasen et al. 2018; Lynch and Martins 2015).

Horror games, then, infuse the imaginative lure and excitement of prototypical fear scenarios with progression structures that make for a ludically rewarding experience. They provide gamified incentive. The other side of such deep gamification is the removal or omission of disincentives inherent in unmediated experiences of horror. One such disincentive is immediately obvious: real predators can hurt you, whereas their digital counterparts cannot. Reasonably enough, the risk of death or serious injury limits the enjoyment most of us get out of tempting fate. More subtly, horror games, like other genres, offer a customizable gameplay experience that allows the player to set the intensity of different facets of the experience. For example, the player is frequently able to increase or decrease the game's difficulty, which may modulate the player's access to coping measures, such as weapons. The player may also adjust their own sensory immersion by manipulating the sound volume, for example, or by opting in or out of a virtual reality experience, such as is on offer for *Resident Evil 7: Biohazard* (Capcom, 2017). Finally, players can choose to quit whenever they want, thus segmenting gameplay into 'bounded experiences of fear' (Perron 2005: n.pag.) that are manageable for audiences of diverse temperaments. These choices find counterparts in domains of real-life play, such as play fighting, where the ebullient contestants can signal when things get too rough or too exhausting. Their motivational significance is supported by the psychological literature on *benign masochism*, the phenomenon that people often come to enjoy initially aversive activities, such as eating spicy foods or running long distances, as long as the intensity of those activities can be controlled (Rozin et al. 2013, see also Clasen et al. 2018). All of this is to point out ways in which the experience of playing horror video games is basically *dissimilar* to that of suffering a prototypical horror scenario in real life. These dissimilarities converge in an incentive structure that motivates the player's ludic engagement in activities that, *sans* deep gamification, would put almost anyone off.

Those who set out for the simulated abyss of horror video games, then, will get to experience 'extremity of circumstance in perfect safety', thereby 'deepening and widening [their] emotional experience', to quote horror author Peter Straub (Clasen 2009: 40). They will need to pay close attention to their

environment to progress, as in *Silent Hill 2* (Konami, 2001). They will need vigilance and fast reflexes to escape the frenzied axe-murderer Jason Vorhees in *Friday the 13th: The Game* (IllFonic, 2017). And they will have to control their fear to focus on the life-and-death decisions at hand, as in *Five Nights at Freddy's* (Cawthon, 2014). In short, players will come to practise and master challenges of threat assessment and threat negotiation.

As we shall now argue, the same kinds of challenge abound in Playdead's *Limbo*. While *Limbo's* platforming gameplay may not represent a prototypical horror-game experience, such as has been defined by high-profile series including *Resident Evil*, *Silent Hill* and *Alone in the Dark*, its liminal nature will serve to bring out discriminant features of the genre. The analysis of *Limbo* features as a demonstration that the theoretical apparatus we have outlined can explain salient features of a concrete gameplay experience.

Limbo

Limbo is a 2D side-scrolling puzzle-horror game with platforming elements. It was first released as an Xbox Live Arcade exclusive for the Xbox 360 in 2010. The game's success prompted later releases on a range of platforms, including PC, PlayStation 4 and Xbox One.

Limbo's narrative premise is exhausted by its tagline: *Unsure of his sister's fate, a boy enters Limbo*. The player assumes the role of the unnamed boy, who must traverse a series of achromatic, Stygian environments to find his lost sister. These environments include a dark forest, an abandoned factory and a desolate city. When at the end of the game the boy finally reunites with his sister, her strangely ambiguous reaction is eclipsed by the end credits.

Basic though it is, the one-sentence narrative premise of *Limbo* carries motivating significance. This is easily demonstrated with the flat bathos of a modified tagline: *Unsure of a girl's fate, a boy enters Limbo*. The motif of imperilled family has an evolutionary underpinning that accounts for its narrative ubiquity (Boyd et al. 2010). Specifically, humans are intensely social creatures that cross-culturally depend on family to survive and thrive. This fitness dependency explains why human social investment and sacrifice tend to increase with genetic relatedness (Trivers 1972). Children in particular exert an altruistic pull because of their helplessness: an adult left to his or her own devices may survive; a small child will not (Hrdy 2005). In video games as in more traditional media, a helpless child of or related to the protagonist is often introduced and then brought into danger to motivate a protective or restorative effort in the player (Eichner 2016). *Limbo* uses this simple and conventionalized premise to build a meaningful incentive structure with minimal disclosure of narrative contents; it tells the player just enough to make the gameplay effort seem meaningful. This sets an important precedent for the game as a whole. *Limbo's* minimalist set-up invites the player to enter the experience with minimal expectations. We know exactly as little about the gameworld as the name- and faceless avatar. This perspectival alignment pushes the player into an ego-focused mode of engagement characteristic of the genre whereby, as Perron (2009: 125) explains, we are 'urged to act and feel through' the neutral intermediacy of the generic avatar ('a boy'). The game invites the player's virtual presence in providing no psychologically realized character to substitute for it (see Grodal 2003; Nørgård 2011 for similar arguments).

Like its exposition, *Limbo's* interface and controls are rudimentary. The game features no Heads-Up Display (HUD) during actual gameplay, and



Figure 1: In the opening chapter of *Limbo*, the player's avatar awakens in a gloomy forest. The player is given no indication as to what lies in wait. Screenshot from *Limbo*, copyright Playdead 2010. Reproduced under fair use.

hence minimizes the semiotic distance between the player and the game-world (Pinchbeck 2009). The player does not need to interpret symbols such as health gauges or life counters, which telegraph the artificial nature of the game and may therefore break narrative immersion (Saunders and Novak 2007). *Limbo's* director, Arnt Jensen, seems to endorse this rationale. In response to the suggestion that *Limbo* is so popular because it is 'quick to get into, simple, readable', he stressed that '[y]ou should almost never notice the world around, just get sucked into it' (Nutt 2012: 4). The aim of accessibility appears also to have guided the design of the game's controls. In the PC version of the game, the player moves left, right, up (jump, climb up) and down (climb down) by pressing the corresponding arrow keys on the keyboard. The only additional input is a context-sensitive action key, whose functions include grabbing and pushing. Imprecision in operating this control scheme will typically result in the death of the avatar, who may be torn, dismembered, pierced, torched, crushed, electrocuted, flung and drowned over the course of a single play session. Faced with these odds, the player must pay close attention to the gameworld to negotiate its threats, apprehend its affordances, solve its puzzles and ultimately find the lost sister.

The minimalist set-up and simple gameplay of *Limbo* mesh well with its nightmarish themes. As noted, players quickly master the game's controls and mechanics, and this allows them to absorb the game's shadowy ambience. Unidentifiable noises signal danger. The hint of an agent in the distance puts the player on edge. As H. P. Lovecraft saw and exploited in a literary mode, '[t]he oldest and strongest kind of fear is fear of the unknown' ([1927] 1971: 12). *Limbo* conveys a looming sense of peril without revealing its object, and consequently the player's imagination runs laps to supply it. As already discussed, the phenomenon is well understood by evolutionary psychologists: evolved cognitive heuristics make us hyper-vigilant in the face of ambiguous cues. *Limbo* plays to this adaptive bias by presenting objects hard to identify

in the game's 2D, fog-ridden darkness. Yet it also nudges sinister interpretations. A nondescript bundle on the ground, for example, becomes more salient because of the flies buzzing about it. *Could that be a dead body?*

Fictional worlds may be necessarily incomplete (Pavel 1986), but *Limbo's* ubiquitous sense of vagueness is by design. Jensen has been at pains to stress ambiguity and uncertainty as central to all aspects of *Limbo*, from individual sound bites to overarching narrative:

The whole concept of the visuals, the horizon is always blurred so you can project your own things into the spaces. I tried to do the same with the sound with noise and textures – you start to hear things that aren't there.

(Thomsen 2010: 2)

While the game does feature sequences of frantic threat negotiation, as we shall discuss shortly, its overall affective mood is one of anxious threat assessment.

The hostile denizens of *Limbo's* netherworld fall within a constrained possibility space of ancestral dangers. A particularly nasty example is the aforementioned giant spider that stalks the avatar throughout the early game. Poisonous spiders and snakes have exerted significant selection pressures on our mammalian fear system, and this explains why they crowd the imaginary landscapes of horror fiction across different media, cultures and historical periods (Clasen 2017). In support of this thesis, researchers have found that humans, like other mammals, come to fear some things, and especially some living things, much more easily than others. Evidence converges from the ubiquity of spider and snake phobias (Öhman and Mineka 2001), asymmetrically rapid – or 'prepared' – fear conditioning to such natural predators (Öhman 2007) and their enhanced salience in visual identification tasks (LoBue and DeLoache 2008). *Limbo's* giant spider, moreover, is even more



Figure 2: *Limbo's* atmosphere is deeply unsettling and intensely suggestive. Screenshot from *Limbo*, copyright Playdead 2010. Reproduced under fair use.

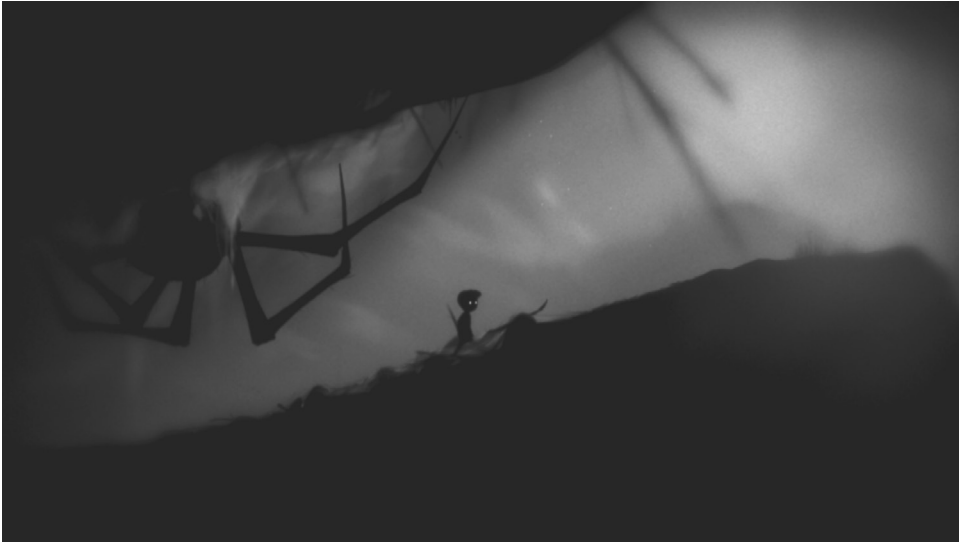


Figure 3: A giant arachnid creature stalks the avatar. Screenshot from *Limbo*, copyright Playdead 2010. Reproduced under fair use.

frightening than real arachnids because of its absurdly enlarged morphology. As such, it instantiates a basic psychological principle: human reactions tend to scale with their elicitors (Barrett 2010). This is because the magnitude of the elicitor tends to correlate with its positive or negative fitness value: a big meal nourishes more than its less satiating counterpart. *Limbo's* spider is especially threatening, then, because it is a *supernormal* stimulus – an artificially hypertrophied predator-antagonist. If one were to search through abstract morphological design space for something sure to scare genus *Homo*, this would be it.

Another predictable threat in *Limbo* is strangers. The first half of the game features groups of psychotic children, who are out to kill the player with weapons and traps of various kinds. These murderous silhouettes trigger continuous anxiety and vigilance in the player for good adaptive reasons. Conspecifics from competing coalitions have, like spiders, exerted a substantial selection pressure on the hominin lineage (Gat 2006). Humans, in turn, have evolved to respond to strangers with vigilant apprehension (Navarrete et al. 2009). Following the first encounters with the strangers in *Limbo*, players interpret environmental hazards as traps set specifically for them, whether or not that is indeed the case. The humanoid agents come to hint at this disconcerting connection because we intuitively assume them to be deeply intentionalistic – to want specific outcomes and to proactively organize their environments to bring about those outcomes. Similarly, strange noises come to signal the machinations of hostile agents because, again, it generally pays to assume the worst (Garner and Grimshaw 2011).

Limbo's atmosphere changes quite suddenly about midway through the game, when the player enters a deserted city. The gameworld's malicious agents disappear, and the number of scripted chills is markedly reduced. In their place, the game predominantly loads on puzzles. Jensen has commented on this shift, admitting that he views it as a genuine design flaw, a 'big wound' in his own words (Thomsen 2010). The shift does counterbalance *Limbo's* unsettling mood, as the player's attention shifts from the game's oppressive ambiance and occasional horrific spectacle to the abstracted mechanics of

puzzle solving. For the purposes of this analysis, the change is mostly interesting in a negative sense; it is the reason why the first half of *Limbo* is much more frightening than the second. The human fear system is especially attuned to agency, to things that act on their own accord (Arrindell et al. 1991). When *Limbo* subtracts (the suggestion of) threatening agency, it also largely subtracts what otherwise qualifies it as a puzzle-horror game. As a *GameSpot* reviewer put this point, '[t]he later puzzles are complex and clever, but they don't haunt the heart' (VanOrd 2014). The gameplay experience becomes less about absorption into the anxiety-inducing fictional world – an evocative setting for simulative engagement – and more about the gameplay emotions that attend mechanical challenge, such as pride and frustration (Lazzaro 2004; Perron 2005).

Principally in its early and most frightening parts, *Limbo* uses a variety of technical emphases to chilling effect. The game's dynamic sound design is particularly noteworthy. The sounds of on-screen and oncoming dangerous agents and obstacles are consistently accentuated relative to the ambient underscore. Take, for example, the first encounter with the game's giant spider: partially occluded by vegetation in the foreground parallax, the eldritch monster suddenly thrusts an enormous, spiked leg towards the player avatar, and the kinesonic experience of virtual impalement is suitably piercing. Likewise, the gameworld's many traps, including bear traps, automated machine guns and falling rocks, trigger scripted sound sequences of discrepantly high volume. Such auditory spikes induce strong reactions in the player, partly due to the inherently frightening nature of loud noises, partly to potentiation by antecedent cues to danger (Grillon and Davis 1997; Garner and Grimshaw 2011). As in *Outlast*, these spikes signal a shift from explorative coping to dynamic coping, from deliberate threat assessment to fervent threat negotiation.

These devices, moreover, never work in isolation. When the player blunders, a frequent result is the death of the avatar followed by the retrieval of the last save state. This negative feedback, combined with the game's implicit promise of its own surmountability, encourages vigilance and practice: coping, in a word. The coping of *Limbo* is genre-consistent and thematically addresses the evolved human fear system, whose function is exactly the instigation of adaptive coping in response to environmental threat (Öhman and Mineka 2001). Such priming sharpens player focus and accords apperceptive primacy to the stimulated senses – a fact that, coming full circle, is exploited in the game's densely acousmatic sound design, which always suggests at unknown agentic forces operating beyond the confines of the *mise-en-scène*. *Limbo*, like other competent horror games, approximates the structural invariants of real danger across its modalities, and this integration makes it powerfully engrossing (Anderson 1996; Toprac and Abdel-Meguid 2011).

The sense of careful integration of all aspects of *Limbo* extends upwards even to the game's evocative art direction, which draws inspiration from German expressionism and film noir. These stylistic frames are not just aesthetically appealing in *Limbo*. They guide the player's expectations to its bleak and dilapidated gameworld. Notably, the theme of insanity, a leitmotif of the expressionist tradition, looms large about one-third into the game, when the player begins to encounter parasitic 'brain worms'. These slugs descend from ledges and latch onto the boy's head, boring into his brain to take control of his body. Players experience reduced control, as they can only retard the slug's overriding will by pressing the arrow keys in the direction opposite to its pull. *Limbo* represents the boy's loss of sanity and agency by warping and twisting the player's semi-subjective visual field, and by manipulating the loudness and timbre of the diegetic sounds to make them appear

distant. This cross-modal cinematic convention draws inspiration from such classic works as *The Cabinet of Dr. Caligari* (Wiene, 1920), in which twisted and impossible angles convey the main character's mental breakdown. But the convention also pivots on a naturalistic basis: insanity really does have something to do with perceiving one's environment in an altered way. *Limbo* thus uses a conventional phenomenal representation of insanity to construct a metaludic frame, allowing it to evoke themes of perceptual unreliability: if you are insane, you cannot trust your own senses. What you hear and see may represent what is haunting your mind rather than what is haunting your surroundings. The theme of insanity thus plays right into human hyper-vigilance. In addition, the game's stark minimalism allows it to represent concrete threats with minimal conceptual texture. The 2D gameworld is replete with

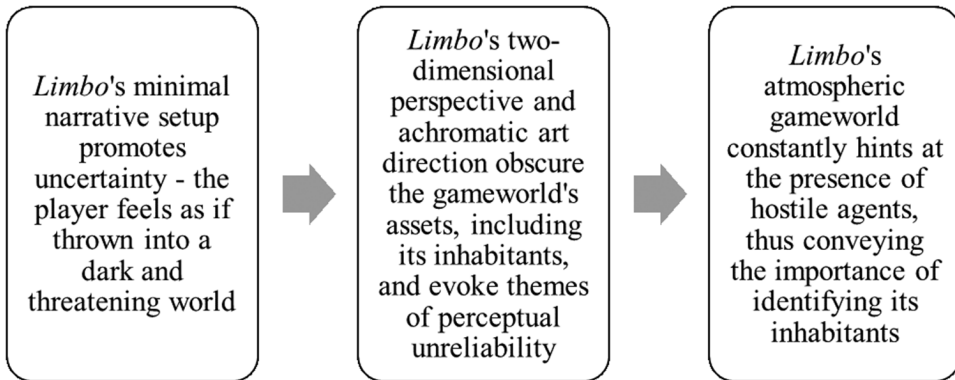


Figure 4: *Limbo's* design comes together to minimize what players know about their situation while simultaneously motivating their survival-based need-to-know – their threat assessment. Diagram created by the authors.

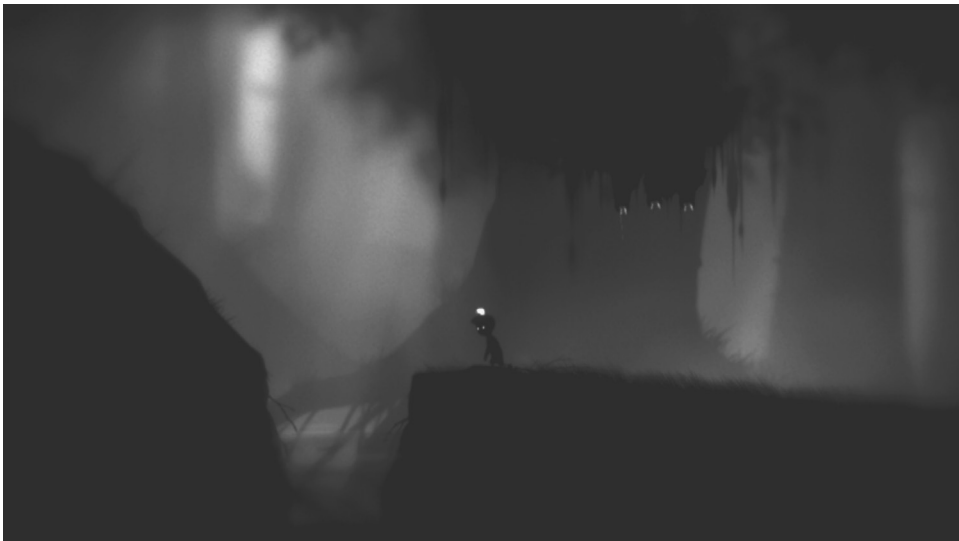


Figure 5: A brain worm has wrested bodily control from the avatar. Screenshot from *Limbo*, copyright Playdead 2010. Reproduced under fair use.

black contours that are inherently difficult to classify. This is a felicitous setting for suspenseful engagement – ‘is that just a bough or something living and dangerous?’ – and it fractionates seamlessly from a higher-level design choice. The point, once more, is design-dimensional synergy. *Limbo*'s stylistic makeup harmonizes with its inherently frightening subject matter. It is a dark and unsettling game through and through.

The core experience of playing *Limbo* can be accurately characterized as a survival gauntlet – a series of life-threatening events and encounters endured under conditions of profound uncertainty. This conception is mirrored in the developers' characterization of the gameplay experience as one of ‘trial and death’ (Hatfield 2010). Such an experience could only prove attractive when ludically transformed. The transformation is signalled by the very nature of the video game medium, as discussed in the previous section, but it is also evident in the flow and progression of *Limbo*'s gameplay specifically. When players first face a novel threat, such as the giant spider or the murderous children, the threat is presented distally and only in glimpses. These fleeting encounters warn players that a serious threat is out there and eminently worthy of their attention. They encourage coping measures that centre on threat assessment, such as vigilantly scanning the horizon for more hints of what lies in wait. After some such fleeting encounters, the threat suddenly intrudes fully into the frame. Players must now engage dynamically with the threat in attempting to evade its attacks. This happens, for instance, when the murderous children send a flaming tire rolling towards the player from atop an overhang. The player must dash forward to avoid a fatal collision.

Finally, players find themselves in situations that allow them to overcome the threat through problem-focused coping. For example, coming upon a large boulder while being chased by the spider, and having themselves been squashed by a boulder at an earlier point in the game, players immediately perceive the boulder as a weapon to use against the spider. And after having earlier been repeatedly flattened by pressure-activated hydraulic crushers, players realize that they can bait the murderous kids onto the crushers to pay the lesson forward. These learning sequences conform to the distinctly survival-themed progression structure of threat assessment and negotiation. They give the player a palatable sense of progression and mastery within a dangerous virtual world designed to test them.

As a simulative system, *Limbo* invites players to experience their primal fear circuits blasted from within – through cuing the player's nervous projections of hostile agents into the gameworld – and without – through few but impactful confrontations with such fearsome agents as the gameworld contains. The appeal of this experience is that of daunting but ultimately risk-free challenge, of venturing into the virtual darkness with its heartening promise of a safe return.

Conclusion

An evolutionary analysis explains the paradox of virtual horror, such as that found in *Limbo*, by linking the genre's forms and functions. Horror games do not just motivate players by frightening them. That truly would be paradoxical. Instead, they challenge players to *overcome* fear and danger, an aim that is entirely comprehensible in evolutionary terms. To reliably provoke fear, horror games let players experience ancestral fear scenarios. To reliably motivate

gameplay, horror games ludically stage these scenarios as obstacles to be overcome – as adaptive challenges of fearful coping.

We hope that the evolutionary approach to horror video games outlined in this article will prove fruitful to both humanist and social scientific researchers of horror video games. Even more so, we hope that it may point a way towards collaborative empirical and interpretative efforts to understand this rich genre.

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CONTRIBUTOR DETAILS

Jens Kjeldgaard-Christiansen is Ph.D. fellow in the Department of English, Aarhus University, Denmark. His research applies biocultural and cognitive perspectives to the heroes and villains of popular culture. His work appears in journals such as *The Journal of Popular Culture*, *Evolutionary Studies in Imaginative Culture* and *Projections: The Journal for Movies and Mind*.

Contact: Department of English, Aarhus University, Jens Chr. Skous Vej 4, 8000 Aarhus C, Denmark.

E-mail: jkc@cc.au.dk

 <https://orcid.org/0000-0002-5270-4531>

Mathias Clasen is associate professor of literature and media in the Department of English, Aarhus University, Denmark, and associate editor of the journal *Evolutionary Studies in Imaginative Culture*. His research focuses on horror across media, and he has developed a biocultural framework for the analysis of scary entertainment. His research monograph, *Why Horror Seduces*, was published in 2017 by Oxford University Press.

Contact: Department of English, Aarhus University, Jens Chr. Skous Vej 4, 8000 Aarhus C, Denmark.

E-mail: mc@cc.au.dk

 <https://orcid.org/0000-0003-0830-0078>

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