# Physiological Fear Response Amplitude in Visual Stimuli vs Audio-Visual Stimuli: A Comparative Gender Study

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## Abstract

The comparison between unimodal stimuli (visual stimuli only) and bimodal stimuli (simultaneous audio-visual stimuli) is an under-studied but interesting subject in physiology. This study aims to explore gender differences in fear response by implementing and comparing both unimodal and bimodal stimuli. Across both genders, it was hypothesized that bimodal stimuli will induce a stronger fear response than unimodal stimuli. Specifically for the purpose of this study, it was also hypothesized that females will show a higher degree of fear response when compared to males. Fear response was defined by changes to heart rate, blood pressure, and respiratory rate; and these physiological measures were taken before stimuli presentation and during both a unimodal and bimodal film clip. Analysis indicated that males and females had an increased fear response to bimodal stimuli than to unimodal stimuli, but between genders there was no significant difference in degree of response. Post-stimulus surveys reported that woman indicated that the film clips were significantly more frightening than their male counterparts. Further research will need to be conducted in order to understand this enhanced fear perception in females.

## Introduction

Film plays a large role in cultures all over the world. Across every genre of film, a wide range of emotional responses are intentionally elicited from the viewer. These responses have undoubtedly been amplified by the addition of auditory stimuli; movies originally began as silent films, but evolved to include music for an enhanced total experience. Auditory stimulation can serve many purposes in film as they elicit a target emotion and typically coincide with the mood and characteristics of the visual stimuli (Fischoff, 2005).

Although evoking a specific emotional response from an individual can appear subjective to the viewer, a study by Hewig et al. (2005) provides evidence that film clips can induce specific emotional responses. Brumbaugh et al. (2013) studied autonomic nervous system responses to video presentations by analyzing skin conductance, respiration, and heart rate. The discussion by Brumbaugh et al. (2013) proposed that a significant increase in the activity of the sympathetic nervous system was caused by an emotionally provoked scene, as was indicated by their results of increased heart rate and skin conductance (Brumbaugh et al., 2013).

Our study focused on exploring the physiological fear response induced by a frightening/suspenseful/stressful film clip with and without audio stimuli. Taffou et al. (2013) explored the impact of multisensory stimuli on the experience of fear, and indicated that participants were more fearful to the congruence of audiovisual stimuli compared to single stimuli exposure. This suggested that information processed in multi-sensory pathways lead to a heightened fear response.

Hung et al. (2013) investigated the differing perceptions of emotional acoustic stimuli in gender. The study challenged the stereotype that women are more sensitive to acoustics than men, and their results indicated that in response to fearful syllables, females elicited a stronger response than males. Brumbaugh et al. (2013) also demonstrated that particular groups of females, as classified by personality, elicit stronger physiological responses to emotional film clips than all males. The finding provides a link to the current study as well as evidence that a greater fear response in females will be found in bimodal stimuli in comparison to unimodal stimuli.

## Hypothesis

When comparing audiovisual stimuli to visual stimuli presentation of a short, fear/stress inducing video clip, females will show a higher degree in fear response as defined by blood pressure, heart rate, and respiratory rate measurements.

## Data Collection & Analysis

Respiratory rate in breaths per minute was measured via the Biopac Student Lab (©1998-2010, Goleta, CA) respiration belt attachment. Blood pressure was measured by a Panasonic EW3101 digital home blood pressure monitor. Pulse rate was measured using the Biopac pulse oximeter. Measurements were taken at three points during the course of a video clip that was shown to participants. The respiratory rate was measured as an average value over the course of the video clip and as the same period of time during our control period to measure a baseline for respiration. The blood pressure and pulse rate were both measured at the end of the video clips and at the end of the respiratory measurement for the control period. Blood pressure data was used to calculate the Mean Arterial Pressure (MAP). A survey was given post-experiment to assess the participants' subjective feelings and experiences regarding the study.

Statistical analyses were performed on the change from the baseline measurement for respiratory rate, pulse rate, and MAP. T-tests were performed to compare between the changes from the baseline rate for watching the video clip with sound and without sound for all participants. The data was then also analyzed using t-tests for the change from baseline for males and females separately.

## Study Design

Each participant was shown video clips in four separate sections of the experiment. Two of the sections included the neutral, non fear-evoking video with sound; the other two sections were the same fear-evoking video clip, one with sound and the other without sound. The fear clip is of a man entering his apartment during the night, while someone else is watching him. The man watching him sneaks up behind the man entering his apartment and reaches out to grab the man. The neutral clip is of a tranquil tropical beach with mellow tide sounds. The order of the audiovisual clip and visual clip presentation were randomized via coin-flip. In the beginning of each trial each participant was seated in front of a laptop computer in a dark, quiet room. After being shown a neutral, non fear-evoking video for one minute, the participant's respiratory rate, heart rate, and blood pressure was recorded. This duration of each recording lasted approximately 30 seconds, which is both the length of the fear-evoking video and the approximate time required for the automated blood pressure cuff. The participants continued watching the neutral clip for an additional minute after the initial measurement recording. They were then shown the fear-evoking clip with or without audio. The next recording of measurements was started immediately at the beginning of the fear-evoking video clip, regardless of sound. In an effort to reset the participants' physiological status back to baseline, we showed them the neutral clip for one minute, however no measurements were taken during this trial. Finally, the participants were exposed to the second fear-evoking clip, depending on which version was shown first. The final set of measurements were recorded during this clip.

## Results

This experiment measured data from 28 participants of which 17 were female and 11 were male. There was no significant change in MAP for the entire test pool ($t = 1.703$, $p = 0.377$) for change from basline between watching the clip with sound ($M = -.303$, $SD = 2.696$) or without sound ($M = -.482$, $SD = 2.807$). There was also no significant difference found within males ($t = 1.81$, $p = 0.19$) for sound ($M = -.403$, $SD = 1.77$) and no sound ($M = -1.13$, $SD = 2.32$) and no significant difference found within females ($t = 1.74$, $p = 0.41$) for sound ($M = -.239$, $SD = 3.21$) and no sound (M= -.063, SD= 3.08) for baseline changes from MAP (Figure 2, Figure 5). We found a significant difference from baseline using a t-test for pulse rate for the entire group (Sound: M= 3.179, SD= 5.90; No Sound: M= -.679, SD= 4.45) (t= 1.703, p= $7.21x10^{-5}$) and significance was maintained when broken down between males (Sound:M= 1.909, SD= 7.422; No Sound: M= -.636, SD= 5.143) (t= 1.812, p=$5.26x10^{-2}$) and females (Sound: M= 4.00, SD= 4.743; No Sound: M= -.706, SD= 4.120) (t= 1.745, p=$2.52x10^{-4}$) (Figure 3, Figure 4). The t-test also showed that there was a significant difference for the change in respiration rates from baseline for the whole group (Sound: M= 1.611, SD= 4.313; No Sound: M= 0.401, SD= 3.202) (t= 1.703, p=$9.6x10^{-3}$) as well as for within males (Sound: M= 0.500, SD= 2.836; No Sound: M= -.474, SD= 2.547) (t= 1.812, p=$4.23x10^{-2}$) and within females (Sound: M= 2.330, SD= 4.996; No Sound: M= .967, SD= 3.518) (t= 1.746, p=$4.21x10^{-2}$) when analyzed separately (Figure 1, Figure 6). When given a post experiment survey asking to rate intensity of fear without sound on a scale of 0-10, 67% of male participants and 35% of females were slightly scared (0-2 range), while 33% of males and 65% females admitted to being moderately scared (3-6 range) (Figure 7). The range for the clip with sound was the same and showed that 8% of males and 6% of females were only slightly scared. 67% of males and 41% of females stated that they were moderately scared and 25% of males and 53% of females admitted to being extremely scared (Figure 8). Overall females reported a larger increase in anxiety when viewing the video clip with sound compared to the video clip without sound (Figure 9).

## Discussion

Based on our results we can state that there is a significant difference in the change from the baseline for both heart rate and respiratory rate, but not in pulse pressure from exposure to a combination of visual and audio stimuli over simple exposure to visual stimuli in both genders and in the entire participant pool. We did not find that gender of the participant had any significant impact on how strong their physiological fear response was to either audio-visual or solely visual stimulus in any of the three variables that we tested for. Based on these results our hypothesis that females would have a stronger physiological response than males was proven to be false. The post viewing survey that we administered indicated that our participants did find the bimodal audio-visual stimuli to be more fear inducing than the silent video clip. Females rated both video clips as more frightening and indicated that they felt a more severe increase in anxiety than males. This is important to note because while our data shows that they all had a more significant response to the sound clip, there was not significant evidence indicating greater physiological fear response in females.

While our data for heart rate and respirations coincide with our hypothesis, the data for MAP was inconsistent with what was expected (Figure 2). This suggests that the neutral clip may have been more stimulating than the fear-evoking clip. Another reason may be that the fear clip was not scary enough, which was the general consensus from the post-experiment survey. Randomizing the order of bimodal and unimodal visual clips to minimize confounding variables may have also had an impact because the video clips were of the same scene, which may have acclimated the participant to the frightening scene. A final possibility for this inconsistency could have been due to the fact that the neutral clip was of a tropical beach, and since we conducted this experiment in the winter, our participants may have experienced some sort of aroused response rather than a relaxed response. Although measurements for the fear-evoking clips were lower than baseline measurements, when comparing data from the fear clip trials (with and without sound), participants showed increased rates with auditory stimulation.

Another explanation for the negative change in MAP from baseline recordings could be due to human error in timing consistency among participants, as well as the ability to synchronize the commencement of the three devices. In addition to timing, the reaction of each participant would also be affected by the fact that we were monitoring their behavior. Each participant was hooked up to three machines that recorded data during the viewing period. Specifically the blood pressure cuff made noises while it was taking measurements and this could have affected their response if the sound was too loud or annoyed them. This would have changed their response because it will not be the natural way in which they would view a video. Furthermore, it is likely that equipment error accounted for some of the deviations within our results. When initially preparing to run the experiment, we found that some of the lab equipment can be very sensitive to error from multiple sources. This is especially true with the respiratory monitor, which can have highly altered results if the participant moves and causes the bands to expand without actually corresponding to a breath (Figure 3a). To reduce the error for heart rate measurement, we have employed both the pulse-oximeter and the blood pressure cuff to obtain a reading. Our greatest challenge was obtaining reliable and accurate blood pressure data. The provided equipment in the lab produced widely variable and highly inaccurate results, so we purchased a new automatic blood pressure arm cuff, which conveniently also accurately records pulse. This new cuff was still prone to some error as we noted that when we took multiple resting blood pressure measurements on the same individual there was some significant variability. We speculate that the heart rate readings are more accurate and less variable than the blood pressure readings, which may explain the difference in statistical significance between Figure 1 and Figure 2.

Ultimately, previous exposure to the fear clip is most likely the primary factor in altering participant fear response and confounding our findings between the audio and visual stimuli and for this reason we chose an unfamiliar clip. Similarly, we used the same clip twice in our study (with and without sound). We were unsure of this aspect of our design because the latter viewing of the clip could have a reduced fear response solely due to prior exposure. In order to account for this issue and control this variability we decided to use the same clip and randomize the order of the sound. We understand that this solution may not always be effective among all participants which could minimize the effect of either stimulus. To truly test whether using the same fear clip for both trials (with or without sound) would have an effect on our results we decided to run a pilot study. This study was conducted in the same manner however two different fear clips were used (randomizing which of the two had sound). We found the results of the pilot study to be insignificant. The additional clip was a scene from *The Shining* and was chosen as a replication of methods from the findings of Hewig et al. (2005).

In addition to the previous shortcomings, we also anticipate errors due to ineffective experimental design and/or inappropriate assumptions made by our group. The major example is our assumption that showing the neutral clip for one minute after the first treatment would return the participant to baseline physiological levels. If this assumption is not true, an elevated baseline could cause our results to be skewed because it's crucial to begin each treatment at baseline levels. Further error may have been introduced by the participants themselves. We looked at the response differences between males and females primarily in our experiment. We hoped to see varied response from each participant, but it was hard to conclude a significant gender difference because there were likely confounding factors. Some factors that could have affected our results included the emotional state of the participant before they watched the clips. Someone who was experiencing depression, stress, happiness or any number of emotions before watching our videos would respond differently to the clips.

Finally we discussed the use of a dark environment to watch the video clips so that we could induce a strong fear response. This was difficult to accomplish because we needed to watch the test equipment during the experiment so we were not able to have the subject in complete darkness. This could have decreased the fear response of each individual. This could also have been beneficial in removing a source of error from our experiment because some participants most likely had an innate fear of darkness or nyctophobia. While we could hopefully have accounted for this by taking their baseline measurement, the surroundings of the participant, including darkness and noise level within the room, would affect how they responded to our clips.

Further research would include surveying a sample population to find "scary" clips and implementing the original design as well as the pilot design concurrently with a larger population. Alternate tools such as an electrocardiograph or a galvanic skin response (GSR) may be more accurate ways of measuring the physiological response to fear. Relevant studies suggest that males and females process auditory and visual stimuli differently which may impact the conclusions of our study.

Appendix

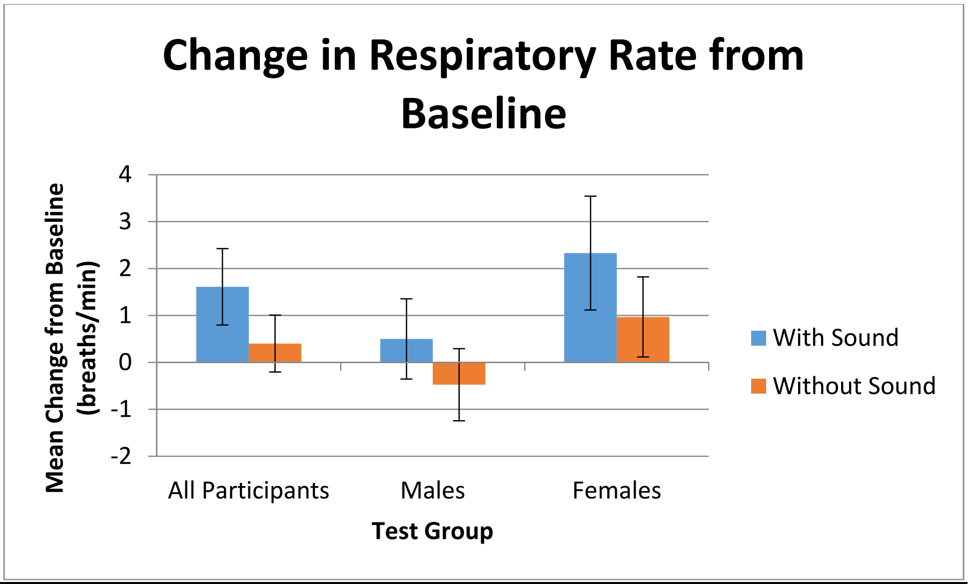


Figure 1: Representation of the mean change of respiratory rate from the baseline measurement for clips with and without sound. Participants had a stronger deviation from baseline measurements in the clip with sound with females showing a greater response than males. Changes in respiratory rate from baseline were found to be significant in all groups with p-values of 0.009 for all participants, 0.042 for males as well as 0.042 for females.

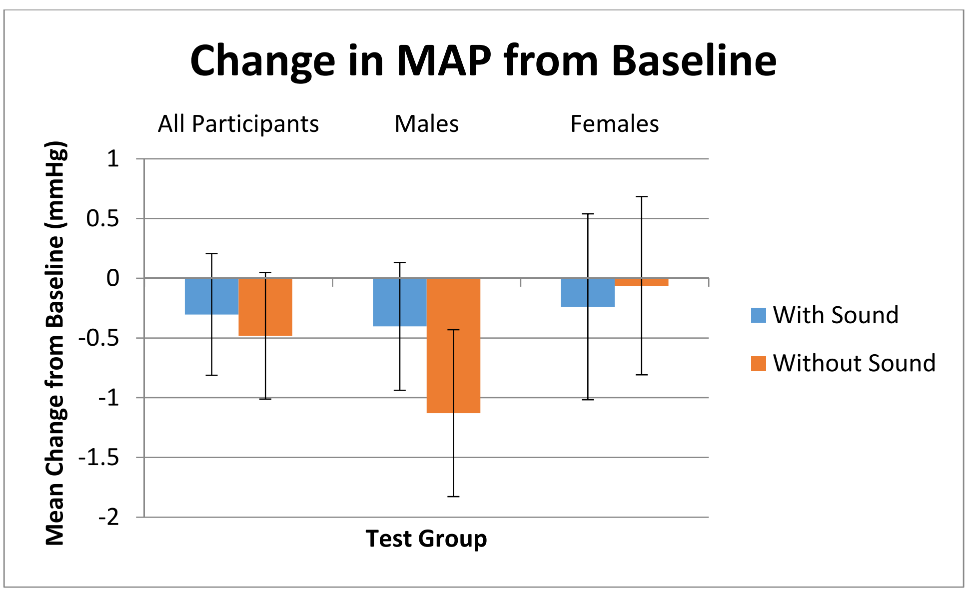


Figure 2: Representation of change in pulse pressure from baseline in clips with and without sound. Participants showed a negative change from baseline. The mean change for males was more robust during the clip without sound. The mean change for females was more robust with sound. Change in Mean Arterial Pressure from baseline was found to be insignificant in all groups with p-values of 0.378 for all participants, 0.191 for males and 0.412 for females.

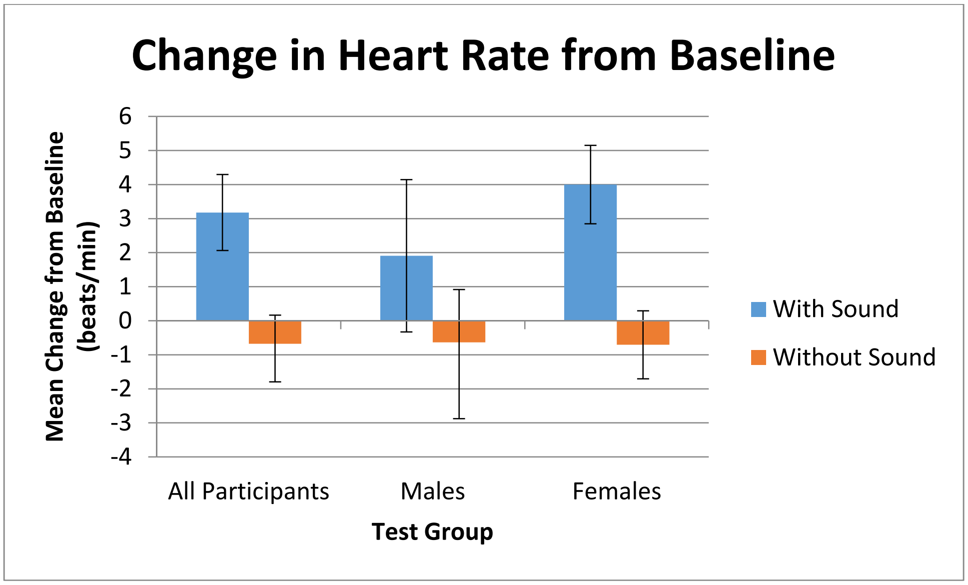


Figure 3: Representation of change in heart rate from baseline in clips with and without sound. Participant heart rates increased in the clip with sound, with female heart rates increasing more than male heart rates. Change in heart rate from baseline was found to be significant with the exception of males with p-values of 7.21E-5 for all participants, 0.0526 for males and 2.52E-4 for females.

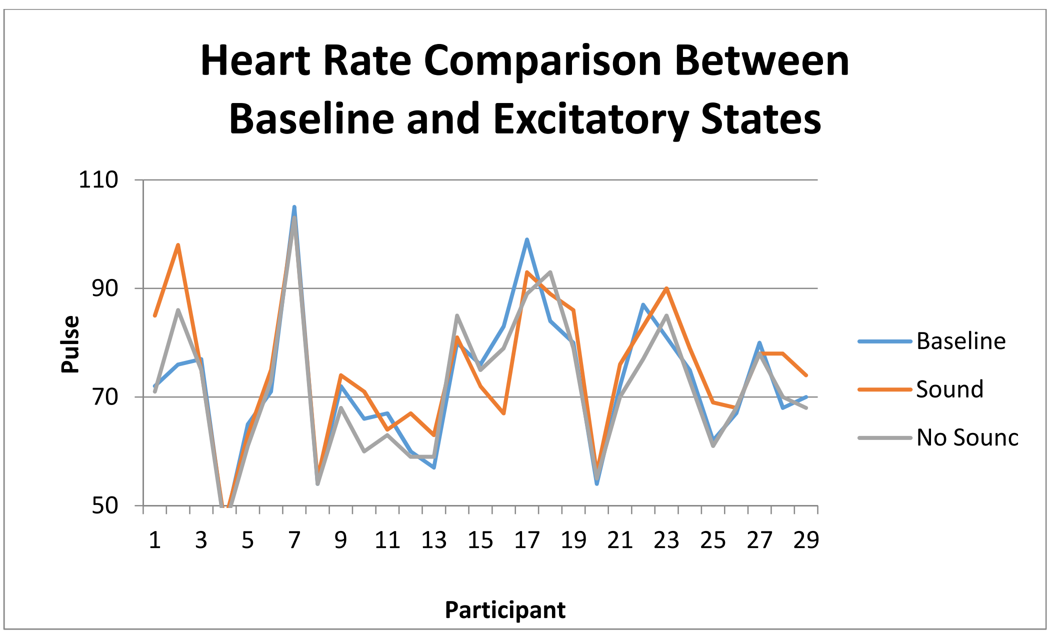


Figure 4: Representation of actual heart rate measurements for each participant for baseline, audio-visual and visual stimulation. Auditory stimulation resulted in an increased pulse for most of the participants.

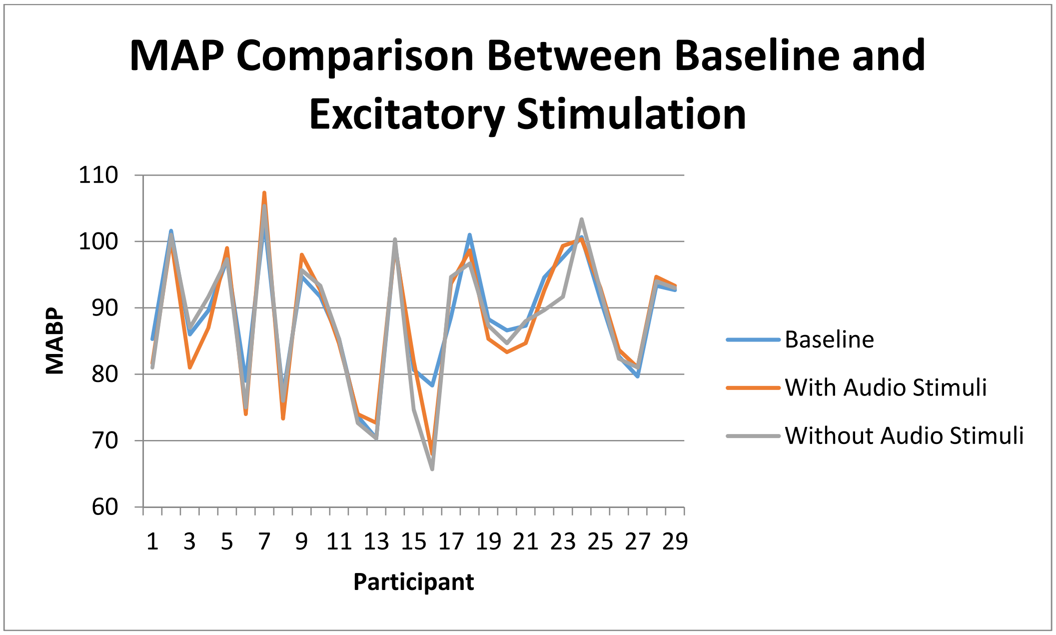


Figure 5: Representation of actual MAP measurements for each participant for baseline, audio-visual and visual stimulation. Auditory stimulation resulted in an increased MABP for most participants.

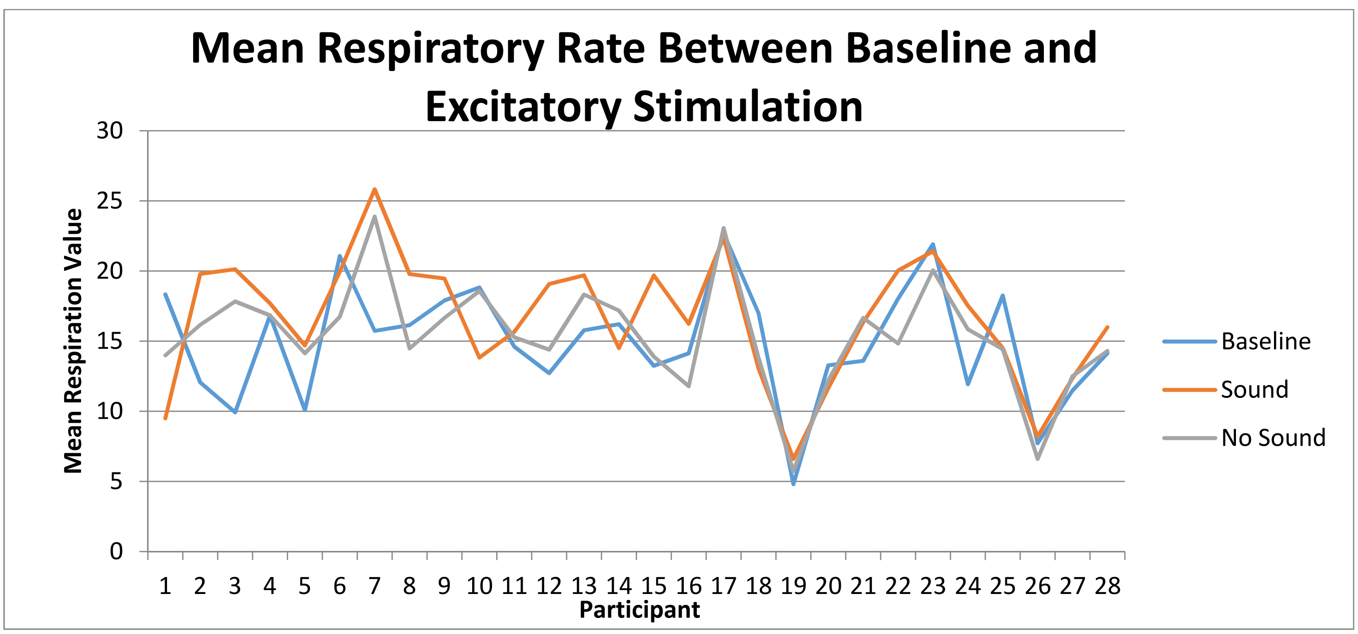


Figure 6: Representation of actual mean respiratory measurements for each participant for baseline, audio-visual and visual stimulation. Auditory stimulation resulted in an increased Mean Respiratory Value for most participants.

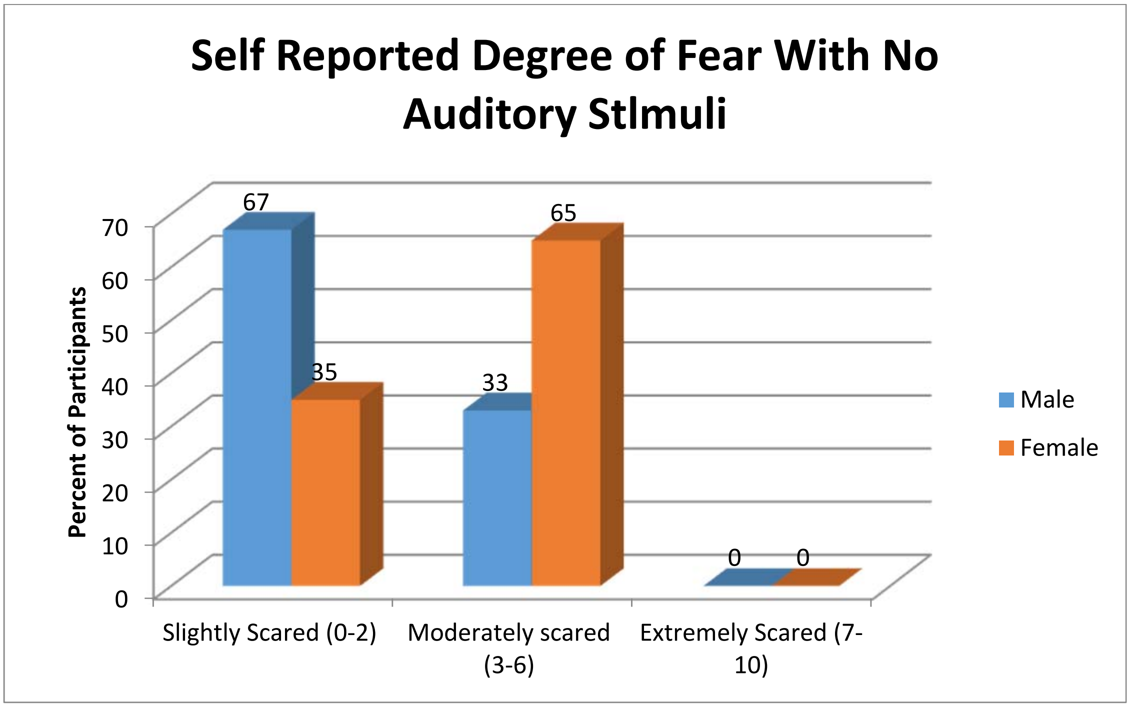


Figure 7: Participants were given a survey after watching the video clip and asked to rate how scary they found the video clip on a scale of 1-10. The majority of females reported feeling moderately scared in comparison to the majority of males feeling slightly scared.

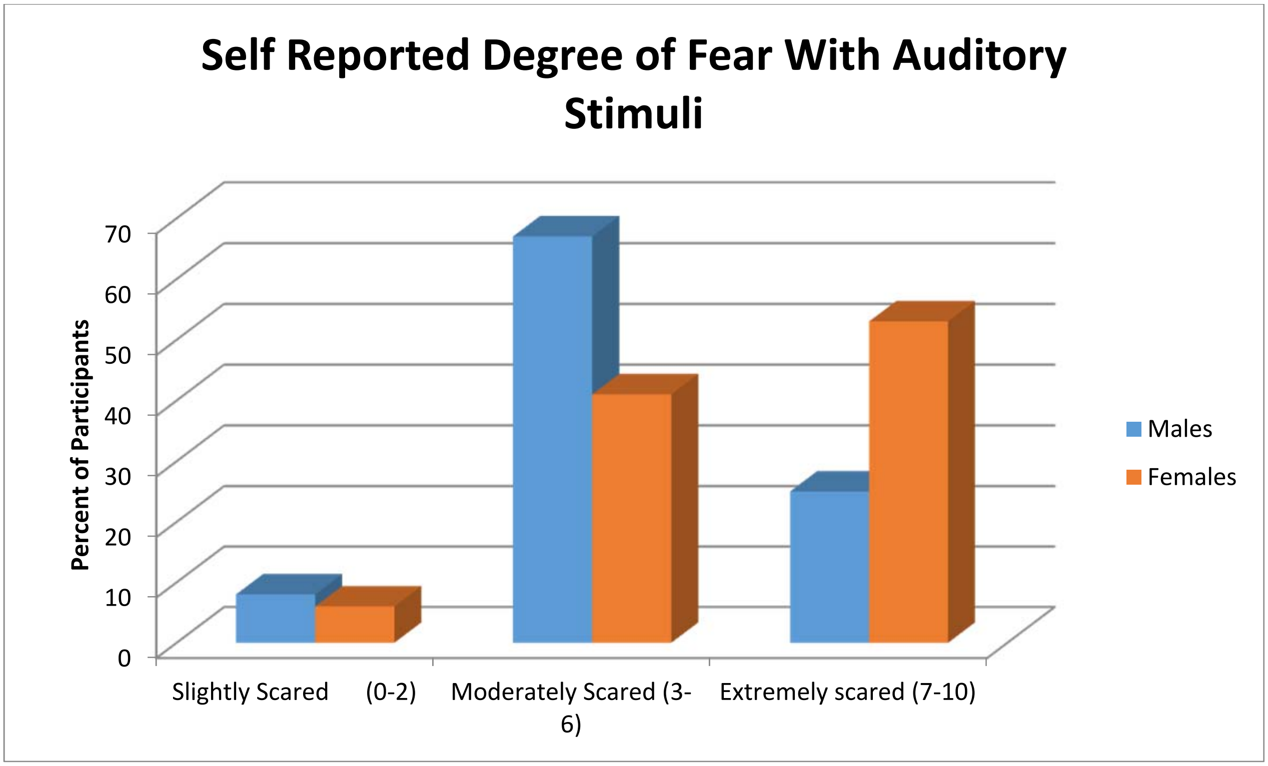


Figure 8: Participants were given a survey after watching the video clip and asked to rate how

scary they found the video clip on a scale of 1-10. The majority of females reported feeling moderately to extremely scared whereas the majority of males felt moderately scared with multiple male participants feeling extremely scared.

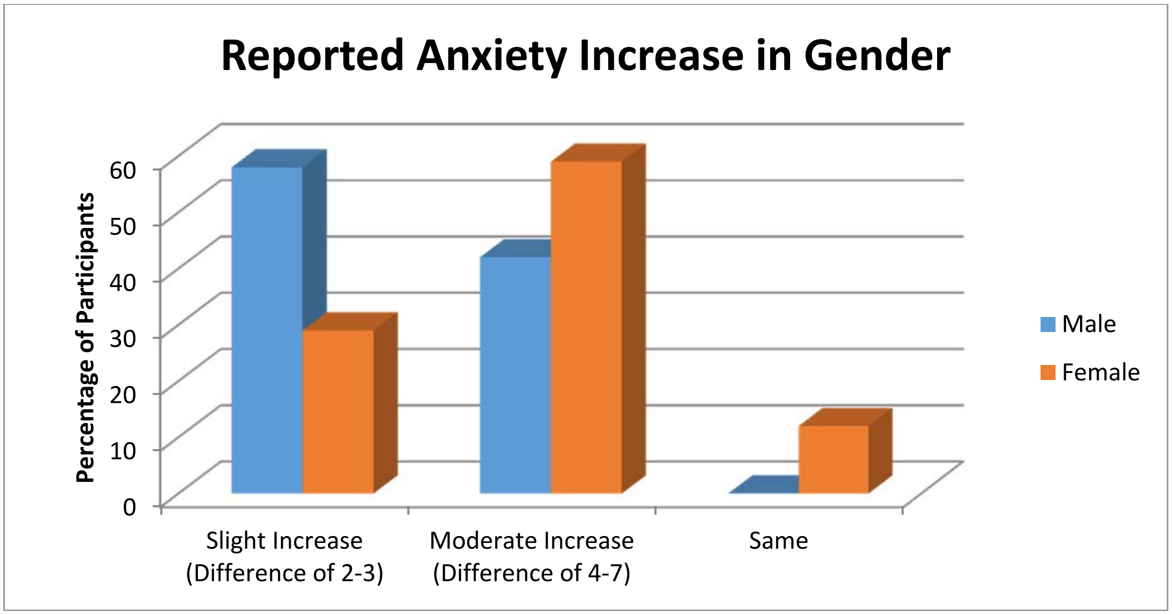


Figure 9: Representation of the difference between survey responses given fear with sound and without sound indicating the anxiety increase between clips. Participants felt more scared with sound. Males only felt a slight increase, while females felt a moderate increase in fear when watching the clip with sound compared to their experience watching the clip without sound.

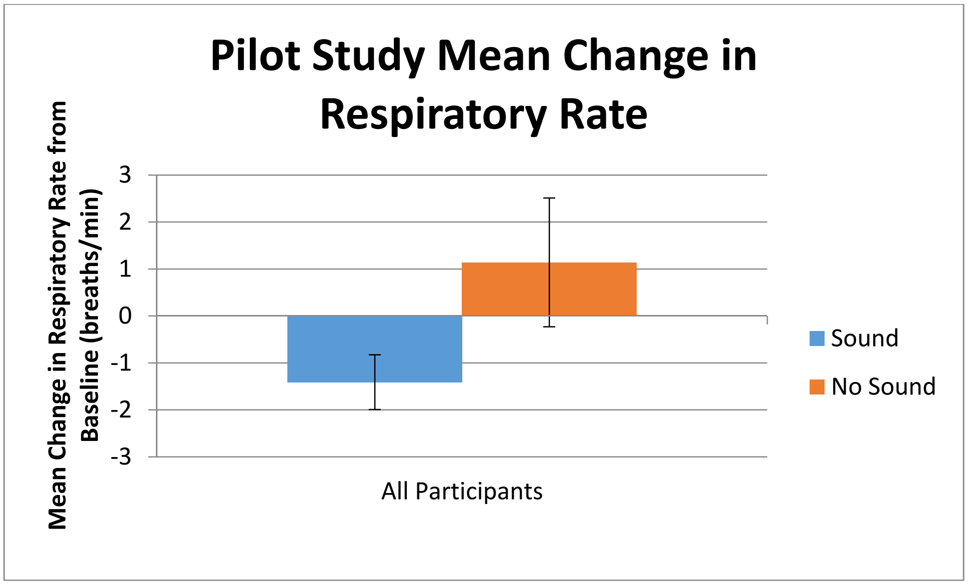


Figure 10: Pilot study change in respiratory rate from base was found to be significant with a p-value of 0.038 for all participants.

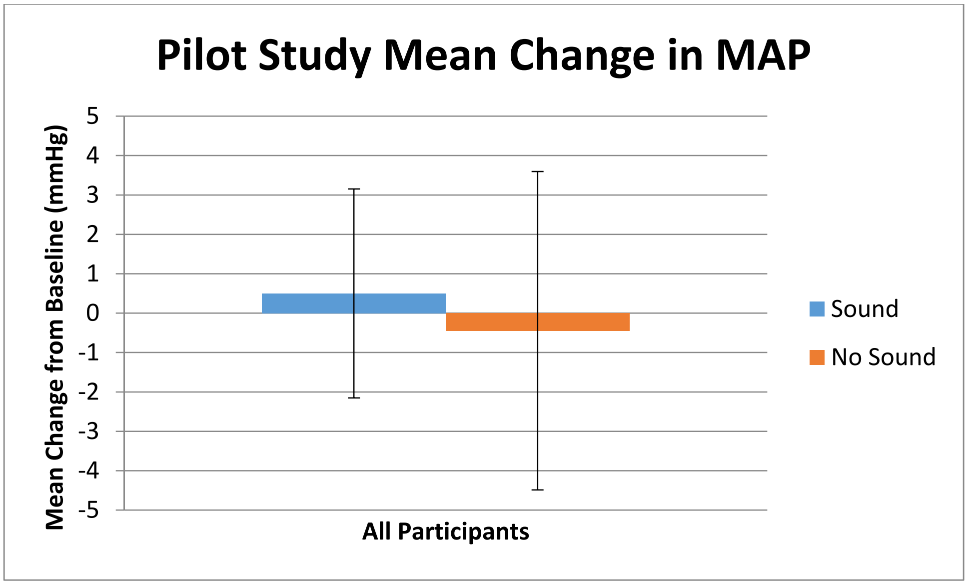


Fig 11:
Pilot study change in MAP from base was found to be insignificant with a p-value of 0.305 for all participants.

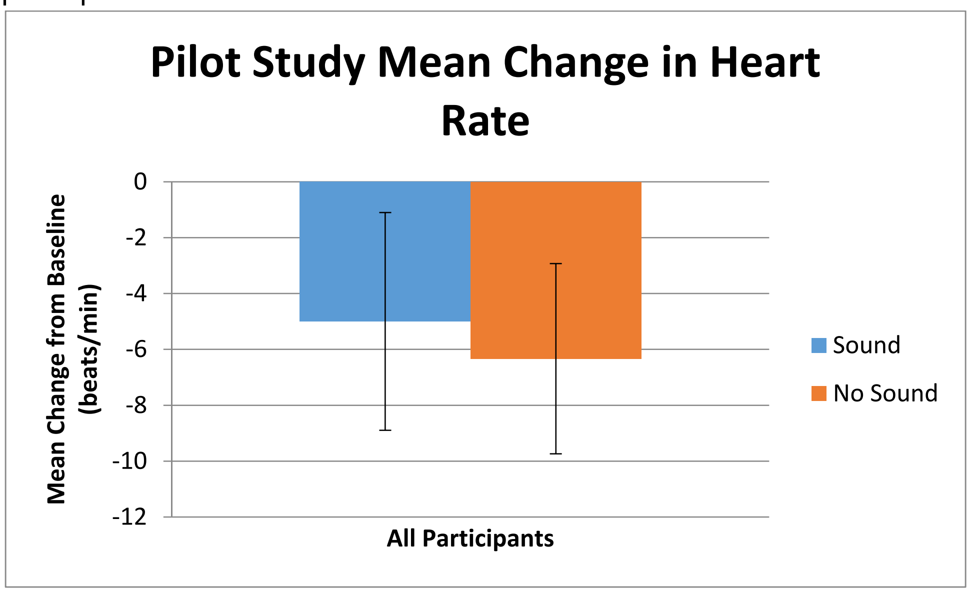


Fig 12:
Pilot study change in heart rate from base was found to be insignificant with a p-value of 0.314 for all participants.

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