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A climate of fear

considerations for designing a virtual acoustic ecology of fear

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A Climate of Fear: Considerations for Designing a Virtual Acoustic Ecology of Fear

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ABSTRACT
This paper proposes a framework that incorporates fear, acoustics, thought processing and digital game sound theory; with the potential to not only improve understanding of our relationship with fear, but also generate a foundation for reliable and significant manipulation of the fear experience. A brief literature review provides the context for a discussion of fear and sound in virtual worlds before the framework is described; concluding remarks point to future empirical work testing and refining the framework.

Categories & Subject Descriptors
H.5.1 [**Information Interfaces & Presentation**]: audio input/output

General Terms
Human factors, theory

Keywords
Emotion, affect, fear, perception, ecology

1. INTRODUCTION
The intrinsic presence of hope and fear within a suspenseful narrative increases the potential for user-character investment and emotional experience [1]. In a non-interactive context, Zillman [2] identifies fear as the crucial component of suspense, arguing that concern for the well-being of the narrative characters and anticipation of negative plot resolutions generates the suspense that hooks the viewer. For video games, the habitual association with scenarios containing a variety of severely negative potential outcomes suggests that fear and suspense are already acknowledged, and within game genres such as survival-horror, fear is a necessity [3]. Whilst the fundamental approach to fear manipulation is drawn from the creative instinct of the developer, we suggest that a theoretical framework for understanding the macro and micro processes that exist within a fearful experience would serve to increase the intensity and reliability of fear-induction design in survival horror video games and other related media.

The potential for a digital game to evoke emotional responses beyond those intrinsically drawn from gameplay (such as frustration, anger, joy, competitiveness) supports the increasing sophistication of game design that is allowing virtual worlds to more closely reflect aspects of reality. Whilst several game genres would arguably benefit from emotion-related developments, it is the fundamental first-person shooter approach of positioning of the player within a simulated world that supports the notion of emotional ecologies paralleling those of the real world. Here, ecology refers to the relationship between a living organism (player) and their surroundings. Experience of computer gameplay seats the player within a virtual environment in addition to reality, revealing three interrelating entities that separate a conventional ecology from a virtual ecology.

For the purposes of this discussion, reality refers to the everyday world in which we operate, whilst virtuality refers to the artificial environment contained within a computer game. Players relate to the environment of reality through visual, acoustic, kinaesthetic, haptic, olfactory and gustatory interactions that can be mapped onto ecological profiles. However, it should be acknowledged that reality and virtuality are not independent. The *reality-virtuality* continuum is a concept that highlights not only their differences but also their shared properties. Thus, in order to achieve a comprehensive understanding of a virtual ecology, we must first comprehend the ecology through the lens of reality.

Human-computer interaction has been argued to be largely social, and an understanding and appreciation of emotional function is as crucial to human-computer interfacing as it is to exchanges between two people [4]. The nature of computer games makes them ideal for exploring human-computer relations [5]. The cognitive perspective has long been metaphorically associated with computing; traditional cognitive theory disassociates emotion from cognition, describing each as individual processes that interact [6]. This has recently been challenged, however, and emotions argued to be not only an integral component of the cognitive process, but also to influence attention, thought and behaviour [7; 8]. The subsequent sections explore the concept of fear; first by defining key components and relevant terminology, then utilising existing research to explore the inner processes, individual variables and relationships that characterise fear. Differences between reality and virtuality-based experience are documented, and computer game audio research is reviewed to assess the roles of acoustic parameters, psychoacoustic listening modes and cognitive appraisals of audio, within a virtual acoustic ecology of fear.

2. UNDERSTANDING FEAR
For the purposes of this paper, fear is positioned as a master-term, to which all associated words (horror, terror, anxiety, suspense, etc.) branch from. Freud [9] asserts that fears are subconscious efforts to avoid disturbing experiences; generating aversive behavioural responses to stimuli perceived as threatening to an

individual's physical and/or psychological well-being. A more recent perspective defines fear similarly as 'an activated, aversive emotional state that serves to […] cope with events that provide threats to the survival or well-being of organisms' [10]. The fear response is commonly associated with aversive behaviour [11] neatly characterised as fight, flight and freeze actions [12]. This concept positions object (stimulus), perception (of threat) and response (aversive action) as organised components of an interactive process.

A step towards a more reductionist view positions the awful apprehension of *terror* and the sickening realisation of *horror* [13] as crucial elements of the fear sensation. Similarly, horror is a revelatory event, incurring deep upset manifest as overt human behaviour, and terror as the anticipatory trepidation [14]. Terror is evasive, action-orientated and situational whilst horror encourages fixation and is object-focused [15; 16]. The two components are very possibly co-dependent (each requiring the other to exist) and the causality between them appears to be unidirectional; an existing appreciation of a horrific stimulus is required to rouse the relevant sensation of terror, as can be observed in phenomena such as phobias [17] and post-traumatic stress disorder [18]. The computer games industry shows an awareness of the various cogs spinning within the fear machine with different titles employing varied tactics based upon these elements. A good example of this distinction are the original *Resident Evil* (Capcom, 1996) and *Silent Hill* (Konami 1999) games; the former relying heavily upon horrific gore and startle, and the latter employing steady pacing and terrifying, slow-building tension. This is not to say that these titles were opposites in their approach. Both utilise gore, violence, horrific monstrous antagonists, tense uncertainties, and striking revelations. Baird's [19] fear process of '(1) a character presence, (2) an implied off-screen threat, and (3) a disturbing intrusion' arguably applies to both games; the difference lies in subtle variations in pacing and direction of attention.

One of the core elements of a horrific experience is startle (also referred to as shock or surprise). Abruptness is the key to startle elicitation and the attack of the startle stimulus should ideally be instantaneous [20]. The two components of startle are 'evaluation of the stimulus as unanticipated' and 'reaction time' [21], supporting the notion that a startle must be both unexpected and sudden, allowing little or no time to appraise the situation cognitively or produce a rational reaction. Perceiving the startle effect as a variable in the horror-terror interaction helps us to neatly distinguish the two gaming approaches to evoking fear during play. Whereas the horror approach utilises immediate startle probes that encourage autonomic response behaviour, the terror approach employs forewarning and paced revelations that support cognitive appraisals and generation of unnerving hypotheses from our expectations of the macabre. It is the temporal element that establishes the difference between horror and terror-based approaches to fear elicitation.

Terror, anxiety and suspense cannot be viewed simply as indicators of intensity. Whilst it logical to assume that the relative values of the quantitative variables associated with fear (probability, temporal immediacy, potential damage, coping ability and spacial proximity of the negative event) can distinguish between these three types, they do not merely exist on a basic linear construct. Whilst certain definitions of anxiety bear resemblance to terror [22; 23], anxiety can refer to a relatively long-term state of distress incited by more general, implicit cues [11]. Svendsen [24] identifies anxiety as an internal experience, greatly associated with physiological responses of the Sympathetic Nervous System (SNS); a view reciprocated with Bourke [25], who described anxiety as fear from within, and to distinguish between fear and anxiety quotes Freud: '[A]nxiety relates to the condition and ignores the object, whereas in the word fear attention is focussed on the object'. Freud's theory does not suggest that the framework of anxiety is devoid of an object, but that the connection between object and individual is indirect and distant.

The concept of object is analogous to that of threat which is at the heart of an anticipatory fear response [26]. Other synonymous terms within this context include *danger* and *peril* [27]. Ultimately, such terms could be defined as loss of that which is perceived valuable and gain of that which is painful. If threat is defined as the true underlying source of a fear response it could be suggested that the threat is not the invading entity, nor the action; but instead the loss that may result. For example, the true source of our fear is not necessarily the psychotic killer advancing, or the act of a vicious attack, but the permanent damage or death that their assault signifies. The notion of loss has been applied to our understanding of CVG emotional experiences with research suggesting that loss of progress and flow is a key contributor to stress and tension during gameplay [8; 28]. Although both fear and anxiety can be reduced to wellbeing defence procedures, the absence of an immediate and objective threat distinguishes between the two. Here anxiety is described as an undesirable internalisation of the *horror-terror* process and it is consequently associated with the purely negative response to fear stimuli. After experiencing a terrifying stimulus, such an internalisation would lead to continued production of unnerving hypotheses for a prolonged period even after the object has been removed. The fearful sensation would continue outside the boundaries of the stimulus and potentially attach itself to perceptually related entities, all of this outside the control of the individual. In a CVG context, all cognitive, autonomic and behavioural responses to fear can be viewed as positive provided they occur only within the temporal boundaries of gameplay and the user-defined intensity margins. The survival horror players have willingly subjected themselves to these stimuli, understanding the consequences but reserving the right to cease all frightening sensation at their command and expectant that removal of the fear object will indeed do so. In this circumstance, a continued sensation without object denotes loss of emotional control and there is the potential that such anxiety may harm emotional and physical wellness [29].

Acting in this framework as a counterpart to anxiety, *suspense* is defined as a desirable emotional sensation and is identified as a critical component of fiction media and a driver of CVG enjoyment [30]. Zillman defines suspense as 'an experience of uncertainty whose hedonic properties can vary from noxious to pleasant' [2], suggesting that the value of uncertainty is the causal variable that defines the experience and that high levels of uncertainty are likely to be distinctly unpleasant. Within the boundaries of fictional media, however, this unpleasantness would arguably be a lack of coherence in the plot or a difficulty for the audience to relate to the events rather than a response of genuine upset. The notion of uncertainty is arguably a requirement of both fear and suspense [16; 31]. Furthermore, it can be attributed to both the concepts of terror and horror; the former because 'uncertainty and danger are always closely allied; thus making any kind of an unknown world a world of peril and evil possibilities' [27], the latter because shock is an intrinsic part of a horrific event (distinguishing horror from pain, sadness and disgust). Massumi

argues that fear is derived from threat and that a genuine threat cannot take a substantial and immediate form; the nature of a threat is an indeterminate futurity, '[i]ts future looming casts a present shadow, and that shadow is fear' [31]. Perron [16] argues that without uncertainty, suspense cannot occur; a view supported by Comisky and Bryant [32] who noted participant-rated suspense was minimal when either success or failure appeared absolutely certain. Audiences are even capable of experiencing suspense during repetitions of fiction because the investment in the protagonist is sustainable over several repeat experiences, and recidivist behaviour creates a sense of denial where the outcome is displaced and the focus is on the present chronology within the fiction [33].

3. PROCESSES AND VARIABLES

Existing theory asserts that fear responses originate from both a central evolutionary circuit and conditioned behavioural responses [34]. Evolutionary based emotional responses (arguably including fear) are hard-wired processes that can be observed in both humans and animals [35], suggesting that a fear response is likely to be instinctive and display comparable response behaviours. Massumi [31] argues that, if exposed to the same fear stimulus, each individual will experience the sensation differently; a notion supported by Cacioppo [36] who observed varying emotional experiences between individuals in response to identical physiological and somatic states. Massumi does, however, outline a process which exists along a temporal plane that can be interpreted as a universal framework of the fear experience. Threat is the origin of a fear sensation but ironically is a futurity that can only be manifest in the present if a fearful response is generated. Massumi refers to the chronological order of events as the *line of fright* and argues that, during the initial stages of fear, the emotional sensation and physical actions of the body are indistinguishable, moving in parallel along the line of fright. At this stage emotional and physical responses are both governed by the conditioned autonomic processing of the threat. Overt physical action (characterised as fight or flight within a fear scenario), although typically determined consciously by the somatic nervous system, appears automated. Certain involuntary motor movements (covering face, shutting eyelids, evasive running, etc.) can result when action impulses bypass the brain; a procedure known as a *somatic reflex arc* [37]. Massumi argues that beyond this stage the subconscious and cognitive loops begin to diverge as the former continues to be influenced primarily by the origin stimulus and begins to desist over time. A hierarchy of emotional processing [38] supports this model by suggesting that expressive motor actions are the primary response to emotional stimuli, followed by perceptual and then conceptual processing. For example, when confronted by a predator, the subconscious response to run is activated and, as the threat reduces due to increased distance, speed decreases and the autonomic action tendency concludes. Massumi describes the cognitive loop as cumulative; taking continuing influence from the changing environment, the response actions and internal representations. Cognitive processing continues beyond the cessation of the subconscious loop and it is at this stage that initial shock and automated response subsides, allowing emotional evaluation and reflective thought to occur. The above describes a process similar to the stimulus-behaviour-emotion-interpretation (motor feedback) pathway of Ellsworth [39], whose research also documented two alternative pathways and suggested that the nature of the stimulus would determine which was employed.

The interior of human emotion processing consists of the subcortical system and cognitive appraisal; two interrelated, continuous feedback loops connecting the physical environment to the human mind [40]. Located in structures such as the thalamus [10], the sub-cortical routine is concerned with the immediate environment; information is only partially processed, allowing for more instantaneous communication with the (ANS) nervous system; which commands several physiological responses known to be affected by fearful stimuli such as heart rate, respiration, pupil dilation, and blood flow [41]. In contrast, cognitive appraisal (located in the prefrontal cortex) introduces numerous conceptual notions such as logic, comprehension, and semantics; it also involves the identification and communication of our emotional states [42]. One perspective argues that high level construals originate from low level received sensory input in a bottom-up model [43]. For example, a creaking floorboard heard downstairs under cognitive analysis could return increasingly high level construals such as *there is an intruder downstairs*, leading to *their intention may be to hurt me* and finally *I am in danger*.

Cognition is capable of regulating the sub-cortical output, the somatic response and (to an extent) autonomic reactions for various task-orientated goals; including suppression, accentuation and false response [44; 45; 46]. Lang et al. [40] argue that the reactions of the human body to negative stimuli 'depend on the activation of an evolutionarily primitive subcortical circuit, including the amygdala and the neural structures to which it projects'. They suggest that fear appraisal and response originates from human ancestry and the evolutionary principle of survival; a procedure that reveals matching response patterns 'as [we] process objective, memorial, and media stimuli'. Further research expands upon this notion, positioning cognitive reasoning as an integrated development (much like an upgrade). *Rational Darwinism* identifies reason as evolutionary, arguing that all information processes (including rational, higher level cognition) and behavioural responses are developments of animal processes [47].

Having identified the physical and abstract components that make up the fear response, the question remains as to how these systems work together to mobilise the most appropriate behaviour in response to the vast array of fear-related scenarios. To understand this, we must attempt to chronologically examine the individual sub-processes and related variables. Within this framework, the fear process must arguably commence with an input threat assessment to establish which routine to activate, *horror* or *terror*. The characteristics of threat associated stimuli under initial scrutiny are physical and temporal distance [48]. Immediacy of the threat as defined via these variables activates the horror-pathway leading to defensive action, and nociceptive reflexes should damage be sustained [49]. Increased distance instead stimulates the terror-pathway, characteristically resulting in immobility, bradycardia and hyper-attentiveness [50]; a response known as the behavioural inhibition system [12].

Within a genuinely fearful situation, several cues may be observed and terror may not invariably precede horror. A horrific experience is partially characterised by a startle response and consequently, any cue perceived to be sudden has the potential to initiate the horror-pathway. However, the intensity of the stimulus dictates the subcortical activation and the degree to which the cognitive feedback loop can attenuate behaviour. Gameplay during a particularly frightening scene may include several sudden audio stimuli that stimulate a low-intensity response (creaking floorboard, object knocked over) accentuating the terror in

anticipation of the final revelation. Three stages of fear behaviour can be readily applied to a survival horror scenario: *pre-encounter defence* refers to initial anxiety experienced when entering an environment where predators are expected to appear (a dark tunnel, old mansion, or dilapidated factory); *post-encounter defence* describes heightened fear in response to cues that signify the presence of a predator (approaching footsteps, nearby items knocked over, etc.); and *circa-strike* defence refers to an intense fight or flight response when in the region of physical contact and imminent threat (revelation of monster and attack) [48]. The descriptions of the latter two stages reveal a striking similarity to our established definitions of terror and horror respectively. The concept of pre-encounter defence, however, is one that has not yet been addressed within our fear framework and for the purposes of this paper, is referred to as the *caution* stage.

Fearful stimuli can be understood as emotional prompts and cognitive cues for problem solving [16]. Understanding of the relationship that exists between cognitive and subcortical processing requires identification of the variables that determine the degree of control each opposing force will exert. Whilst the immediacy of the threat determines the type of behavioural and autonomic response, it is the intensity of the fear sensation that defines the dynamic between cognitive and subcortical control.However, ease of perceptual processing is a causal variable of emotional experience [51]. Causes of disassociation between input cues such as semantics, modality (visual, auditory, etc.) and attributes have been shown to decrease temporal processing speeds and evoke negative emotional valence [52]. In accordance with the routines described earlier, an increased negative emotional experience is expected to further increase activation of the subcortical response (and, correspondingly, attenuate cognitive processing); the mind essentially perceiving the complexity of the threat cues as a rise in danger level. However, ease of processing should not be confused with ease of identification. Within the context of audio processing, sub-cortical (referred to as pre-attentive) processing can be observed in subjects when appraising complex patterns of sound [53]; this suggests that the sub-cortical routine is capable of processing more than very basic stimuli. However, whilst this autonomic process is capable of identifying a deviant object within a complex and dynamic environment, the task of identification is still arguably a base-level thought process in accordance with Bloom's taxonomy of thought [54].

The purpose of the terror routine is to alter the physiological state in a way that maximises opportunity for aversive response should an immediate threat be presented. Utilising positron emission topography to measure cerebral blood flow, Kimbrell et al. [55] noted that fearful stimuli induced greater blood flow in the inferior frontal gyrus (associated with the go/no go principle) and decreased activity in the cortex. Here, neurobiology supports behaviour, as the inferior frontal and right medial cortex initiates an urgent and direct response routine and the left temporal pole and parietal lobe can be attributed to context (the participants were recollecting past experiences of anxiety, not experiencing physical fearful stimuli). The contextualization of their experiment suggests that overall activity is unlikely to fit the above profile in a direct-interactive fearful scenario and ethical considerations limit researchers' ability to expose participants to immediate physical threats. However, the nature of a CVG environment allows for a simulation that may well reveal the exact neurophysiology of an individual's fear response.

Unpleasant stimuli potentiate startle regardless of subtext and stimuli connoting threat potentiate startle regardless of inherent meaning [56]. This supports the notion that the fear response process is sensitive to both objective and subjective fear-object attributes. In response to a fearful scenario we are primed by the initial stimulus, allowing us to respond to associated subsequent stimuli immediately; as Smith [57] states: 'A fearful mood puts us on emotional alert, and we patrol our environment searching for frightening objects', allowing us to react with more immediacy and increasing the probability of successfully evading the threat. The above findings support the notion that subconscious appraisal (dependent on biological variation and behavioural conditioning) of a terror stimulus stimulates a pattern of physiology that primes the individual for action in response to a horror stimulus (immediate threat). In the context of a horror film, prior knowledge of upcoming events generated increased sensations of fright and upset [58]. However, the nature of the forewarning arguably contained little information that could be utilised to aid survival (supporting uncertainty); with cues consisting of shadowy figures and sounds of masked position as opposed to cues that could reveal the location, identity or weaknesses of the threat. This suggests that forewarning cues that insinuate threat rather than describe it have greater potential to evoke a terror response.

As mentioned earlier, the startle component of a horrifying experience has the potential to significantly alter the intensity of the overall sensation. It has been proposed that the startle mechanism is continuous and that the human individual is unlikely to ever be in a complete state of non-alert [59]. However, a startle response can be potentiated by a preceding cue that connotes danger and threat via a conditioned association [11]. The response is sensitive to the individual's current emotional state and, consequently, such affect-toned material preceding a startle probe has the potential to significantly potentiate or attenuate the intensity of the response [60]. One particular emotional state, capable of dramatically potentiating the startle effect is anxiety [61]; an effect further increased if the nature of the anxious state relates semantically or perceptually to the startle probe. The threat of pain and the induction of disgust have also been associated with potentiating of the startle reflex [57]. Whilst comparison of startle modulation affects (such as fear, disgust, sexual arousal, etc.) strongly supports a valence dimension model, it does not identify the position of individual emotional states within this model.

The relationship between fear types is arguably not unidirectional, and a horrific experience has the potential to influence future terror appraisals. *Triple vulnerability theory* [62], an integrated model of anxiety induction, identifies biological factors: *generalised psychological vulnerability* (associated with a lack of self-confidence and an overarching belief that the world is a dangerous place); and *specific psychological vulnerability* (a belief pertaining towards a discrete object or situation) as causes of anxiety. The latter can be associated with horrifying experience in that specific, intensely emotional events such as these are strong candidates for future anxiety developments. A horrific experience can potentially connect a substantial number of seemingly disparate items via conceptual networking links [63] creating an intricate mesh of associations and, as a result, massively increasing the number of memory items that could potentially impact upon the perception of future objects or events as fear-related and terror inducing. The bidirectional relationship appears to exist within a two-stage framework of fear (terror primes horror). If we are to accept Fanselow's [48] three-tier construct then there is the relationship between pre-encounter

(environment orientated caution) and post-encounter defence (object orientated terror) to consider. Understanding of the exact nature of these relationships remains, at present, theoretical. However, an initial hypothesis is worthy of consideration; that the same priming relationship that exists between terror and horror also incorporates caution and the three stages are interrelated

It has been asserted that two individuals, both placed in identical fear scenarios could experience significantly different intensities with regards to their emotional fear response. This is most apparent within the concept of *monitors* and *blunters*. Monitors are individuals highly sensitive to fearful stimuli; revealing strong semantic associations between the context of threat and numerous memory items. In contrast, a blunter is comparatively insensitive to fearful stimuli and significantly less likely to associate memory items or current stimuli to their concept of threat [64]. Sparks [65] revealed that individuals identified as monitors generated positive emotional responses in the presence of forewarning cues and negative response in their absence; individuals identified as blunters revealed opposite results. Emotional response was identified via debrief questionnaire and galvanic skin response data designed to assess the overall experience rather than phasic examination of the startle response. This suggests that although forewarning invariably amplifies startle, an absence of warning may create a more frightening overall experience (providing the individual is a monitor). A logical conclusion could be that, in order to maximise the potential intensity of both a terrifying (preceding) and horrifying (startle) experience, the environment preceding a startle probe is required to contain stimuli that connote negative affect but that (in the case of monitors) reveal little or no information to assist in coping (size, position, movement, speed, etc.).

In summary, the subcortical processes and autonomic physiology in response to terror stimuli are designed to prepare the body for a horrific confrontation. The function of higher level thought is primarily homeostatic; attenuating the subcortical routine to mitigate the physiological changes in response to absence of threat. It is the cognitive appraisal routine that is most susceptible to fault however. The nature of the cortical system means that thoughts transcend the here and now and, as a result, past experiences and future conjecture can bias an otherwise objective evaluation of the current situation. These biases appear as *type 1* and *type 2* statistical hypothesis errors (*false positive* and *false negative*) that either risk an individual under-preparing in the face of a threat or cause needless anxiety through the conjuring of an unreal threat that is unsubstantiated by objective evidence. The chronological period within which both errors can occur is after the physiological priming of terror and before the possibility of horrific revelation. A suitable period of time between these events allows the cognitive functions to analyse the situation. It is here that a blunter may underestimate the threat by semantically associating the stimulus to non-threatening concepts whilst the monitor overestimates, relating the stimulus to inappropriately dangerous theories. At this time, such a structure remains theoretical and would require real-time observation of neural activation during a genuine fear experience. It is also acknowledged that these dynamics are focussed upon the short term and do not account for effects such as prolonged horrific experiences on the perception of terror and anxiety.

4. FEAR AND AUDIO
The preceding sections address the substantial terminology associated with fear and utilise existing research to construct a framework; elucidating the individual processes that exist within a fearful experience and their interaction along a chronological path. This section integrates game audio into a model of fear processing. Existing empirical and conceptual work is addressed and then expanded upon; integrating acoustic parameters, audio classes and modes of listening, into the virtual fear model. The question remains as to what properties within an audio stimulus cause a fear response, and whether such parameters can be manipulated to attenuate or amplify a fear response.

Several concepts from the sparse collection of research regarding the potential of specific sound parameters to manipulate emotional affect are concisely accumulated by Grimshaw [66]. Identified notions include: rapid onset/offset (attack/release) of an audio signal relates to a perception of urgency, slower attack relative to faster release increases perceived intensity by way of connoting an approaching source, and both loudness and frequency equalisation have the capacity to attenuate and amplify negative emotional activation. Grimshaw addresses audio de-localisation (manipulating the sound to mask the position of the source), suggesting that in the context of a predator sound, occlusion of the source's position may augment the fear sensation but that this de-localisation effect cannot be generalised to all sounds. Acousmatic audio (sounds that have no visible source on screen) are argued to cause similar emotional effects if connoting a threat whilst limiting information that may support a coping strategy [67]. Grimshaw [66] also documents several additional psychoacoustic sonic properties associated with negative emotion experience; highlighting the unexpected nature and occurrence of an audio entity and the concept of defamiliarisation (the processing/distortion of a familiar sound to create the strange/uncanny).

The power of suggestion has been documented in studies pertaining to experiences of the paranormal [68] and could be extrapolated to suggest that it is the preparation of the individual by establishing a situational context before exposure to explicit fear cues (activation of *pre-encounter defence)* that chiefly determines the impact of subsequent fear stimuli. Garner et al. [69] compared relative pitch, loudness, and localisation changes across several sounds experienced whilst playing a computer game and discovered no significant association to parameter modulations and emotional impact. The test game did not characterise the nature or situational context for the sounds employed and it could be asserted that this lack of participant preparation and integrated contextualisation may have attenuated the potential of the parameter modifications. Adding a heavy reverb without context may have little effect on the impact of a sound, whilst a pre-established gameplay element in which the player is required to identify the position of a sound to avoid the source may have a significant impact as, within this context, the reverb obscures localisation, reduces coping affordance and increases player-action uncertainty. From the above, fear, in response to audio stimuli, cannot be significantly augmented by way of universal quantitative acoustic parameter manipulation. The modulating of acoustic parameters must be integrated as part of a situational framework that considers both an established fear experience profile and variation between individuals, creating perceptual audio characteristics that are the key to effective fear manipulation.

The three stages of one such existing fear induction profile, developed by Fanselow [48], provide a contextually relevant method of sound classification in which perceptual audio

characteristics can be mapped onto a typical experience of fear. Pre-encounter defence dictates that stimuli have greater psychological distance (future-orientated, physical distance, hypothetical, etc.) suggesting that the threat-object is not present and that the audio stimuli available embody the immediate environment and entities indirectly relating to the threat. Aionoplast (defines a period in history), chronoplast (denotes a passing of time) and topoplast (characterises the architectural space) [70] function alongside keynote (ambient), low-intensity kinediegetic (initiated directly by player action) and proprioceptive (internal bodily) sounds; sounds whose primary function is to illustrate the environment. Stimulus appraisal in this stage is likely to employ cognitive, high level construal appraisals and anxiety is hypothesised to be present but relatively low. Listening function is expected to be functional, semantic and/or reduced. Within a computer game context, critical listening is also feasible, whereby the player may assess the quality and appropriateness of the sound. To successfully evoke pre-encounter defence, the sonic environment must suggest a locale in which threat exists at a psychological distance. Avatar footsteps treading on disembodied flesh and bone, distant screams of an agonised victim, reverberant acoustic paraspaces that obscure localisation, all connote danger at a distance and strongly advise caution without presenting a sound that is directly causally related to the threat-object.

Post-encounter defence demands decreased psychological distance (PD) whilst maintaining uncertainty. Within this section there is arguably a great deal of flexibility available as alternative aspects of PD can be manipulated to reach the same affect. Signal sounds (sound that is designed to be consciously attended to) are hypothetically more appropriate within this stage, whereby the player is expected to perceive these sounds as originating directly from the threat source. If we are to accept that the terror stage potentially activates the behavioural inhibition system, freezes movement and potentiates hyper-attentiveness, then an audio stimulus that generates such a response matches the profile of a retainer – a sound that encourages a player to remain in the same location [70]. Kinediegetic and proprioceptive sounds may also be present; however, the more intense nature of the post-encounter stage suggests that such sounds should reflect this increase (heavier breathing, increased heart-rate, lighter footsteps).

Hypotheticality and social distance is reduced as the source is assumed actual and attentive towards the player. If player attention is more acutely focussed, then causal, empathetic, semantic and functional listening is expected as the player may attempt to derive actionable information to support a coping strategy. Here audio designers may decide what information they wish to reveal. Sounds with a threat intention and emotional state may serve to accentuate fear intensity whilst localisation data may attenuate it. Acoustic properties that signify physical characteristics are deeply subjective in their capacity to modulate a fear response. Clichéd characteristics including large size, fast movement, unpredictable behaviour, distorted appearance, and great strength are preferential but their effectiveness remains at the mercy of the player's individuality.

As discussed previously, the circa-strike defence (horror) operates initially by way of an automated behavioural process dependent upon evolutionary and conditioned response routines. As a result, initial appraisal of horror-type audio stimuli is expected to induce reflexive and connotative listening functions to support immediate and decisive response behaviour. An audio stimulus within this

context could be described as an attractor – a sound that induces immediate player response [70]. Kinediegetic and proprioceptive sounds are hypothesised to reflect the nature of the horrifying sensation (gasp, scream, player damage). Continuing along the line of fright [31], the initial reflexive function is expected to be gradually replaced by higher level appraisal (assuming the individual has successfully increased psychological distance between themselves and the threat) as the individual moves out of the circa-strike defence state. The horrifying stimulus is then more comprehensively evaluated as the individual reverts to either a terror or caution state (or is relieved from the fear sensation entirely).
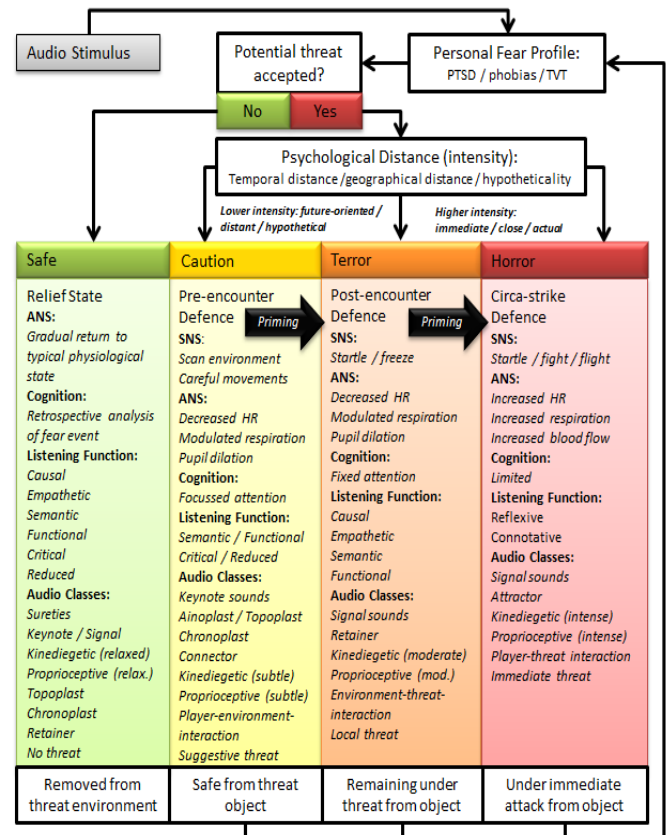

Figure 1: Game sound within a fear scenario.

Figure 1 consolidates the above theories to elucidate the interactions between audio stimuli and emotional response in a fear context. It is suggested that perceived characteristics of a sound determine the processing pathway and that appraisals of stimuli have the potential to influence the perception of subsequent audio input; in certain cases, conceptually priming the individual for appropriate action in response to possible, high intensity stimuli. Comparative analysis of the four alternative fear-arousal states reveals increasing autonomic processing and limited cognitive appraisal in response to greater perceived intensity. Listening function reflects this assumption; aligning critical and evaluative functions to cognitive appraisal whilst immediate and reflexive listening is allied with an autonomic response.

5. CONCLUSIONS AND FUTURE WORK
This paper has presented a framework for the processes of a fearful experience within a computer video game context and attempted to classify perceptual characteristics of audio within the various potential components of a fearful scenario. From this,

several opportunities for further study are revealed. Adjustments in quantitative acoustic parameters such as reverberation, tempo, rhythm, loudness, spectral frequency, etc. could be compared in both situation-integrated and disassociated classes during survival-horror gameplay to establish the potential of individual acoustic qualities in modulating the intensity of player fear. Use of proprioceptive audio remains inconsistent within mainstream horror game titles and the opportunity exists to compare presence, contextualisation and acoustic characteristics of this sound type.

Event logging systems support the collection of player action during play, providing an opportunity to confirm the classification of a sound as an attractor, retainer or connector. Electroencephalogram hardware supplies a means of testing listening function by way of measuring cortical activity to suggest the way in which the player is auditioning the sounds presented. Ultimately, future games may perhaps attempt to direct the intensity of the player-fear experience by effectively preparing the player in the initial (caution) stage, then utilising biometrics and avatar action logging to identify real-time heightened anxiety and emotional arousal in order to activate both terror and horror sounds that capitalise upon prior preparation. Such a system has the potential to both extend the replay value of a horror game and present a genuinely frightening recreational experience, testing the nerves of even hardened computer game enthusiasts.

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