

Differences in Physiological Responses to Exposure of Disturbing Auditory Versus Audiovisual Stimuli

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Abstract

Fear plays a significant role in the lives of many people, from crippling fear that prevents people from performing everyday activities, to that which is intentionally experienced from video game or horror movies. The physiological responses to fear-inducing stimuli may vary between individuals, but some common reactions include increased heart rate, respiration rate and muscle tension, collectively referred to in this study as the “fear response”. These common reactions are a result of the sympathetic nervous system reacting when presented with a threat, a.k.a: a scary scene in a horror movie. The hypothalamic-pituitary adrenal axis regulates the body’s behavior, including the autonomic responses that are being measured in this experiment. The purpose of this study is to analyze the fear response to either audio or audiovisual stimuli, and compare the severity of the physiological changes induced by both stimuli against each other. The 29 participants were randomly assigned to one of two groups: 15 Audio (Group A) and 14 Audiovisual (Group AV). Group A was instructed to listen only to the audio track of a stimulating horror movie trailer broken up into 4 segments, and Group AV was subjected to the same trailer but also experienced the visual aspects of the stimulus. It was hypothesized that the fear response to an auditory stimulus would be larger than the response to the audiovisual stimulus. Of the two groups, those who received the audiovisual stimulus elicited a stronger physiological response than the audio group in heart rate and respiration frequency, but there were no statistically significant difference between the two groups when measuring muscle tension and respiration frequency. However, the audio stimulus induced a biological response of greater magnitude in muscle tension compared to the audiovisual stimulus. The reason for heart rates showing the only significant difference in physiological measurements between Group A and Group AV may be because heart rate is an involuntary physiological response. In contrast, the measurements for EMG and respiration could be voluntarily altered by participants during the experiment. Overall, although our results did not all show statistical significance, differences between the two treatments groups were observed for each variable and therefore show a degree of biological significance.

Introduction

In our society, people watch horror movies despite the disturbing emotions and images that they present. Whether it is in groups or alone, scary movies are used for entertainment, for study, etc. According to Dr. Glenn Walters, people are lured into watching horror films because of their unrealism (Griffiths, 2015). The unrealistic qualities incorporated in scary films, allow viewers to place themselves at a distance from the horror they are viewing and instead enjoy it as entertainment (Griffiths, 2015). In addition, gender, age and personality are important underlying factors that contribute to one’s motivation for watching a scary movie (Johnston, 1995).

Fear has evolved as a necessary tool to help a person increase their likelihood of survival. When watching horror movies, fear is often experienced because of the mystery, shock, terror and gore being shown (Griffiths, 2015). To deal with this emotion, the neurological, endocrine, cardiovascular, and other organ systems become activated (Palmer, 2008). The physiological reactions elicited when people subject themselves to this genre affect their experience and emotions both during the film.

Scary movies' use of audio and visual cues have been shown to change heart rate, respiration rate, and muscle tension in response to the fear they create. As Palmer stated, "[e]veryone has seen the person frightened so badly at the movie theater that he is perspiring... [or] felt your heart rate increase during an intense scene right before the movie's killer strikes" (2008). In one study, physiological reactions were examined in people viewing a video that involved threat versus a film that involved surgery (Palomba et al., 2000). The violent threat film resulted in a reaction consistent with sympathetic nervous system activation. The participants exhibited significant cardiac acceleration. The threat film group also presented the largest increase in heart rate during the first minute of the film, followed by smaller increase as the film proceeded (Palomba, 2000). This all suggests that the fear stimulus significantly induced a fight-or-flight reaction (Palomba et al., 2000). In another study, participants sat in a room viewing the Texas Chainsaw Massacre film and other participants sat in the room watching a neutral video. Data showed significant increases in heart rate and blood pressure in response to viewing the Texas Chainsaw Massacre film compared to those not watching the film's stressful scenes (Main et al., 2002). A third study, measured heart rate, respiration, and skin conductance while watching a horror movie (Fukumoto & Tsukino 2015). The participants then reported how scared they were and when they were scared during the film watching period. The experimental data

showed a change in all three physiological variables, with greater changes being observed at points when the participant admitted to being scared. Respiration intensity was increased and respiration cycle decreased during the film watching period for all ten male subjects (Fukumoto & Tsukino 2015). This data again shows sympathetic activation. But what this study shows is that fear is a subjective response and one's physiological response to fear can be altered by their perception. Most of the existing data significantly correlates horror scenes to fear and fear to sympathetic nervous system responses, however, a majority of these results are found from studies with experimental stimuli which include both visual and auditory cues.

While the essence of horror movies elicit the fear emotion and sympathetic physiological responses, hearing and seeing said horror movies may have very different effects. It has been argued that the key to making a horror movie scary is the sound (Hanson, 2013). If the sound is sudden or utilizes frightful tones, our brains interpret the scene as scary. Many scare sounds are produced from animal distress calls and are used to invoke terror because of humans' evolutionary adaptation of survival when faced with animal danger (Hanson, 2013). Frightful tones come with rapid frequency jumps, nonstandard harmonies, and noises pushed beyond their normal range. These sounds innately trigger our brains to stimulate a danger signal that results in fear (Haggin, 2012). Therefore, scary movies could evoke less fear if it weren't for their audio component.

In addition, physiological responses may be different due to the amount of sensory stimuli one is experiencing. Because of the greater amount of sensory information produced from the audiovisual stimuli, the brain has more to process and has the potential to trigger greater compounded physiological reactions (Collingnon et al., 2008). However, in the auditory group, despite there being only one sensory stimuli, there may be fear of the unknown that comes with

the absence of visual cues. An unknown outcome can trigger the sensation of suspense which then triggers an increased magnitude of physiological responses (Miko, 1996). Because of our evolutionary instincts to avoid potential threats, regardless of there being an imminent threat or not, humans have evolved to outrun predators even before their visual presence (Lima, 1990). The auditory stimulus alone may elicit greater fear response than the same auditory stimulus accompanied visually because the visual stimulus might constrain the imagination. Can it be argued then that hearing a scary movie could generate a stronger physiological response, than both seeing and hearing the same stimulus? Or does the combination of sensory intake create a more realistic and compound experience, ultimately causing an even greater physiological experience of fear? We hypothesize that if presented with a disturbing stimulus via auditory or audio-visual means, then the fear response to an auditory stimulus will be larger than the physiological response to an audiovisual stimulus.

Methods

Participants

Study participants were students enrolled in Physiology 435 at the University of Wisconsin-Madison. There was a total of 29 participants that varied in age from 18-30 years old and in gender with a total of 11 males and 18 females. Each participant was given a consent form, which allowed them to accept or decline their involvement in this emotionally evocative experiment. Upon their consent, students were randomly assigned, alternately by the order in which they volunteered, to one of two groups. Group AV consisted of participants exposed to audiovisual stimuli and Group A were participants exposed to auditory stimuli only. Each participant was allowed to terminate their involvement at any point in the study. Zero people ended their participation before completion.

Equipment

We compiled stimulating and neutral video clips with the use of iMovie to attempt to elicit the physiological responses of participants in both experimental groups. The participants watched the compiled video on a Mac Laptop (Model: Macbook Pro, Apple). In addition, each participant wore Sony Professional Dynamic Stereo Headphones (Model: MDR-7506, Sony) for noise cancellation purposes.

The pre-experiment consent form was adapted and modified from the University of Wisconsin-Madison Department of Physiology consent template (Appendix A). The post-experiment questionnaire was created and administered through Qualtrics on another Mac Laptop (Model: Macbook Air, Apple) (Appendix B).

We recorded respiratory rate, skeletal muscle tension, and heart rate as the three physiological measurements in response to the stimuli. A BIOPAC Pulse Oximeter (Model: 9843, Part: 2432-002-03, Nonin Medical Inc.) measured heart rate (beats/min). The heart rate data was video recorded by an iPhone (Model: 6, Apple) and transmitted into an excel spreadsheet for further analysis. A BIOPAC Student Lab (BSL) Respiratory Belt (Model: SS5LB, Part: 1602007553, BIOPAC Systems Inc.) measured respiratory rate (number of breaths/min). BSL Shielded Electrode Assembly (Model: SS2L, Part: 604A11648, BIOPAC Systems Inc.) and BIOPAC Electrodes (BIOPAC System Inc.) measured skeletal muscle tension through electromyography (EMG). The respiratory and EMG data transmitted to the BSL Student Lab Application (Model 4.0, BIOPAC Systems Inc.) on a Dell computer.

Stimuli

The overall video was a combination of the Youtube official movie trailer of New Line Cinema horror film, Annabelle. We divided the trailer into four segments of the following

durations: stimulus 1 = 38 s, stimulus 2 = 43 s, stimulus 3 = 24 s, and stimulus 4 = 41 s. These trailer clips represented the scary stimuli and either contained the visual and audio components (Group AV) or a black screen and only the audio component (Group A). We interrupted the disturbing stimuli clips with neutral clips of nature scenery from Youtube video “220 min. Classical Music for Studying-Relaxing Study Sounds- Sleep Relaxation.” These clips were intermittent time periods to get participants back down to their physiological baselines and serve as a comparison for the following stimulated responses. These clips only contained a visual component and were identical in both the Group AV video and Group A video. The neutral clips durations, generated with a random number generator, were the following: neutral 1= 25 s, neutral 2 = 17 s, neutral 3 = 10 s, and neutral 4 = 12 s, respectively. These clips served the purpose of better demonstrating the increase in physiological response to the horror stimulus. Returning the subjects to a baseline only to be given the same stimulus and having them respond multiple times gave much clearer evidence of what we were trying to address. The stimuli itself

Negative Control

Physiological baseline measurements of heart rate, respiration, and EMG were taken during a 61 second video clip of calming scenery prior to the neutral and stimulated video clips for each participant. This served as a buffer period to allow participant adaptation to the experimental conditions.

Positive Control

A subject exposed to the auditory stimulus video (Group A positive control) and a subject exposed to the audiovisual stimulus video (Group AV positive control) demonstrated changes in respiration frequency, heart rate and muscle tension between each neutral clip and the subsequent stimulated clip.

Procedure (Figure 1)

We assigned students, who voluntarily participated, to either Group A or Group AV. Students were brought to a quiet secluded room where they were connected to a respiratory belt, pulse oximeter and EMG electrodes. The participant then put on a pair of noise-canceling headphones. Once the participant was connected and ready, we began the video and the measurement devices simultaneously, turned off the lights and left the room for the remainder of the video. At the completion of the entire four and a half minute video, we ended the measurement recordings. We then asked the participant to complete a Qualtrics Survey. The purpose of the questionnaire was to test the participant's perception of fear during the experiment. The survey included questions asking participants how much fear they felt during each individual stimulating clip and about their prior exposure to scary stimuli.

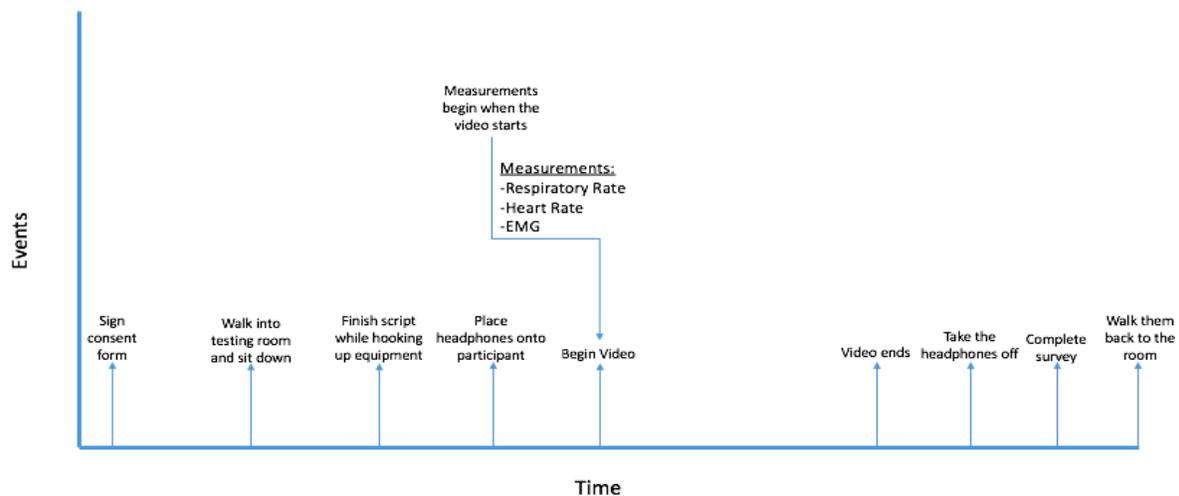


Figure 1: Experimental timeline of volunteer experience showing when specific events and measurements occurred throughout the study. Video duration was 4.5 minutes and total volunteer time was 7 minutes.

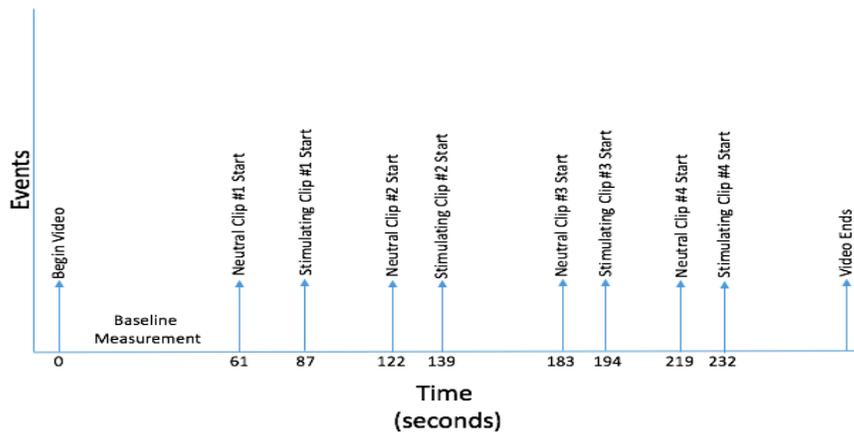


Figure 2. Timeline of experimental video. The compiled video was a combination of stimulating clips of the horror movie trailer, Annabelle, and neutral clips of calming nature scenery of different time durations.

Data Analysis

We processed and analyzed study results for each variable by looking at absolute changes between each neutral clip and its subsequent stimulated clip for each participant and for each group.

We measured the frequency of respirations for each of the eight clips (4 stimulating and 4 neutral) in BIOPAC. We did this by highlighting each clip during their specified time range (Neutral 1= 61- 87s, Stimulated 1: 87-122s, Neutral 2: 122- 139s, Stimulated 2: 139- 183s, Neutral 3: 183- 194s, Stimulated 3: 194-219s, Neutral 4: 219- 232s, Stimulated 4: 232- 274s), taking the BIOPAC respiration frequency (Hz= cycles/sec) and multiplying it by 60 to obtain frequency in cycles/min (Figure 2 and 3).

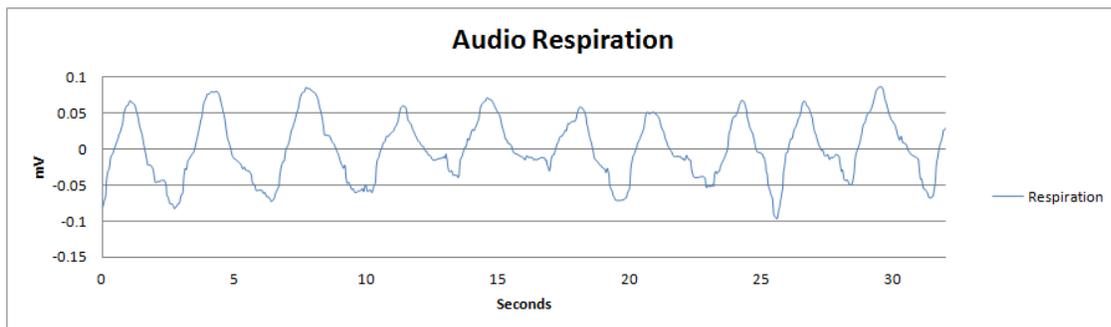


Figure 2. Respiration BIOPAC Data- Group A representative participant. One waveform (trough to trough) represents a full respiration (inhale to exhale). Data from 0 to 10 seconds is respiration frequency data during the baseline clip 1 and data from 10 to 32 seconds is respiration frequency data extracted from stimulated clip 1. Analyzing this data in BIOPAC shows an increase in respiration frequency (breaths/sec) in the stimulated clip compared to the neutral/baseline clip. This representative participant had respiratory frequency data similar to the average respiration frequencies for all individuals in Group A.

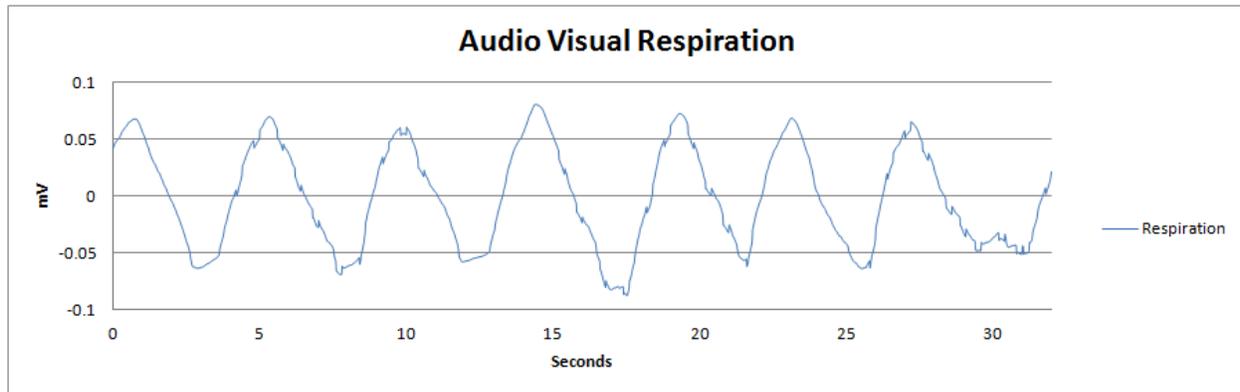


Figure 3. Respiration BIOPAC Data- Group AV representative participant. One waveform (trough to trough) represents a full respiration (inhale to exhale). Data from 0 to 10 seconds is respiration frequency data during the baseline clip 1 and data from 10 to 32 seconds is respiration frequency data extracted from stimulated clip 1. Analyzing this data in BIOPAC shows an increase in respiratory frequency (breaths/sec) in the stimulated clip compared to the neutral/baseline clip. This representative participant had respiratory frequency data similar to the average respiration frequencies for all individuals in Group AV.

We calculated the differences between each stimulated clip frequency and its previous neutral clip frequency to obtain a total of four consecutive changes in respiration frequency per participant. We then took each of the four specific changes from all the participants in each group and averaged those together. This resulted in four mean changes from each neutral to stimulated clip for Group A and Group AV to be compared. These changes (Group A: Changes 1-4, Group AV: Changes 1-4) were analyzed individually to test whether or not a statistically significant change in respiratory rate occurred at the stimuli. Next, we compared the average Change 1 for Group A to the average Change 1 for Group AV, and we repeated this process for Changes 2, 3 and 4 as well. Finally, we averaged all changes (1-4) for Group A and Group AV separately and compared these single, overall mean changes between the two groups.

For each individual, we recorded the maximum heart rate that occurred during each stimulating trailer clip and the average heart rate from each neutral clip. The average neutral heart rate was obtained by averaging the heart rates at each second during the entire neutral clip. We then calculated the change in heart rate (difference between maximum and mean) from each neutral video clip to the following stimulating for each individual. We obtained four changes in heart rate per participant (Change 1, 2, 3, and 4) and averaged all those specific changes between all participants in each group. This gave us four overall specific heart rate changes in Group A to compare to four overall specific heart rate changes in Group AV. We also averaged the four specific changes for each individual to get an overall change in neutral to stimulated heart rate for the entire video per each participant. Then we averaged each participant's overall change to get a mean heart rate change in Group AV to compare to Group A.

Next, we used the EMG BIOPAC measurements to find the maximum amplitude change in muscle tension for each clip. We did this by estimating the largest amplitude peak within each clip, highlighting that peak, and taking its minimum (trough) and maximum (peak) values (Figure 4 and 5).

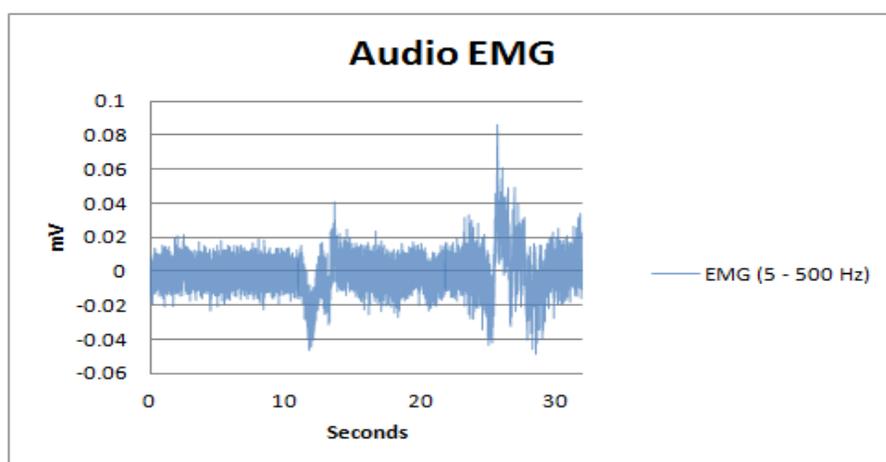


Figure 4. EMG BIOPAC Data- Group A representative participant. Filter settings= 5-500 Hz. Each peak represents the amount of skeletal muscle tension developed in the participant's right forearm. The larger amplitude peaks represents an increase in skeletal muscle force tension in response to the auditory stimulus. Data from 0 to 10 seconds is EMG data taken during the baseline clip 1 and data from 10 to 32 seconds is EMG data extracted from

stimulated clip 1. Analyzing this data in BIOPAC shows an increase in EMG muscle tension in the stimulated clip compared to the neutral/baseline clip. The representative participant had EMG amplitude changes similar to the average EMG amplitude changes for all individuals in Group A.

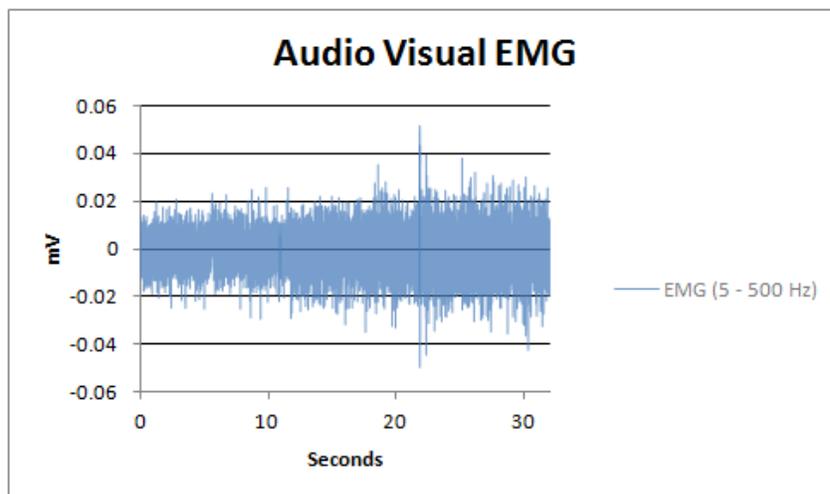


Figure 5. EMG BIOPAC Data- Group AV representative participant. .Filter settings= 5-500 Hz. Each peak represents the amount of skeletal muscle tension developed in the participant's right forearm. The larger amplitude peaks represents an increase in skeletal muscle force tension in response to the auditory stimulus. Data from 0 to 10 seconds is EMG data taken during the baseline clip 1 and data from 10 to 32 seconds is EMG data extracted from stimulated clip 1. Analyzing this data in BIOPAC shows an increase in EMG muscle tension in the stimulated clip compared to the neutral/baseline clip. The representative participant had EMG amplitude changes similar to the average EMG amplitude changes for all individuals in Group AV.

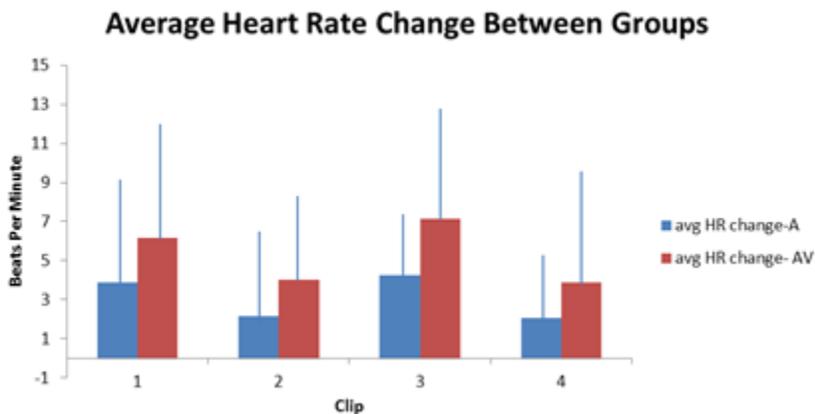
The min and max values were added together to get the EMG amplitude per clip. We calculated the change in amplitude between each stimulated and neutral clip for each participant. We averaged the four specific changes among all the individuals in each group and then compared the mean specific changes between the two groups. In addition, we averaged the four changes per individual and then averaged all the individuals' overall EMG changes to get a mean Group A change from neutral to stimulated to compare to a mean Group AV neutral to stimulated change.

All of the calculated data was then analyzed using an ANOVA T-test to find a p-value and determine if statistically significant changes occurred within our study between the treatment groups.

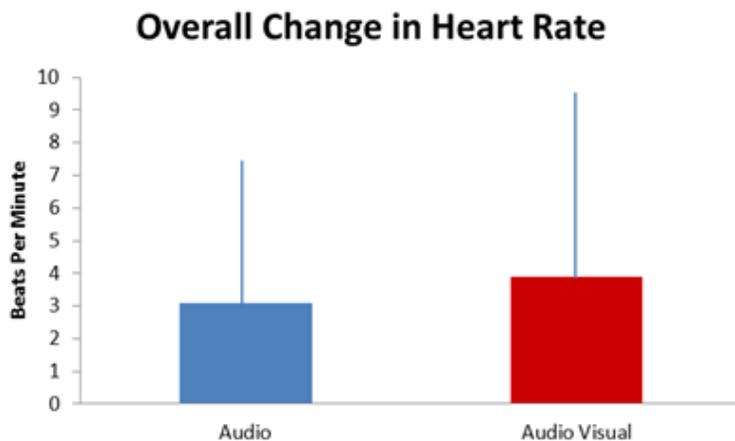
Results

For all three variables, the data found that one group consistently exhibited a greater magnitude of physiological change than the other across all four clips.

The heart rate data shows the average neutral heart rate subtracted from the maximum stimulated heart rate for each of the four clips. The averaged data showed a larger physiological change in heart rate in Group AV compared to Group A in each clip. In Group A, the average Change 1 was 3.86 beats/min, average Change 2 was 2.15 beats/min, average Change 3 was 4.27 beats/min, and average Change 4 was 2.08 extra beats/min (Graph 1). The Group AV heart rate results were the following: average Change 1 was 6.14 beats/min, average Change 2 was 4.03 beats/min, average Change 3 was 7.12 beats/min, and average Change 4 resulted in 3.90 extra beats/min in the stimulated portion (Graph 1). While our results show that the changes in heart rate of Group AV were biologically more elevated than those of Group A in response to all clip segments of the aversive stimulus, these differences were not statistically significant. When the changes were averaged across the entire aversive stimulus, values of 3.09 beats/min and 3.98 beats/min were determined for Group A and AV respectively (Graph 2). Between the two groups, statistical significance was found between the overall heart rate changes (p -value = 0.03), resulting in a greater physiological fear response in heart rate to the audiovisual stimulus than the auditory stimulus alone.



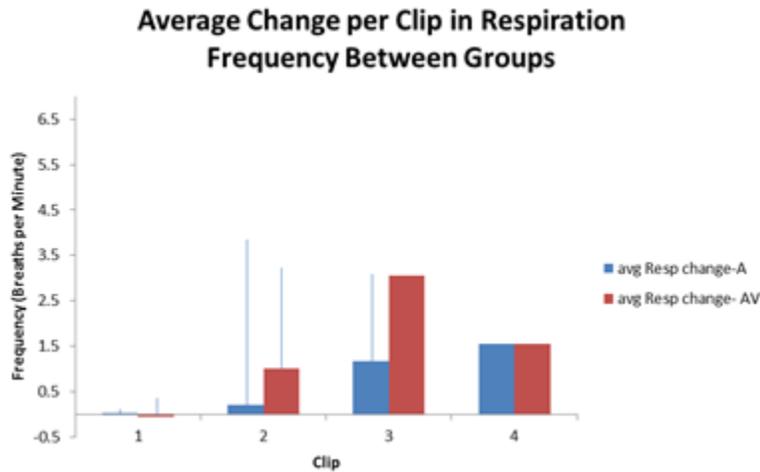
Graph 1. Average heart rate change between audio and audio visual groups. The change in heart rate (beats per minute) is the difference between the stimulating clip and its preceding neutral clip (clip 1= stimulated 1- baseline 1, clip 2= stimulated 2- baseline 2, clip 3= stimulated 3- baseline 3, clip 4= stimulated 4- baseline 4). The change per clip period was averaged among all individuals in each group. Standard deviations for each clip are shown by the errors bars (A: SD 1=5.7 , SD 2=4.3 , SD 3=3.9 , SD 4=3.2) (AV: SD 1=6.8 , SD 2=4.4 , SD 3=5.2 , SD 4=5.4). The difference per clip between averages heart rate changes in group A compared to group AV is not statistically significant (p1=0.38, p2= 0.54, p3=0.09, p4=0.26). (p1=0.38, p2= 0.54, p3=0.09, p4=0.26).



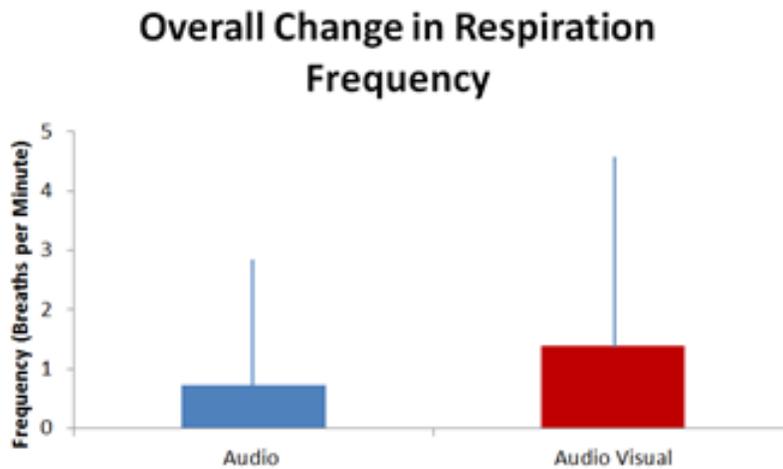
Graph 2. Overall average HR change between audio and audio visual groups. The change in heart rate (beats per minute) is the difference between the stimulating clip and its preceding neutral clip (clip 1= stimulated 1- baseline 1, clip 2= stimulated 2- baseline 2, clip 3= stimulated 3- baseline 3, clip 4= stimulated 4- baseline 4). The change per clip period was averaged among all individuals in each group. The 4 average clip changes were further averaged to get a mean audio heart rate change and a mean audiovisual heart rate change. This difference in heart rate change from baseline to stimulated is significant between Group A and AV for the overall video period (p=.03).Standard deviations are shown by the errors bars (A SD=4.4, AV SD= 5.6).

In regards to the analysis of the respiratory rate data, none of the comparisons of individual Changes, 1, 2, 3 or 4, from one group to the other produced statistically significant results. The Group A data is as follows: Change 1 = 0.003 breaths/min, Change 2 = 0.21 breaths/min, Change 3 = 1.17 breaths/min, Change 4 = 1.54 breaths/min, and mean Overall Change = 0.73. The data for Group AV is as follows: Change 1 = -0.05 breaths/min, Change 2 = 1.00 breaths/min, Change 3 = 3.06 breaths/min, Change 4 = 1.55 breaths/min, and mean Overall Change = 1.38 breaths/min. (Graph 3 and 4). The rates of respiration in Group AV did increase more than those of Group A for Clips 2, 3 and 4, but these differences are not statistically significant. However, the mean Overall Change of each group in response to the stimuli was

statistically significant, producing p-values of 0.01 and 0.003 for Group A and Group AV respectively.

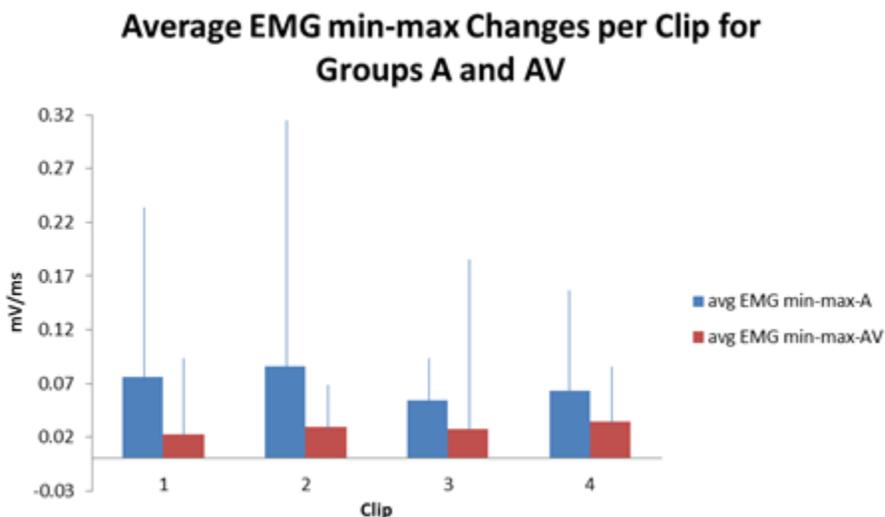


Graph 3. Average change in respiration frequency between audio and audio visual groups. The change in respiration (breaths per minute) is the difference between the stimulating clip and its preceding neutral clip (clip 1= stimulated 1- baseline 1, clip 2= stimulated 2- baseline 2, clip 3= stimulated 3- baseline 3, clip 4= stimulated 4- baseline 4). The change per clip period was averaged among all individuals in each group. Standard deviations for each clip are shown by the errors bars (A: SD 1=0.10 , SD 2=3.5 , SD 3=2.0 , SD 4=1.6) (AV: SD 1=0.40 , SD 2=2.3, SD 3=3.2 , SD 4=5.1). The difference in average respiration frequency change between clips in Group A compared to Group AV is not statistically significant ($p_1=0.63$, $p_2= 0.49$, $p_3=0.07$, $p_4=0.99$).



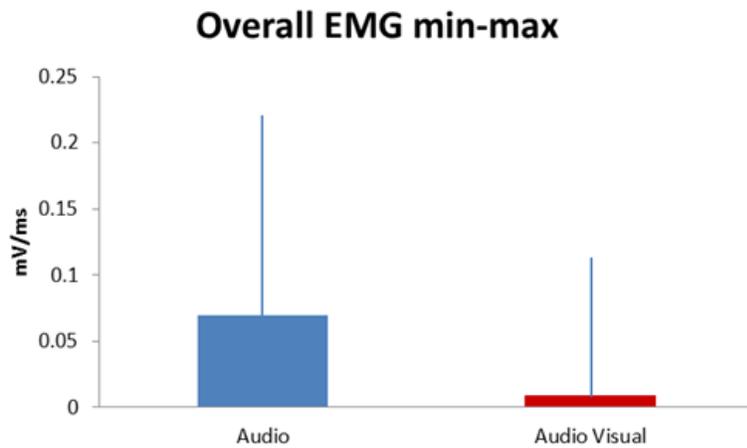
Graph 4. Overall average respiration frequency change between audio and audiovisual groups. The change in respiration (breaths per minute) is the difference between the stimulating clip and its preceding neutral clip (clip 1= stimulated 1- baseline 1, clip 2= stimulated 2- baseline 2, clip 3= stimulated 3- baseline 3, clip 4= stimulated 4- baseline 4). The change per clip period was averaged among all individuals in each group. The 4 average clip changes were further averaged to get a mean audio respiration frequency change and a mean audiovisual respiration frequency change. The average respiration frequency change within Group A and Group AV separately is statistically significant ($p=0.01$ for Group A, $p=0.003$ for Group AV). The difference in the overall respiration frequency change between Groups A and AV is not statistically significant ($p=0.21$).

Skeletal muscle tension among each video clip demonstrated average min-max changes of 0.076 mV/ms (A) versus 0.023 mV/ms (AV) for clip 1, 0.086 mV/ms (A) versus 0.030 mV/ms (AV) for clip 2, 0.054 mV/ms (A) versus 0.028 mV/ms (AV) clip 3 and 0.063 mV/ms (A) versus 0.034 mV/ms (AV) (Graph 5). While the audio stimulus elicited stronger physiological responses in all 4 individual clips compared to the audiovisual stimulus, these changes were not statistically significant. In further analysis we took the average muscle tension change for both stimuli and compared the difference (Graph 6). The average min-max change for the Group A stimulus was 0.070 mV/ms and the Group AV stimulus was 0.009 mV/ms (Graph 6). None of the above data proved to have statistical significance, but in all clips and overall EMG for each stimuli, the audio stimulus alone elicited a stronger biological response than the audiovisual stimulus.



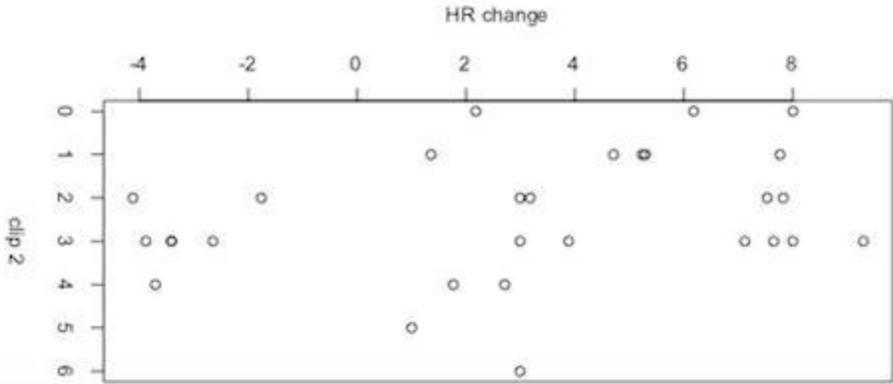
Graph 5. Average change in EMG min to max between audio and audio visual groups. The change in EMG min to max (millivolts per millisecond) is the difference between the stimulating clip and its preceding neutral clip (clip1= stimulated 1- baseline 1, clip 2= stimulated 2- baseline 2, clip 3= stimulated 3- baseline 3, clip 4= stimulated 4- baseline 4). The change per clip period was averaged among all individuals in each group. Standard deviations for each clip are shown by the errors bars (A: SD 1=.16 , SD 2=.23 , SD 3=0.091 , SD 4=0.10) (AV: SD 1=0.069 , SD

2=0.044, SD 3=.16 , SD 4=.063). The difference per clip between average EMG Min to Max changes in group A compared to group AV is not statistically significant ($p_1=0.26$, $p_2= 0.38$, $p_3=0.59$, $p_4=0.36$).



Graph 6. Overall average EMG min to max change between audio and audio visual groups. The change in EMG min to max (millivolts per millisecond) is the difference between the stimulating clip and its preceding neutral clip (clip1= stimulated 1- baseline 1, clip 2= stimulated 2- baseline 2, clip 3= stimulated 3- baseline 3, clip 4= stimulated 4- baseline 4). The change per clip period was averaged among all individuals in each group. The 4 average clip changes were further averaged to get a mean audio EMG min to max change and a mean audiovisual EMG min to max change. Standard deviations are shown by the errors bars (A SD=0.15, AV SD=0.09). The difference between overall average EMG min to max change in Group A compared to Group AV is not statistically significant ($p=0.08$).

The participants were required to fill out a survey that included questions about the individual's preference with fear/horror. The purpose of this was to test each subject's perception of fear from each clip and compare that to their physiological changes, thus discovering whether or not there was a correlation between perception and physiological response. The result was that no correlation between perception and physiological changes existed for any variable in any of the four clips. Graph 7, a comparison between the participants' perceived fear of Clip 2 and their physiological response in regards to heart rate, exemplifies this lack of correlation that was seen for all clips and all three variables.



Graph 7. Change in heart rate vs perceived fear during clip 2. This graph shows no trendline and therefore demonstrates that regardless of perceived fear, all participants experienced a similar physiological heart rate response. This graph is representative of all variables (change in heart rate, EMG min-max, and change in respiration frequency) during all clips (1-4).

Discussion

Certain results coincided with our previous hypothesis, while others differed from the predicted response. Background research led us to predict that an increase in sympathetic response (while watching the scare clips) would cause increased physiological responses in all three variables. Our results demonstrated a physiologically greater response in EMG in the auditory group while heart rate and respiration rate changes were physiologically larger in response to the audiovisual stimulus. We predict that this is likely due to the compounded amount of sensory stimuli strongly activating the sympathetic nervous system in Group AV participants and having a greater effect over their respiration and heart rates than the Group A participants. On the other hand, we predict that EMG was more heavily influenced by the fear of the unknown that was part of the Group A stimulus. Without visual cues, the scare may have been less expected leading to a greater skeletal muscle reaction to a frightful sound.

Increasing one’s breathing rate (as seen in our respiration study results), allow the participants to saturate their muscles with oxygen anticipating for the potential threat. This makes a connection to our evolutionary instinct, for when a danger is present, our bodies enter ‘flight or flight’ and prepares for fighting or fleeing from danger. Increasing respiratory rate is a

part of this sympathetic response and occurs innately, despite the fact that respiration is an action that is normally under direct physiological control. Our experiment deduced that there was not a statistically significant difference between the two groups when it came to a change in the respiration between clips. The reason for this may be because our video was not stimulating enough to change the respiration frequencies for our participants. Another reason may be because the change of respiration was due to the audio aspect of our experiment which both groups encountered, therefore changing each group equally.

The results of both tests showed that another physiological variable, the change in EMG, was not statistically significant. Many factors may have contributed to this result. If the participant was not engaged during the baseline clips, they could have been more likely to fidget when bored, whereas, when watching the intermittent scare clips intently, they had something intriguing to focus on and, therefore, moved less and exhibited less EMG activity.

Participants number six, seven, and twenty-five each had one variable of the three that was not accurately measured due to technological difficulties. In order to conduct both an ANOVA test and a t-test without excluding these participants in our data, we replaced the single missing variable data with averages from the other 26 participants on a clip-by-clip basis. This also assures the lack of data from these participants does not skew the data for the tests for significance.

Heart rate was another variable that deviated from our hypothesized results and was also the only variable that generated a response of statistical significance due to several possible reasons. Heart rate was the only variable of the three that was entirely controlled by involuntary muscle contractions. Both respiratory rate and EMG can be regulated voluntarily to an extent. Furthermore, all of the participants of the study had a working knowledge of the apparatuses to

which they were connected, and could have been unconsciously attempting to control the biological reactions that they knew were being measured, exacerbating the voluntary influence on the respirations and skeletal muscle tension. Further research would need to be conducted in order to understand indisputably the causes of this discrepancy in biological response and statistical significance. The use of random participants who have no previous experience with BIOPAC measurement tools could possibly control for this voluntary influence and produce less corrupted data.

When comparing the survey results, how scary participant's felt each of the four clips were, with the actual physiological responses to each clip, the results indicated a uniform physiological response of change in heart rate, respiration and EMG regardless of how "scary" each participant ranked the different clips. The participant's physiological responses to the stimuli were unrelated to their perceived thought of fear. We found that regardless of fear ranking, the physiological responses to the stimuli still showed a change in heart rate, respiration rate, and muscle tension in equal magnitude.

Internal controls are vital to the stability of experiments by showing the baseline of a variable before a change is observed. Each participant provided their own internal control through their baseline physiological responses which were compared to their later results. An alternative internal control would have been using the same subjects in both the audiovisual group and the audio-only group in order to draw a comparison between the two stimuli groups. However, this method of experimentation and data collection was decided against. We determined that subjects would experience desensitization toward the second group they were tested in after being exposed to the shocking stimulus in the first group. The physiological

response witnessed when exposed to a stimulus the first time is drastically different than when participants are exposed to the same stimulus a second time.

The addition of a visual-only experimental group would have given another perspective in determining the physiological responses to fear. Our initial research determined that the auditory component was the essential element comprising horror movies. This led us to mainly consider the audio stimulus in our experimental testing of fear. Thus, we compared an audio stimulus to an audiovisual stimulus to gather data and draw statistically meaningful conclusions given our limited number of subjects. It also streamlined our data comparisons on our specific physiological variables, while still addressing and providing a potential answer to our initial hypothesis. In future experiments, the comparison of physiological effects between auditory-only, visual-only, and audiovisual only would be of interest to examine and better understand the key elements eliciting the fear response from horror movies.

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Appendix A

UNIVERSITY OF WISCONSIN-MADISON Research Participant Information and Consent Form

Title of the Study: Differences in Physiological Responses to Exposure of Aversive Audio and Audiovisual Stimuli

Principal Investigators: Tyler Evans, Jenna Hatab, Elyse Linsmeier, Taylor Olson, Jacob Rabichev, Amanda Reisner

DESCRIPTION OF THE RESEARCH

You are invited to participate in a research study about physiological responses between exposure to aversive audio and audiovisual stimuli

You have been asked to participate because you are enrolled in Physiology 435.

The purpose of the study is to measure physiological differences of auditory and audiovisual stimuli.

This study will invite the participation of all students enrolled in Physiology 435.

This research will take place within Physiology 435 laboratory sections on Tuesdays from 1:20-4:20pm in room 2360.

WHAT WILL MY PARTICIPATION INVOLVE?

If you decide to participate in this research you will be asked to observe an aversive video clip approximately 6 minutes in length while connected to a pulse oximeter, an electromyograph, and a respiratory belt. Following the clip, you will be asked to complete a short questionnaire. Following this experiment, we ask that you do not share your experience with any other participants.

Your participation will last approximately 10 minutes between February 1st and March 31st, 2016.

The results we receive from your trial will be analyzed and compiled into our research data.

No credit will be assigned for your complete and voluntary participation. If you do not wish to participate, simply return this blank consent form.

ARE THERE ANY RISKS TO ME?

You will be exposed to emotionally evocative stimuli. Therefore you must consent that you are psychologically and emotionally stable enough to be experience such stimuli. _____

ARE THERE ANY BENEFITS TO ME?

You will be aiding in the advance of scientific research. This is completely voluntary. _____

HOW WILL MY CONFIDENTIALITY BE PROTECTED?

While there may be printed reports as a result of this study, your name will be masked with a participant code. Only group characteristics will be reported – that is results with no identifying information about individuals will be used in any reported or publicly presented work.

WHOM SHOULD I CONTACT IF I HAVE QUESTIONS?

Amanda Reisner, areisner@wisc.edu_____

If you are not satisfied with response of research team, have more questions, or want to talk with someone about your rights as a research participant, you should contact Dr. Andrew Lokuta, 608-263-7488, ajlokuta@wisc.edu.

Your participation is completely voluntary. If you decide not to participate or to withdraw from the study it will have no effect on your grade in this class.

Your signature indicates that you have read this consent form, had an opportunity to ask any questions about your participation in this research and voluntarily consent to participate.

Name of Participant (please print):_____

Signature _____

Date_____

Appendix B

How scared were you during: ..?

Unphased 0 1 2 3 4 5 Terrified 6

Trailer Clip 1

Trailer Clip 2

Trailer Clip 3

Trailer Clip 4

Do you like watching horror movies?

Yes

No

Do you play video games?

Yes

No

If yes to the prior question, how often?

Never 0 Less than once a month 1 Once a month 2 2-3 times a month 3 Once a week 4 2-3 times a week 5 Daily 6

How often

If yes to the prior question, how violent would you rate the video games you usually play?

No violence 0 1 2 3 4 5 Extreme Violence 6

How

How often do you watch horror movies?

Never 0 Less than once a month 1 Once a month 2 2-3 times a month 3 Once a week 4 2-3 times a week 5 Daily 6

How often:

How often do you watch crime television shows (e.g. Law & Order, CSI, NCIS...)?

Never 0 Less than once a month 1 Once a month 2 2-3 times a month 3 Once a week 4 2-3 times a week 5 Daily 6

How often:

How often do you watch the news?

Never 0 Less than once a month 1 Once a month 2 2-3 times a month 3 Once a week 4 2-3 times a week 5 Daily 6

How often

At about what age were you first exposed to horror movies?

How desensitized do you feel towards fear inducing stimuli

completely desensitized 0 1 2 3 4 5 Highly sensitized 6

sensitivity 0-6

How old are you?

What was your participant number?



