Increasing the Emotionality of Horror Games with Infrasound

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INTRODUCTION
Infrasound refers to soundwaves with a frequency below 20 hertz (Hz), the lower limit of human hearing. Infrasonic waves are common—they are generated by seismic activity, windmills and whales. Exposure to infrasound in humans appears to produce myriad effects including wakefulness (Landström 1987), breathlessness, panic, anxiety, and even a sense of something paranormal (Tandy & Lawrence 1998; Landström & Pelmear 1993). Adding a 17 Hz tone to an orchestral performance increased "Unusual reports includ[ing] a sense of coldness, anxiety and shivers down the spine" (Angliss 2003). This motivates the following research question:

> ***Research question:*** *Can infrasound increase players' emotional responses to horror video games?*

Addressing this question requires three things:

1. *A sound system that can produce infrasound*. Commercial-off-the-shelf speakers cannot produce infrasound at noticeable volume. Even the speakers rated to 20 Hz that we tested fell off dramatically between 23 and 25 Hz.
2. *A sensible way of injecting infrasonic sound effects into a horror game.*
3. *An experiment comparing an infrasonic treatment group to a suitable control group*.

We therefore built an infrasonic speaker, inserted infrasound into an existing game and conducted a lab study to measure its effect on player's emotional responses.

INSTRUMENTATION
To build the infrasonic speaker, we began with a 1 m^3 cabinet constructed from six 18mm medium-density fiberboard sheets. We installed four Alpine 12DW 1500W RMS subwoofers on a vertical face of the cube in a grid formation. We increased the mass of the speakers (and thereby lowered their resonant frequency), by attaching (with Blu-Tack) 250 grams of M10 galvanised washers to each speaker cone, layered in an overlapping radial pattern (Figure 1).

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Figure 1: Radial Washer Pattern

Figure 2: The InfraSub

The top and bottom speaker pairs were wired in parallel. The speakers were driven by a 1000-watt amplifier running in bridge mode. The amplifier was run through a Phonic PCR2213 low pass filter with a roll-off at 120 Hz for protection. This was fed by a Peavy PV10 twelve channel mixing console set with a gain and amplification of 0 decibels (dB).

We double verified that this setup could produce frequencies down to 17 Hz at volumes exceeding 80 dB using two different diagnostic microphones (Shure SM27 and DBX RTA-M), digital frequency analyzing software (SpectrumView) and an analog oscilloscope. To reduce harmonic distortion, we sealed the cabinet with wood glue, installed three lengths of M10 threaded rod running between the centre of opposing faces, with internal and external nuts and large washers (Figure 2). We tightened the interior and exterior nuts against one another, sandwiching the panel to prevent bowing, and isolated the rods using Blu-Tak to prevent rattling. This produced a clean sinusoidal waveform at 17 Hz.

We chose to modify the 2D side-scrolling horror-puzzle game, *Limbo* (2010), because of its anxiety-inducing atmosphere and publicly available audio files. We divided the game into sixteen sections (based on its puzzles and transitions) and used the sound engine Wwise to insert a 17 Hz tone such that, for each playthrough, each section has a 50% chance of the infrasonic tone occurring for the duration of that section.

DATA COLLECTION

We recruited eight female and four male undergraduate students for a within-subjects experimental design. Participants played Limbo (one at a time) on a PC connected to an Xbox 360 controller and a Sony Bravia TV at a resolution of 1920x1080. The lighting in the room was dim and there were no distractions. The audio feed from the gaming computer was run to the mixing console at line level via RCA from the subwoofer pre-out of a Pioneer VSX-830 5.1 audio receiver. All other audio was fed to a pair of monitor audio stereo speakers. Infrasound was injected at 17 Hz / 84 dB(C).

We measured participant heart rate using a Polar H7 chest strap sensor. Heart rate is a common reflective indicator of stress and anxiety (cf. Dobkin & Pihl 1992). Participants played the game until they completed it or decided to stop. Average play time was approximately 1.5 hours. If stuck, participants could request help, and were shown a short clip of gameplay for that section.

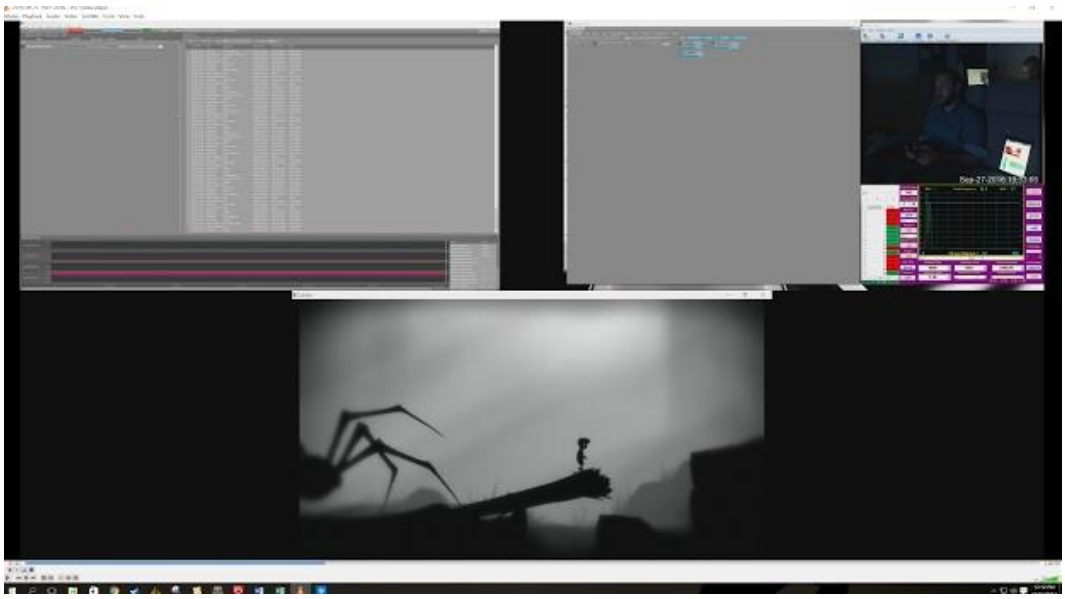

Figure 3: Screen Shot of Experimenter's View (participants saw only the game screen)

RESULTS AND DISCUSSION

Taking heart rate as a surrogate for emotional reaction, we hypothesized that infrasound would increase heart rate. Analysis of the collected data is in progress and we will present our findings at the conference.

This exploratory study is limited by: 1) convenience sampling, 2) a single surrogate measure of emotional response, and 3) a single combination of frequency and volume. Future research may involve more ambitious studies with more diverse frequencies, volumes and participants. Moreover, while infrasonic speakers may be impractical for home theatres, potential commercial applications include theme parks, cinemas and expos.

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