**An Analysis of the Physiological Expression of Amusement and Anger and the Effects of Distraction**

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**Abstract:**

Happiness and anger are two emotions that play a very important role in the creation and maintenance of social bonds through their ability to influence attention to environmental stimuli. There has been significant research indicating the effect each of these emotions have on attention. However, there lacks research investigating the manner in which external distractions, such as noise, affect the emotional expression of anger and happiness. Therefore, we examined the physiological expression of heart rate, blood pressure and skin conductance in 36 participants after watching both anger and happiness-inducing video stimuli. Each participant was randomly assigned to receive 0 dB, 50 dB, or 70 dB of noise, which was played during the entire duration of both video stimuli. We predicted that the anger stimulus would induce greater increases of physiological expression than the amusement stimulus. Regarding the noise, we predicted that participants receiving greater levels of noise would experience a smaller increase in physiological expression regardless of the emotion induced. Our results partially support our hypothesis with the anger stimulus eliciting greater increases in heart rate than the amusement stimulus. However, our results did not indicate a relationship between levels of noise distraction and physiological expression of either amusement and anger.

**Introduction:**

There are six commonly accepted universal emotions (anger, happiness, sadness, surprise, disgust, and fear), each of which is accompanied with a unique pattern of physiological responses (Lisetti, 2004; Scherer, 2005). Because emotional states actively influence people's behaviors and ability to communicate, being able to correctly identify an emotion is incredibly important in understanding an individual’s success in a social group or context (Kemper, 1978; Scheff, 1977).

Another important element of emotions is their connection to attention-related processes in the brain. They influence one's attention to important information from the environment. Of all the emotions, happiness (amusement) and anger play an important role in one's ability to regulate the formation of social bonds through attention-mediated processes in the brain (Niedenthal & Ric, 2017). In research about anger, there has been particular interest in the relationship between high levels of chronic anger and selective attention. There is a consensus that anger has a significant effect on selective attention such that aggressive words are more salient to aggressive individuals (Smith & Waterman, 2003). Additionally, aggressive individuals are also more likely to interpret ambiguous images and situations as hostile, making them less likely to maintain strong, healthy social relationships (Graham, Hudley & Williams, 1992).

While these studies demonstrate a strong correlation between anger and attention, they address anger as a personality trait, rather than an induced emotion. In 2010, Ford and his colleagues designed a study to address this gap. After inducing anger, excitement, or fear, they tracked participant's eye movements in response to images that were classified as rewarding, threatening, or neutral. They found that participants who had been induced with anger selectively increased their visual attention towards the rewarding, but not threatening, stimuli (Ford et al., 2010).

In contrast, when amusement is induced, individuals tend to broaden their attention to focus on the "global picture." In 2003, Frederickson induced amusement in participants and asked them to complete a global-local visual processing task. Participants induced with amusement were more likely to analyze the global characteristics of a provided figure instead of focusing on the local details. In a similar experiment, Gasper and Clore found that happy individuals were more likely to access global concepts when completing a Mednick's Remote Associates Test, an activity which asks people to think of a word that relates to a list of three other words (2002).

It is clear that both happiness and anger have a connection with attention-related processes as demonstrated above. However, to our knowledge, previous studies have only looked at the impact an induced emotion has on attention, not the degree to which attention can impact an emotion. Therefore, the proposed study will investigate the degree to which various levels of noise distraction affect the expression of amusement and anger. In addition, because the ability to recognize happiness and anger is a vital tool for our society, we decided to analyze and compare the various physiological responses that accompany these emotions.

Inducing anger and amusement with a movie clip, we monitored the effect that 0 dB, 50 dB, or 70 dB of noise had on heart rate, blood pressure and skin conductance. We anticipated that the physiological responses of anger and amusement would significantly differ from one another and predicted that the induction of both amusement and anger would lead to an increase in heart rate, blood pressure, and skin conductance. However, we predicted that participants would experience a greater increase in heart rate, blood pressure, and skin conductance in response to the anger-inducing stimulus in comparison to the amusement stimulus. This prediction was made in accordance with various past experiments investigating the physiological expression of happiness and anger (Hubert & Jong-Meyer, 1991; Lackner, Weiss, Hinghofer-Szalkay & Papousek, 2014).

As for the effect of distractions, we predicted that as the amount of noise introduced increased, the overall physiological response of the individual would decrease, regardless of the emotion being induced. It is plausible to assume that a distraction will affect and redirect attention processes. Since these attention processes and emotional expression are interconnected, we predicted that the distraction would compete with the incoming emotional information induced by the film clip. This competition would redirect the participant's attention away from the emotional content, resulting in a decreased physiological response.

**Methods:**

*Participants*

A total of 36 subjects (23 females,13 males) between the ages of 18 and 22 were recruited from Physiology 435 at the University of Wisconsin-Madison for this study. Participation was voluntary and no incentive was provided. Each participant signed a consent form outlining the details of the experiment at the beginning. An arbitrary Subject ID was assigned to each participant to ensure individual confidentiality. In addition, each participant was asked to sign a form of confidentiality regarding the details about the experiment.

*Materials*

An Omron 10 series + Blood Pressure Monitor was used to take blood pressure measurements in millimeters of Mercury (mmHg) and heart rate in beats per minute (BPM) (Model: BP791IT, Part: SN 20141004364LG, Manufacturer: Lake Forest, Illinois). Skin Conductance was measured in microsiemens using a BSL EDA Finger Electrode Xdcr (Model: SS3LA, Part: 13013862, BIOPAC Systems, Inc. MP36 Manufacturer: Aero Camino Goleta, CA) and Isotonic Recording Electric Gel 101. The BIOPAC Systems, Inc. M3 computer software was used to record the skin conductance measurements.

*Emotional Stimuli*

Video clips were used to elicit the emotional responses of amusement and anger. For amusement, a 2 minute 12 second clip from the film "Harry Meets Sally" was chosen (Link 1). For anger, a 3 minute 19 second clip from the film "Cry Freedom" was chosen (Link 2). These clips were chosen based on their affirmed ability to elicit the appropriate emotional response (Gross & Levenson, 1995). A scale was given to the participants following each video (Figure 1), which allowed each participant to select their perceived emotion given the choices of the following emotions: sad, disgust, anger, surprise, fear, joy. In addition, participants were asked to estimate their degree of physiological arousal on a scale of 1-10 with 1 being little-no arousal and 10 being very high arousal. This information allowed us to ensure that the participants perceived the targeted emotion.

*Experimental Design*

The timeline of events, outlining participant experience can be found in Figure 2. Before beginning the experiment, the participant was given the consent form and a demographic survey asking them to record their age and gender. All participants were randomly assigned to receive either no noise distraction (n=12), a moderate level of noise distraction of 50 dB (n=12), or a high level of noise distraction of 70 dB (n=12). For participants receiving any level of noise distraction, a corresponding level of white noise was played in the background throughout the duration of the stimuli exposure (Link 3).

While sitting two feet in front of a computer screen, a blood pressure cuff was placed on the upper part of the participant's dominant arm. The skin conductance electrode was placed on the middle and index finger of the non-dominant hand. The participant was then instructed to place the headphones over their head and baseline measurements were recorded. All subsequent audio was played for participants through the headphones. After finishing, the experimenter started the first emotional video. The skin conductance was measured during the entire duration of the clip, while measurements of the blood pressure and heart rate were taken within the last 10 seconds of the clip. After the first film, a neutral, “cross” stimulus appeared on the screen for 2 minutes, which gave the participant’s heart rate time to return to baseline. If the participant’s heart rate did not return to baseline within the 2 minutes allotted, the neutral stimulus exposure was extended until the heart rate lowered to within five beats per minute of the baseline heart rate measurement. After this time, the participant was given the opportunity to fill out the emotion and activation scale (Figure 1). This procedure was repeated for the second video clip. The order in which the video clips were presented was randomized for each participant. After the participant had concluded watching the last clip and completing the scale, a short film clip was shown to ensure the participant left in a neutral or elevated mood (Link 4). Finally, the participant was debriefed and excused. All experimental trials took place in a quiet, dark room to eliminate the effects of other distractions.

*Positive Control Trials*

Positive control trials were conducted on group members to measure the variables outlined above. The group members were subject to the same conditions used on future participants. Changes in all three of the physiological measures were observed in each of the control participants. Tables 1 and 2 outline example data taken with each of the variables. This data was used as evidence that physiological differences in blood pressure, skin conductance, and heart rate by emotional arousal are measurable.

*Data Analysis*

Measurements recorded during this experiment were changes in heart rate (beats per minute), blood pressure (mmHg), and skin conductance (microsiemens). Data for blood pressure and heart rate were recorded during each subject trial, which included baseline measurements and measurements post-stimulation. Skin conductance was collected after each trial (Figure 3). These steps were repeated for each stimulus and for all subject trials. All subject data was recorded in a master Excel spreadsheet. The final figures for heart rate, blood pressure, and skin conductance represent the averages of data for all subjects (Tables 3 and 4).

Each variable's average change from baseline and the standard error was calculated by inserting formulas into the master Excel spreadsheet. This process was repeated for every stimulus. To determine the differences among the groups a two factor ANOVA test was performed within the master Excel spreadsheet. Any significant relationships determined from the ANOVA test were investigated using Kruskal-Wallis Tests**.**

**Results:**

*Blood pressure between stimuli*

There was a significant difference between the average percent change in mean arterial pressure (MAP) of the amusement and anger stimuli ($p = 8.2e-3$) according to the two-factor ANOVA. Kruskal-Wallis tests revealed that of the two stimuli, anger was more statistically significant ($p=0.06$) than amusement ($p=0.43$) for mean arterial blood pressure. There was no clear increasing or decreasing trend in the change of blood pressure for either amusement or anger. The means of the percent change of mean arterial pressure for each participant can be found in Table 5. Average values for the percent change of mean arterial pressure can be seen in Figure 4.

*Heart Rate between stimuli*

There was a significant difference between the change in heart rate during the anger and amusement stimuli ($p$=2.4e-3) according to the Two-Factor ANOVA. Kruskal-Wallis tests revealed that of the two stimuli, amusement was more statistically significant ($p$=0.63) than anger ($p$=0.94) for heart rate. Heart rate tended to increase in response to both amusement and anger stimuli. A greater increase was showed for the anger stimulus in comparison to the amusement stimulus. The means of percent change of heart rate for each participant can be found in Table 5. The average values of percent change of heart rate for all participants and each stimulus can be seen in Figure 5.

*Skin Conductance between stimuli*

There was a significant difference in skin conductance (electrodermal activity) between the anger and amusement stimuli (p=.029) according to the two-factor ANOVA. Kruskal-Wallis tests revealed that of the two stimuli, amusement was more statistically significant (p=0.04) than anger (p=0.52) for electrodermal activity (EDA). There was no clear increasing or decreasing trend in the change of skin conductance for either amusement or anger. The means of the percent change can be found in Table 5. Average values of percent change of EDA for all participants and stimuli can be seen in Figure 6.

*Blood pressure across all conditions*

There was not a significant difference in percent change of mean arterial blood pressure across the 0 dB, 50 dB, 70 dB noise conditions for either amusement or anger (p=.577). Participants in the 0 dB condition tended to experience a greater increase in blood pressure in response to the amusement stimulus than to the anger stimulus. Participants in the 50 dB condition typically experienced a greater increase in blood pressure in response to the anger stimulus than the amusement stimulus. Participants in the 70 dB condition experienced an increase in blood pressure with the amusement stimulus and a decrease in blood pressure with the anger stimulus. Average values for the percent change of mean arterial pressure across all noise conditions can be seen in Figure 7.

*Heart Rate across all conditions*

There was not a significant difference in percent change of heart rate across the 0 dB, 50 dB, 70 dB noise conditions for either amusement or anger (p=.577). Participants in all noise conditions experienced a greater increase in heart rate in response to the anger stimulus when compared to the amusement stimulus. Participants in the 0 dB condition experienced the largest overall increase in heart rate while participants in the 70 dB condition experienced the overall least increase in heart rate. Average values for the percent change of mean heart rate across all noise conditions can be seen in Figure 8.

*Skin Conductance across all conditions*

There was not a significant difference in percent change of across the 0 dB, 50 dB, 70 dB noise conditions for either amusement or anger (p=.577). Participants in the 0 dB condition experienced a greater increase in skin conductance in response to the amusement stimulus than to the anger stimulus. Participants in the 50 dB condition experienced a greater decrease in skin conductance in response to the amusement stimulus than the anger stimulus. Participants in the 70 dB condition experienced an increase in skin conductance with the amusement stimulus and a decrease in skin conductance with the anger stimulus. Average values for the percent change of mean skin conductance across all noise conditions can be seen in Figure 9.

**Discussion:**

One of our hypotheses was that the anger stimulus would create a greater physiological response in participants when compared to the amusement stimulus. This hypothesis was partially supported. There was a significant difference in percent change of mean arterial pressure, heart rate, and skin conductance between the anger and amusement stimuli. However, heart rate was the only variable in which an increase in both amusement and anger was confirmed. The increase in heart rate was greater for the anger stimulus than the amusement stimulus as predicted.

In blood pressure and skin conductance there was no general trend in which either of the variables routinely increased in response to either the anger or amusement stimulus. Additionally, we had predicted that increasing levels of noise would lead to decreases in all three of the physiological measures for the participants, regardless of the emotion induced. This hypothesis was not statistically supported as there were no significant differences between percent change of mean arterial blood pressure, heart rate, or skin conductance.

*Heart Rate*

Our results showed a significant difference between the percent change in heart rate induced by the anger stimulus and the percent change in heart rate induced by the amusement stimulus. This supported our hypothesis that the anger stimulus would elicit a greater increase in heart rate when compared to the amusement stimulus. These results correlate with former literature which states that induced anger routinely increases heart rate to a greater degree than amusement (Ekmen, Levenson, & Friesen, 1983; Hubert and Jong-Meyer, 1991).

*Blood Pressure*

Our results showed a significant difference between the percent change in blood pressure induced by the anger stimulus and the percent change in blood pressure induced by the amusement stimulus. This significant difference in blood pressure did not support our hypothesis, as there was not a clear increasing trend in blood pressure in response to either the anger or amusement stimulus. These results did not correlate with past literature, which states that anger routinely elicits a greater increase in blood pressure than does amusement (Lackner, Weiss & Hunghofer-Szalkay, 2014; James, Yee, Harshfield, et al, 1986). We expect that this discrepancy could have been due to an inaccurate perception of the emotional stimuli, especially in the anger stimuli (see *Limitations*).

*Skin Conductance*

Our results showed that there was a significant difference in skin conductance between the anger and amusement stimuli. This significant difference in skin conductance did not support our hypothesis that there would be a greater increase of skin conductance in response to the anger stimulus. These results did not correlate with former literature which states that skin conductance often increases more drastically in response to anger stimulus and less in response to amusement stimulus (Hubbard, et al., 2002; Hubert and Jong-Meyer, 1991). We expect that this discrepancy (similar to the one found with blood pressure) could have been due to an inaccurate perception of emotional stimuli (see *Limitations*).

*Noise*

Our results did not show a significant difference between the percent change in any of the measured physiological variables between amusement or anger in the 0 dB, 50 dB, or 70 dB noise conditions. There are limited studies which have investigated levels of noise distraction and its effect on amusement and anger, so we are unable to check these results against the results of former studies. Though not statistically significant, the expected pattern of the change in heart rate in response to the levels of noise distraction was seen. For both the amusement and anger stimuli, participants in the 0 dB condition experienced the greatest increase in heart rate while participants in the 70 dB condition experienced the smallest increase in heart rate.

*Limitations*

Our experiment had several limitations which could have interfered with our results. Having used film clips to induce each emotion, there is a possibility that participants had already seen the clips before. Any previous memories participants had associated with viewing these film clips may have altered the emotion or intensity of emotion induced in the participants during the experiment. Additionally, while past literature has indicated that each of these clips has been very successful in inducing the targeted emotion (Gross & Levenson, 1995; Rottenberg et al., 2007), there was a discrepancy in the reported emotions for each film clips. Only 25% of participants correctly identified themselves as feeling anger in response or the anger-inducing stimulus. 70% of participants claimed to feel happy or amused in response to the amusement stimulus. Because each emotion is accompanied by a unique physiological response, these discrepancies could have potentially had a large effect on the outcomes of our study, as we cannot confirm the target emotions had been induced. As stated earlier, it is possible that our unexpected blood pressure and skin conductance results were influenced by this, as these measurements could have been recording a different induced emotion than the intended elicited emotions of amusement or anger.

In addition, because the film clips selected had audio, there is a possibility that the highest level of noise distraction (70 dB) interfered with some participants' ability to interpret the content of the clip. If this did occur, it may have limited the efficacy of the emotional induction, thus decreasing the participants' physiological response. Lastly, due to limited space and resources, distractions in the external environment may have interfered with the collection of the physiological variables of the participants, as well as the emotional induction of the participants.

*Future Studies*

Although we were unable to establish a direct significant relationship between the levels of noise distraction and the degree of physiological response, the design of our study has provided a starting point for future studies to expand upon. It is our hope that future studies will be able to build upon our results and establish a clearer relationship between noise distractions and emotion perception. If a correlation between noise distraction and emotion perception is found, this would have potentially important implications for noise pollution and the location of schools, hospitals, and housing developments as emotions have a very important role in determining an individual's success in social contexts.

Looking forward, future experiments should investigate using alternative forms of emotion-inducing stimuli such as photographs. This would eliminate any interference between the noise levels and ability of the participants to interpret the stimuli. Additionally it would be beneficial to include another control group to examine the effect of background noise on heart rate, skin conductance, and blood pressure. This group would be assigned a noise level (0 dB, 50 dB, or 70 dB) but would not receive any emotional-inducing stimuli. Lastly, a chi-squared analysis of gender is another potential way to analyze the data. We chose not to employ this method of analysis for our experiment because the number of female participants outnumbered the number of male participants (3:1 ratio). However, future studies could investigate the role of gender on physiological response and the effects of distraction.

*Implications*

Responses from our emotion scale imply that participants perceive film clips in varying manners. We assume this difference in perception to be a result of individual differences between the participants such as previous experience with the stimulus. These implications are important for future experiments which rely on emotion induction techniques, as they must include verification that participants actually felt the intended emotion. In summary, our results indicated that emotional clips are perceived differently among different individuals, providing important stipulations for future studies. In response to our insignificant noise distraction results, as one of the first studies investigating this relationship, future studies should be conducted before confirmation or rejection of this phenomenon is decided.

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**Appendix:**

| **Amusement** | Blood Pressure (mmHg) | Mean Skin Conductance (microsiemens) | Heart Rate (bpm) |
|---|---|---|---|
| No Noise | Before: 114/80<br>After: 115/82 | Before: 0.00829<br>After: 0.00888 | Before: 83<br>After:85 |
| Moderate Noise | Before: 91/67<br>After: 92/67 | Before: 0.01563<br>After: 0.01604 | Before:79<br>After:80 |
| High Noise | Before: 107/72<br>After: 109/74 | Before: 0.00988<br>After: 0.00997 | Before: 77<br>After: 80 |

| **Anger** | Blood Pressure (mmHG) | Mean Skin Conductance (microsiemens) | Heart Rate (bpm) |
|---|---|---|---|
| No Noise (0 dB) | Before: 111/83<br>After: 116/86 | Before: 0.00422<br>After: 0.00886 | Before: 86<br>After: 93 |

| | | | |
|---|---|---|---|
| Moderate Noise (50 dB) | Before: 96/64<br>After: 98/73 | Before: 0.00902<br>After: 0.00954 | Before: 83<br>After: 88 |
| Elevated Noise (70 dB) | Before: 115/68<br>After: 124/75 | Before: 0.00954<br>After: 0.01269 | Before: 76<br>After: 80 |

**Tables 1 & 2:** The measurements of control data for each stimulus per experimental condition. Blood pressure, measured in millimeters of mercury (mmHg), and Heart rate measured in beats per minute (bpm), were recorded before and after the presentation of each stimulus. Skin Conductance, measured in microsiemens, was recorded for the duration of each stimulus.

| **Amusement** | **Blood Pressure (MAP)** | **Skin Conductance (EDA)** | **Heart Rate** |
|---|---|---|---|
| **0 dB** | 1.470813281% | 26.97811012% | 4.562312213% |
| **50 dB** | 0.673796109% | -13.44181602% | 3.13609838% |
| **70 dB** | 2.995451422% | 6.206745974% | 1.516219277% |

| **Anger** | **Blood Pressure (MAP)** | **Skin Conductance (EDA)** | **Heart Rate** |
|---|---|---|---|
| **0 dB** | 0.643262895% | 8.732189128% | 2.018262443% |

| | | | |
|---|---|---|---|
| **50 dB** | 4.790895985% | -3.91210756% | 1.807619327% |
| **70 dB** | -1.207593362% | -7.102267526% | 1.379554128% |

**Tables 3 & 4:** Average percent change of Mean Arterial Pressure (MAP), Skin Conductance (EDA), and Heart Rate for all participants. Percentages represent changes from the average baseline measurements for each stimulus per experimental condition.

| | **Blood Pressure (MAP)** | **Skin Conductance (EDA)** | **Heart Rate** |
|---|---|---|---|
| **Amusement** | 1.713353604% | 6.581013358% | 3.07154329% |
| **Anger** | 1.408855171% | 0.7607286527% | 1.73351453% |

**Table 5:** Average percent change of Mean Arterial Pressure (MAP), Skin Conductance (EDA), and Heart Rate for all participants. Percentages represent changes from the average baseline measurements for each stimulus across all conditions.

**Link 1**: https://www.youtube.com/watch?v=PdJm3DVg3EM

**Link 2**: https://www.youtube.com/watch?v=2MgQ16fRlXI

**Link 3**: https://www.youtube.com/watch?v=JxJsai5nkGI

**Link 4:** https://mynoise.net/

**Video Links:** Links 1 and 2 are sources of the amusement and anger stimuli. Link 3 is the debriefing clip given to ensure each participant left the lab having returned to their baseline mood. Link 4 is the site used to create the background noise of each experimental condition (0 dB, 50 dB, and 70 dB).


**Figure 1**: Perceived Emotion and Intensity Scale. After viewing the stimulus, each participant was asked to circle the emotion they experienced and indicate the intensity of that emotion.

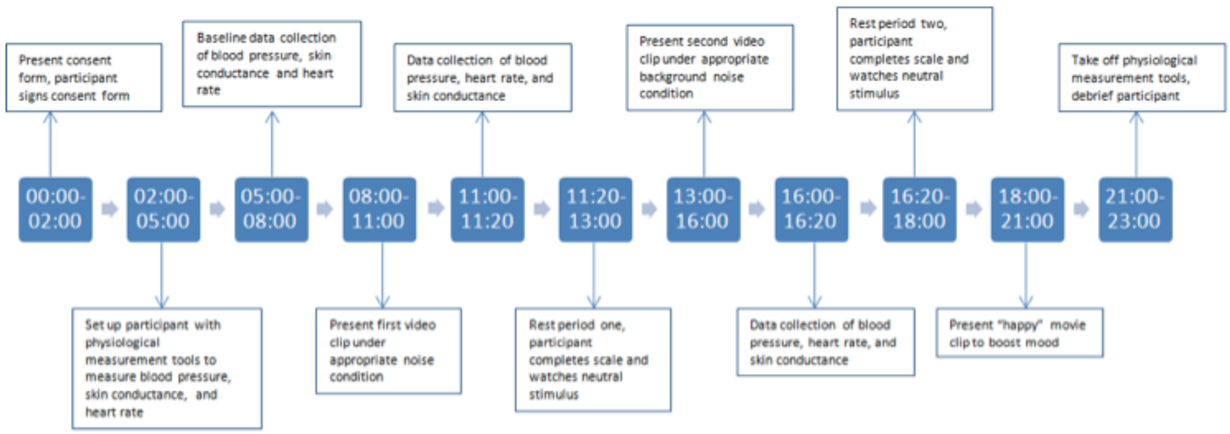


**Figure 2**: Timeline of Events that each participant underwent during the experiment

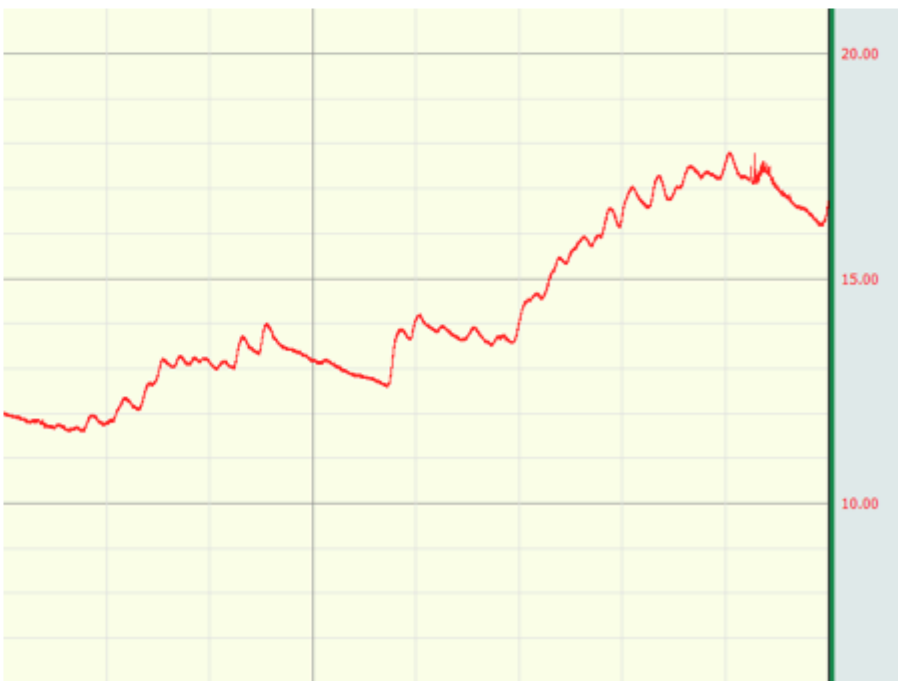


**Figure 3.** Example of changes in skin conductance obtained while viewing stimulus. Using tools in Biopac, the data was selected and the "mean" function was used to calculate the average skin conductance (microsiemens) over time (seconds).

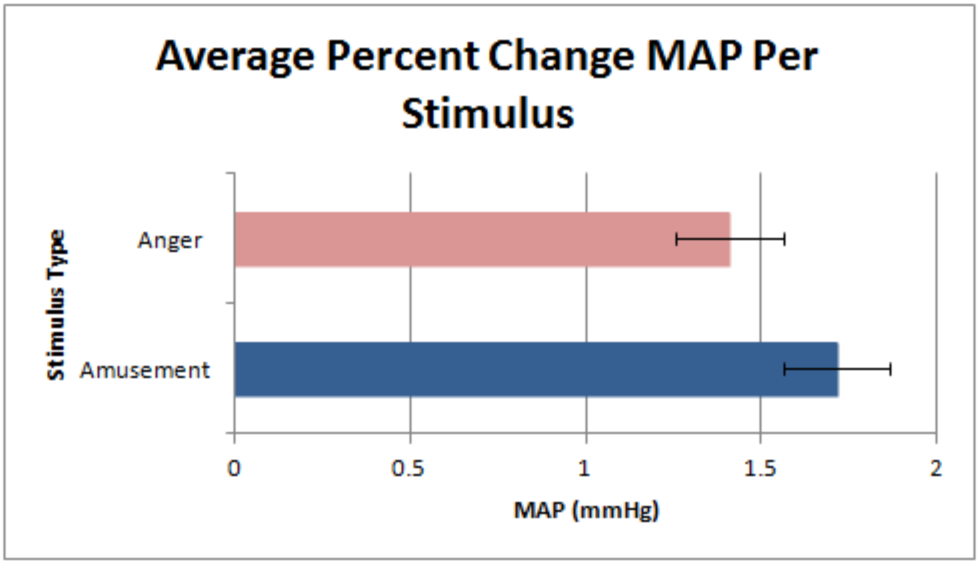


**Figure 4.** Average percent change and standard error of MAP per stimulus, containing all noise conditions (Amusement=Blue, Anger=Red).

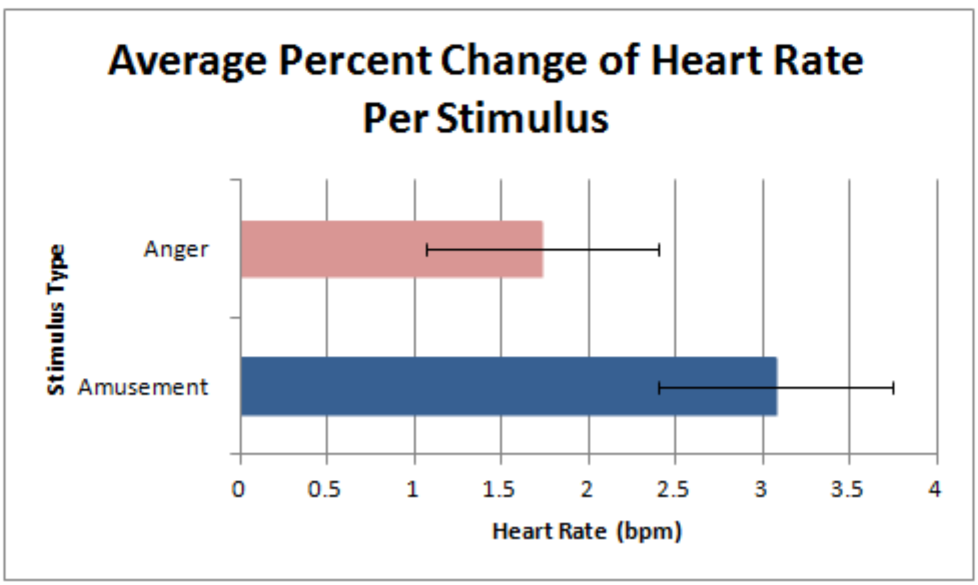


**Figure 5:** Average percent change and standard error of heart rate per stimulus, containing all noise conditions (Amusement=Blue, Anger=Red).

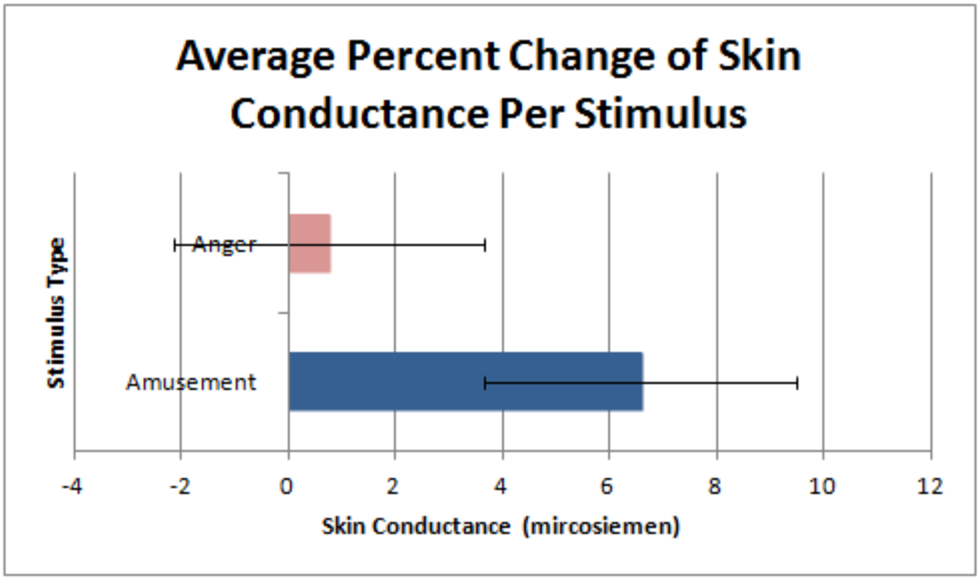


**Figure 6:** Average percent change and standard error of skin conductance per stimulus, containing all noise conditions (Amusement=Blue, Anger=Red).

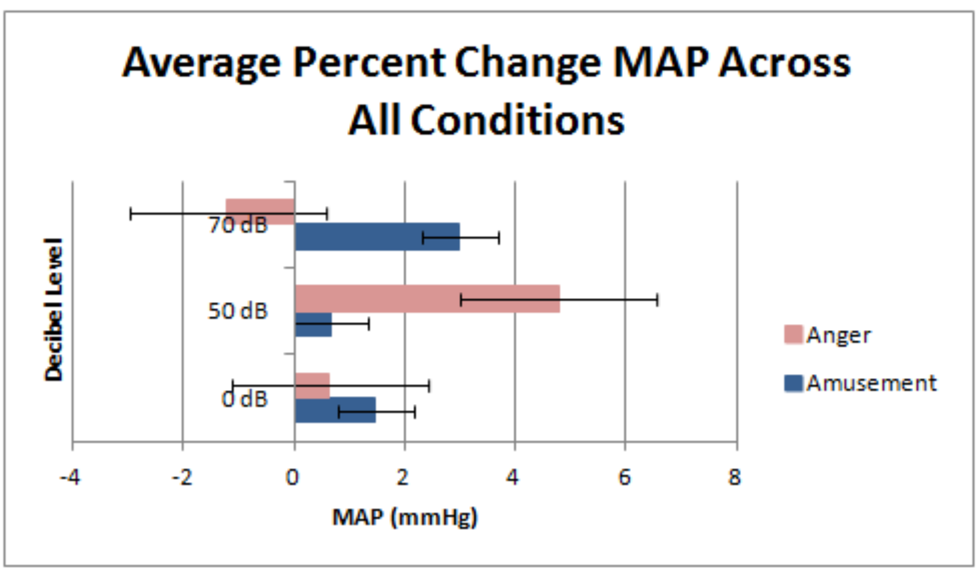


**Figure 7.** Average percent change and standard error of MAP per stimulus (Amusement=Blue, Anger=Red) and for all the experimental groups (0 dB, 50 dB, 70 dB).

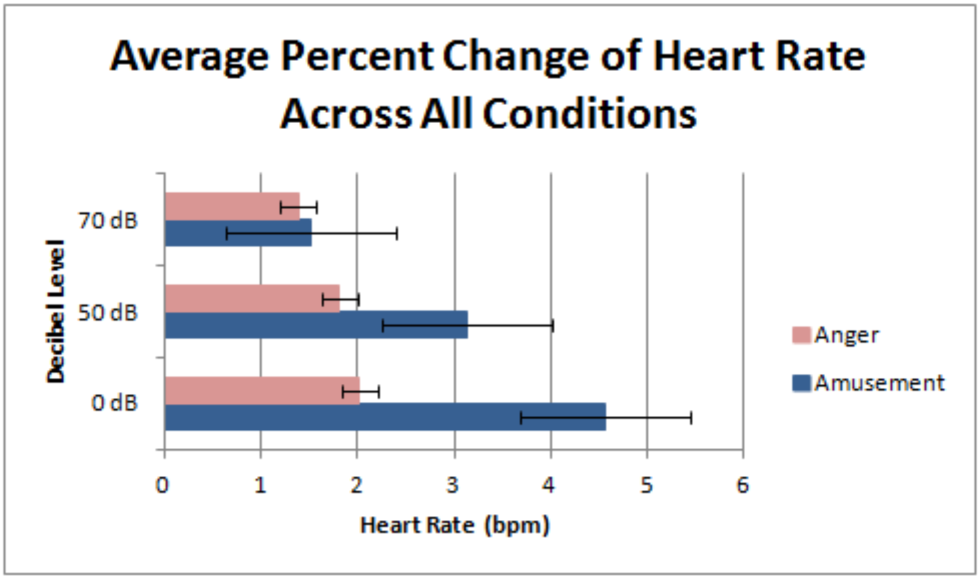


**Figure 8:** Average percent change and standard error of heart rate for each stimulus (Amusement=Blue, Anger=Red) for all the experimental groups (0 dB, 50 dB, 70 dB).

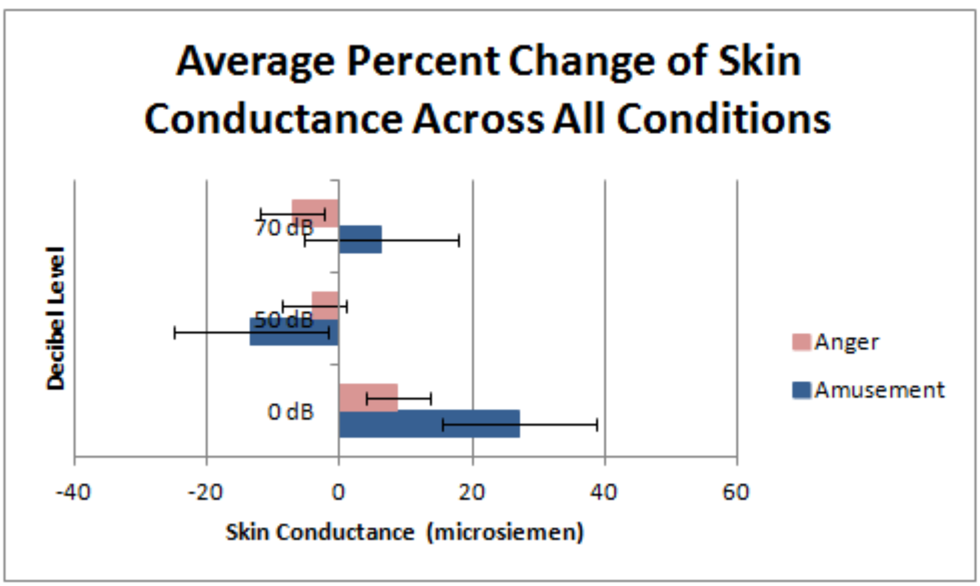


**Figure 9:** Average percent change and standard error of skin conductance per stimulus (Amusement=Blue, Anger=Red) and for all experimental conditions (0 dB, 50 dB, 70 dB).