

**The Effects Virtual Reality Has on Physiological Responses as Compared to  
Two-Dimensional Video**

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Keywords: Anticipation, Anxiety, Beta Waves, Brainwaves, EDS, EEG, Fear, Feedforward, Heart Rate, Jump Scare, Respiration, Sound, Startle Stimulus, Stress, Sympathetic Nervous System, Threat, Virtual Reality

Word Count: 4414

## **Abstract**

One of the newest forms of media to emerge from the technological industry was the creation of a virtual reality headset. The headset is designed to replace all real physical stimuli, virtually transporting the user into another setting. Consequently, it should evoke more realistic responses than traditional 2D media. This particular experiment chose to study physiological differences elicited from participants watching horror clips via a standard 2D screen or virtual reality (VR). Nineteen undergraduate students were selected to participate in the study (n=11 females, n=8 males; mean age of 21.3). If the participants used the virtual reality headset, then they were predicted to have a greater percent change between their baseline and scared physiological measurements. Four variables were measured: sweat conductance, heart rate, beta waves, and respiration rate. After statistically analyzing the data using t tests, the electrodermal activity (EDA) sweat conductance, heart rate, and electroencephalogram (EEG) beta waves showed no significant difference between the physiological responses of the two groups (p values of 0.55, 0.56, 0.67, respectively). The variable that did show significance was the respiration rate (p=0.00053) that indicated a greater percentage change for 2D versus VR. This opposed the hypothesis. Although these results did not prove virtual reality was more realistic, it is still necessary to study the physiological effects virtual reality could elicit.

## **Introduction**

New technologies are continuously emerging to provide an authentic experience for users in a variety of settings. One of the more recent examples is the development and rising use of virtual reality. This form of media engages the senses through vivid imagery coordinated with auditory information to create a new environment for the user (Burdea, 2003). Similar to a classic 2D video, the virtual reality headset allows the participant to watch a video. However, the virtual reality headset eliminates most external visual stimuli and immerses one into a different, virtual environment (Burdea, 2003). The ultimate goal is to allow the user to feel “transported” into a setting independent of the actual location of their body.

The potentials of such technology can be used within education, entertainment, and various therapies for physical or social disorders. Given the important and diverse possibilities, it is important to understand the physiological effects virtual reality can elicit within users. The goal of this experiment is to investigate the difference between the reactions triggered by the presentation of a classical 2D video clip as compared to a clip shown through virtual reality. The two clips are both examples of horror media in which increased suspense culminated in a jump scare -- a figure rapidly approaching the viewer. If the virtual reality group shows significantly more extreme physiological responses, it will support the greater effectiveness of virtual reality as compared to 2D. In turn, this will help evaluate the validity of pursuing virtual reality in its various potential uses (ie. therapies, education, and entertainment).

It would be logical to predict that participating in virtual reality would evoke a greater physiological response as it provides a more complete identification of the user with the perspective shown in virtual reality. The user can feel immersed and in control of their movements as their senses are flooded with information only from the virtual world. Although classic 2D video can engross a person’s attention, it does not eliminate surrounding stimuli, effectively maintaining a barrier between the physical world and the video’s reality. Therefore,

the replacement of the physical reality with virtual reality creates a more lifelike experience and provokes more realistic reactions from the participant (Peng, 2008)

Two studies seemed to support these assumptions. One study explored the physiological responses evoked through watching and playing horror video games. Players consistently showed higher responses associated with fear than watchers of the game (Madsen, 2015). However, the study did not use virtual reality. Another study found that virtual reality heightened emotional responses as shown through MRI imaging of the amygdala to pleasant, neutral, and distasteful settings as compared to standard 2D presentation (Dores, 2014). The limitation in this study is that it only measured one response variable. As fear tends to be a full body experience, more responses need to be tested. Our study hopes to add to the available literature, by elaborating upon the effects of virtual reality on a more diverse set of physiological responses.

In a study done by Thierry Steimer (2002), fear is defined as “a motivational state aroused by specific stimuli that give rise to defensive behavior or escape.” In response to fear, the subject will either use active or passive coping strategies. Active coping strategies are mediated predominantly through sympathetic activation of the nervous system. This response is often called the fight-or-flight response. Common physiological responses of this coping strategy are tachycardia, increased respiration rate, increased production of sweat, and stimulated beta waves (Steimer, 2002).

As the participants gain a more authentic and realistic experience through virtual reality, one would anticipate these physiological effects to be elevated as in reality. Classic media presentation does not completely immerse the user, therefore it could be suggested that a less intense response would be expected. If the participant watches the horror video clip through virtual reality, then there will be a greater change in physiological response measurements than those of the 2D media.

## **Physiological Measurements:**

### *EDA (skin conductance)*

Electrodermal activity (EDA) measures the autonomic changes in skin conductance. Skin conductance includes the measurement from both tonic skin conductance level and phasic skin conductance components that result from sympathetic neuronal activity outputs. EDA is noted as one of the most useful ways to measure emotional and cognitive arousal due to the fact that it is not affected by parasympathetic outputs. Threshold (baseline) measurements are normally between 0.03 and 0.05 microsiemen. When exposed to a stimuli that inflicts a frightened emotional response, measurements tend to increase to 2-3 microsiemen with the most extreme cases measuring up to 8 microsiemen (Braithwaite, 2015). Applying this test to our research will allow us to test the emotional and cognitive arousal one feels when watching their given video in order to determine which type of media elicits a greater fear response.

### *Heart Rate*

The pulse is a measurement of beats per minutes which is a reflection of the amount of blood that your heart is pumping out to the rest of the body. The resting heart rate for someone that is healthy, young, and sitting down should be between 60 and 100 bpm. When one is frightened, the heart rate will rise in order for more blood to be distributed and allowing for the “fright or flight” response of the sympathetic nervous system to occur. The average heart rate of someone that is frightened is 110 bpm. However, since there are such large ranges in heart rate measurements, fear is normally found to cause an average increase of around 40 bpm from baseline (AHA, 2015). Due to its reflection of sympathetic activity, it would help illustrate the degree of fear experienced.

### *EEG (Electroencephalogram)*

The electroencephalogram test allows one to measure the electrical activity of our brain. Beta rhythms occur in those that are exposed to an external stimuli that requires them to be alert and awake. Normal beta readings results in a frequency of 13-30 Hz and an amplitude of 20-200 microvolts (Westminster, 2010). Increase from the given ranges is a sign that the subject is experiencing adrenaline, anxiety, or stress. We chose to record these values due to their relationship with the fear and alertness that scary videos present.

### *Respiration Rate*

Respiration is another physiological measurement that, when raised, is indicative of the subject undergoing a sympathetic response. The normal respiratory rate for an adult is 12-16 breaths per minute. When someone is frightened, their body wants to increase its intake of oxygen. Therefore, measuring the change in respiratory rate from the baseline measurements obtained from each subject will allow us to gauge how frightened each individual is as a result of this physiological reaction. Respiration may also show a sudden gasp or the holding of one’s breath at the scare indicating a reaction to it (Steimer, 2002).

## **Materials**

The following is a list of materials used in this experiment:

- Merge 360 Virtual Reality goggles (Merge Labs, San Antonio, TX, USA)
- Biopac (BSL 4 software, MP36 hardware, BIOPAC Systems, Inc., Goleta, CA, USA)
- EEG (SS2L Electrode, BIOPAC Systems, Inc., Goleta, CA, USA)
- BSL EDA Finger Electrode Xdcr (SS3LA, BIOPAC Systems, Inc., Goleta, CA, USA)
- EDA Gel 101 (Isotonic Recording Electrode Gel, BIOPAC Systems, Inc., Goleta, CA, USA)
- Pulse Oximeter (Nonin, Model 9843, Nonin Medical, Inc., Plymouth, MN, USA)
- BSL Respiratory Effort Xdcr (SS5LB, BIOPAC Systems, Inc., Goleta, CA, USA)
- Electrode Stickers (BIOPAC Systems, Inc., Goleta, CA, USA)
- Headband/prewrap
- Computer (Dell S2409W, Dell, Inc.)

- Noise-cancelling headphones (EO-PN900, Level, Samsung Electro-Mechanics, Suwon, Gyeonggi-do, South Korea)
- VR video: <https://www.youtube.com/watch?v=v2EUMnjJYfw> (13:00-gate closing at 14:07)
- 2-D scare video: <https://www.youtube.com/watch?v=UxkuYebXeX0> (scare at 17 seconds)

## Methods

### *Participants*

Nineteen participants were used for the population of this study (n=11 females and n=8 males). Ten participants were randomly selected to do the virtual reality clip (n=5 females and n=5 males) and nine participants to do the 2D clip (n=6 females and n=3 males). The participants were undergraduate students from the University of Wisconsin-Madison enrolled in the Physiology 435 course. Participants' ages ranged from 20-22 (total mean age of 21.3, mean age for 2D of 21.5, mean age for VR of 21.0). No incentives were provided for participants following the study. All subjects volunteered to participate in the study and signed a consent form that detailed the risks that were involved (See Appendix A).

### *Procedure*

All subjects participated individually. The participants entered an isolated, plain, and relatively quiet room. The temperature in the room was approximately 73 degrees fahrenheit, except for one day, where the temperature was 82 degrees.

Upon entering the room, the participant signed a consent form that informed the subject that they will be watching video clips that may incite emotional responses. The genre of the clip was not specified nor was the appearance of a jump scare shared. The order of participation, labeled on the consent form, determined into which group the subject was placed. If the consent form was numbered with an even number, the person watched a horror clip via a standard laptop screen. If the consent form showed an odd number, the person used virtual reality to watch a horror video clip.

Before equipment was attached, the participant answered a short questionnaire asking their age and sex (Figure 1). The person then was asked to sit next to the equipment in front of a closed laptop. Equipment was attached to the participant in the following order: BSL Respiratory Effort Xdcr monitor, Electroencephalogram (EEG) secured with a wrap bandage, BSL Electrodermal Activity (EDA) Finger Electrode Xdcr on the non-dominant hand, and Pulse Oximeter on the pointer finger of the dominant hand. At this point, if the person was in the virtual reality group, the headset was placed over the wrap bandage. Finally, noise cancelling headphones were put over the participant's ears and the lights were then turned off. This took approximately 4 minutes.

A baseline reading of each test without any stimulus was taken for 30 seconds. Immediately after this, participants were shown a 30 second long video. If the person was in the 2D group, the closed laptop was opened and the video began to play. If the person was in the virtual reality group, a cell phone with the preloaded virtual reality compatible horror clip was

inserted into the headset and played. After the clip ended, the equipment was immediately taken off in any order. Any questions the participants asked were then answered. The participant completed a post-questionnaire quiz (Figure 2) and left the room. The total time of the study was approximately 10 minutes.

The maximum data points of most physiological responses during the baseline and experimental period were recorded. The only exception was respiration rate, in which frequency was recorded. Percentage change values were then calculated for each variable of each participant. T tests were then performed using VassarStats to see if there were significant differences between the values of the Virtual Reality group and the standard 2D group. Using the self assessed fear ratings of participants asked in the post-experiment questionnaire, trend lines of correlation graphs were used to see if there was correlation between the rating and the actual percent change.

The timeline of the events the participants experienced can be found in Figure 3.

### **Positive Control**

In order to determine the effectiveness of our experimental design, we used the same Biopac devices mentioned in the methods to measure physiological response. This included the EEG, EDA, pulse monitor, and respiration monitor. Baseline data was collected by averaging the data over a 30 second time period. Next, a two dimensional video was watched with the sound cancelling headphones and physiological measurements were obtained from the data that correlates with the “moment of scare” in the video. The participant had not seen the scary video prior to this data collection. The results can be seen below in Table 1. Based on the elevations in all physiological tests conducted, we have means to believe that our experiment will accurately be able to test our hypothesis.

### **Results**

All p-values found in statistical analysis are two-tailed p-values to compare the means of the 2D viewing group and the virtual reality viewing group found using VassarStats.

#### Baseline Readings

After an analysis of the baseline data between 2D and VR, there are no statistically significant differences in all physiological measurements before experimentation. Baseline readings are within the range of the positive controls and are expected to show experimental physiological responses.

#### EDA

On average, those who viewed the 2D video measured 8.05 microsiemens while those who viewed the virtual reality video had an average measurement of 11.814 microsiemens. When compared to baseline values, there was a  $1.57\% \pm 12.10$  increase in EDA values in the experiment phase of the 2D experiment and a  $4.26\% \pm 6.31$  change from baseline in those who watched the virtual reality video (Figure 10). The t-test yielded a p value of  $p=0.55$ , therefore indicating that there was no significant difference between the average EDA measurements recorded for the 2D and VR groups.

### Heart Rate

The average experimental heart rate was 80 bpm for 2D video with a 6.97%  $\pm$ 12.74 increase from baseline and 77.8 bpm with a 3.49%  $\pm$ 12.09 increase from baseline for those experiencing the VR video (Figure 8). The t-test resulted in a p value of 0.56, therefore implying that there is no significant differences between the means of the two sample groups.

### EEG

The average EEG beta wave measurement for those viewing the 2D video was 24.22mV with a 55.12%  $\pm$ 86.12 increase from the baseline value while the average for virtual reality was 33.04mV with a 72.96%  $\pm$ 87.10 increase from baseline (Figure 9). The t-test yields a p value of 0.67 and shows that there is no significant difference between the EEG results of the two sample groups.

### Respiration

The average experimental respiration rate for those watching the 2D video was 21.48 breaths per minute with a 31.18%  $\pm$ 8.04 increase from baseline, while the average experimental respiration rate for VR video was 17.88 breaths per minute with a 9.07% $\pm$ 12.50 increase from baseline (Figure 11). The t-test yielded a p-value of  $p = 0.0005$ , therefore suggesting that there is a significant difference between the two sample groups in the amount of respirations caused by each type of video.

### **Discussion**

The results obtained from the experiment did not support the initial hypothesis that virtual reality would evoke a greater percentage change in physiological responses than 2D video. When comparing the percent changes of EDA, heart rate, and EEG maximums as well as respiration rates between 2D and virtual reality viewing groups, only respiration rate percent changes yielded statistically significant data ( $p = 0.00053$ ). Subjects increased their breathing at a higher percent change in the 2D than VR. The respiration rate p value ( $p=0.00053$ ) disproves our hypothesis, and instead suggests that 2D video elicits a significantly larger physiological respiratory response than virtual reality video. The other data suggested no significant difference between the two groups. Therefore, it fails to support the hypothesis that virtual reality elicits a greater physiological response in subjects.

In Figures 4-7, self assessed fear is compared to the percent change for each physiological response for both types of media. Positive correlations were found for both heart rate and respiration (Figures 4 and 7) for subjects presented with the 2D video. However, negative correlations were found for both heart rate and respiration when the subject was presented with the virtual reality video. In Figure 5, a negative correlation was found in 2D viewers between self assessed fear and the percent change of EEG beta waves, while a positive correlation was found in the virtual reality group. Figure 6 shows that there was no positive or negative correlation in either 2D or VR groups regarding self assessed fear and EDA percent changes. These figures show that not all subjects accurately rated themselves. It is thus assumed that each subject's self assessed fear ranking does not accurately predict the

physiological response they will have. While self assessed fear rankings were obtained to hopefully better understand a subject's data, the rankings are no longer accurate explanations due to this found irregularity.

Figures 8-11 display the average percent change calculated for each physiological response for both 2D and VR. In these graphs, the confidence intervals show the drastic variability among the data in all physiological tests except respiration rate change. Should the experiment be recreated, the sample size for both the 2D and VR groups should be increased to allow for more accurate representations of the population. Since everyone has a different response to fear, a larger sample group will be able to encompass more fully the different types of fear responses.

Figure 12 shows a screenshot of the Biopac program displaying the data obtained from subject 15. This data is an example of what we expected to observe in the virtual reality readings. The top reading shows EEG total measurements, which includes all brain waves. While these were not specifically analyzed in this experiment, it is important to notice the significant drop in brain wave mV readings, which shows a typical passive coping strategy to fear. This also explains the next line showing respiration, which display choppy and incomplete breaths. The EDA data shows an expected rise, and EEG beta waves, our analyzed EEG measurement, shows a mild increase in activity. This kind of reaction was also expected from the 2D group subjects, but to a lesser degree according to our hypothesis.

Overall, the hypothesis was proven incorrect, while the null hypothesis seems to be true; there is no significant difference in physiological response to a pop-up horror video stimulus when comparing a 2D medium to a virtual reality medium. Some reasons that this may be true include personal response variability to media familiarity.

While virtual reality is an exciting up-and-coming media industry, human brains may be equally as comfortable in varying medias. However, one study concluded the opposite when they explored the effects of varying agency involving horror themed video games. The group that had played the game recorded significantly more extreme physiological responses than the group that watched the game (Madsen, 2016). The cause of the differences in the results between this study and Madsen's study could be found in the longer length and lack of virtual reality headsets found in Madsen's study. It also may be due to the fact that the participants in Madsen's study were more ingrained in the game instead of just watching a short clip with only one scare. Another study found that virtual reality triggered stronger activation in the amygdala than a standard 2D viewing (Dores, 2014). This would suggest a stronger reaction to the stimuli. The difference between this experiment and our experiment would lie in how physiological responses were measured and the type of stimuli used. The stimuli within the study by Dores et al. simply featured a room with negative, positive, and neutral objects within it, while our study was a longer video that built suspense. The MRI imaging of the amygdala was also a response that was automatic and less prone to interference from a person's attempt to control their fear. While these studies are different than ours, they have contributed valuable information. This does not invalidate our negative results; it simply indicates the greater need to test this area of technology.

## Sources of Error

There are a variety of factors that could have contributed to these results, including the personal nature of how fear is expressed. Though there are certain physiological responses one would expect in a body manifesting fear, they are not strictly followed. This can be seen within the sample. While some participants displayed drastic increases in EEG measurements at the moment of the scare (Figure 12), others showed decreased EEG measurements (Figure 13). This can be explained by the two coping systems: active and passive. The participant may act through an active coping system, which will show increased heart rate, respiration rate, skin conductance, and stimulated beta waves (Steimer, 2002). On the other hand, the participant may act through a passive coping strategy. In this case, the participant will appear to be holding their breath, become immobile, have decreased heart rate, and decreased sweat conductance (Steimer, 2002). Both reactions represent a scare that is unique to the individual. However, the results are not easily comparable and could contribute to the lack of notable differences in the statistical analysis.

Other confounding variables could have been the anticipation felt for watching the 2D video was less than in individuals watching the VR video. The motion of putting on glasses and the resulting feeling of immersion in a video may lead to the self fulfillment prophecy or feed-forward mechanisms in the body. If physiological variables were already elevated during baseline measurements, than a significant percent change would not be found during the experimental measurement. That being said, this response is not guaranteed to happen in every individual and can be subject to how easily scared one is.

The study done by Madsen in 2016 also stated that a participant that had been exposed to a lot of video games that included horror, shootings, and had the person playing in “first person” showed a desensitization to the stimulus (Madsen, 2016). Therefore, an increase in exposure to jump scares or thriller would elicit less of a response than expected.

Another possible source of error was the accuracy of the equipment used. The EDA measurements that were experimentally found did not reflect the pre-established normal ranges found in other literature. The EDA equipment also seemed to differ in its sensitivity to sweat from day to day. However, as only percent change values were used to conduct the statistical analysis, the physiological variable was still measured throughout study. Nonetheless, the varying sensitivity of the EDA equipment could have contributed to the lack of significant difference between the two groups.

A similar problem arose with the use of the EEG equipment that also seemed to vary its effectiveness. One source of this discrepancy was the difficulty of attaching and maintaining contact between the electrodes and the participant’s head due to thickness of hair and the amount of equipment being placed on the head during the experiment. To prevent the electrodes from falling off, a bandage was wrapped around the participant’s head. While it was mostly effective, the electrodes may not have been as tightly pressed to the head as necessary. Another influential factor was a participant’s movement. In a control trial, the movement of a participant’s head impacted the readings of the EEG. While no gross head movements were observed by the experimenters, the EEG may have reflected fidgeting inherent with a participant being placed in a stressful situation.

To eliminate the confounding variable of previous exposure to the horror clips, one subject was eliminated from the study. The participant's familiarity with the video clip may have introduced bias into the results.

To further improve the study, a few alterations could be made to the experimental design in an effort to gain more precise data. The most obvious correction would be the use of more sensitive and accurate equipment. Perhaps the use of a different electrode gel would help the adherence of the electrodes to the scalp. Another possible change would be some form of immobilization of the head to minimize head movement. To prevent the effects of feedforward responses, a potential solution would be showing the participants an emotionally neutral video clip to acclimate them to the situation before recording baseline measurements.

This study is applicable to both the scientific and marketing community. Currently, virtual reality is being considered as an alternative way to introduce patients/subjects to fears or other situations causing psychological unrest. Previous studies have used virtual reality to help people overcome fear of public speaking (Anderson, 2005). If virtual reality did make a significant difference in how the objects of phobias were experienced, it would have the potential to become a more efficient and safer method of treatment. In marketing, virtual reality also offers opportunities for game systems, movies, and other media. A game that provides full immersion and could elicit a more "real" response is a growing and appealing idea as seen in the popularity of first person games. However, the effectiveness of the technology should be questioned given the data collected in this study and its status as a relatively new form of media. This study provides additional information to a potential customer or patient as to whether or not virtual reality is truly beneficial or simply the coolest, new technology. Without significant results presenting virtual reality as a more effective tool, investment and devotion of resources to this area will be halted. In the end, the hypothesis could not be proven correct. We suggest further studies be done to analyze the effects of virtual reality versus 2D video.

### **Acknowledgements**

We would like to thank Dr. Lokuta and the rest of the UW-Madison physiology department.

## Tables and Figures

Table 1. The results from the physiological testing done for the positive controls. These values show the possibility of physiological responses during the experiment as compared to the baseline data.

	EEG	EDA	Pulse	Respirations
<b>Baseline Data for 2D</b>	130.7 microV	12.7 microsiemen	85 beats/min	8.621 mHz (frequency)
<b>2D Scary Movie Data</b>	499.9 microV	13.4 microsiemen	118 beats/min	12.5 mHz
<b>Baseline Data for Virtual Reality</b>	64 microV	21.49 microsiemen	88 beats/min	16.37 mHz
<b>Virtual Reality Scary Movie Data</b>	93.74 microV	23.51 microsiemen	94 beats/min	16.39 mHz

Figure 1

The survey given to the participants before the experiment begins. Subject number was determined by the order in which the participant arrived to the study.

## Phys 435 Lab Questionnaire

\* Required

Subject # \*

Your answer

What is your sex? \*

Male

Female

Prefer not to say

Other: \_\_\_\_\_

What is your age? \*

Your answer

Figure 2

Questionnaire given to participants after watching the second video. Again, subject number was determined by the order in which the participant arrived to the study. Self assessed fear scores were used to see if there was a correlation between how scared subjects think they are compared to how they physiologically responded. If a participant had seen the video prior to the experiment, they were eliminated from the study.

## After Experiment Questions

\* Required

Subject \*

Your answer

Rate yourself on a scale of 1 (harder to scare) to 10 (easily scared). 5 being indifferent \*

Your answer

Have you seen any of these clips before? \*

Yes

No

Not sure

Figure 3

Timeline of events participant experiences throughout experiment. This figure summarized the methods section in a simple flow chart.

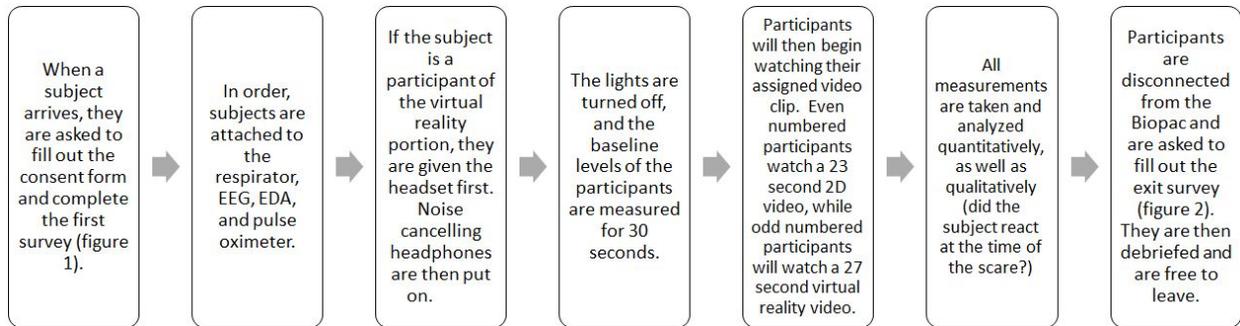


Figure 4

The self assessed fear was taken from the after experiment surveys. Percent change for experimental heart rate for both 2D and VR were calculated. A positive correlation was found in the 2D group, while a negative correlation was presented in the VR group. This shows that self assessment is a poor indicator of actual fear response.

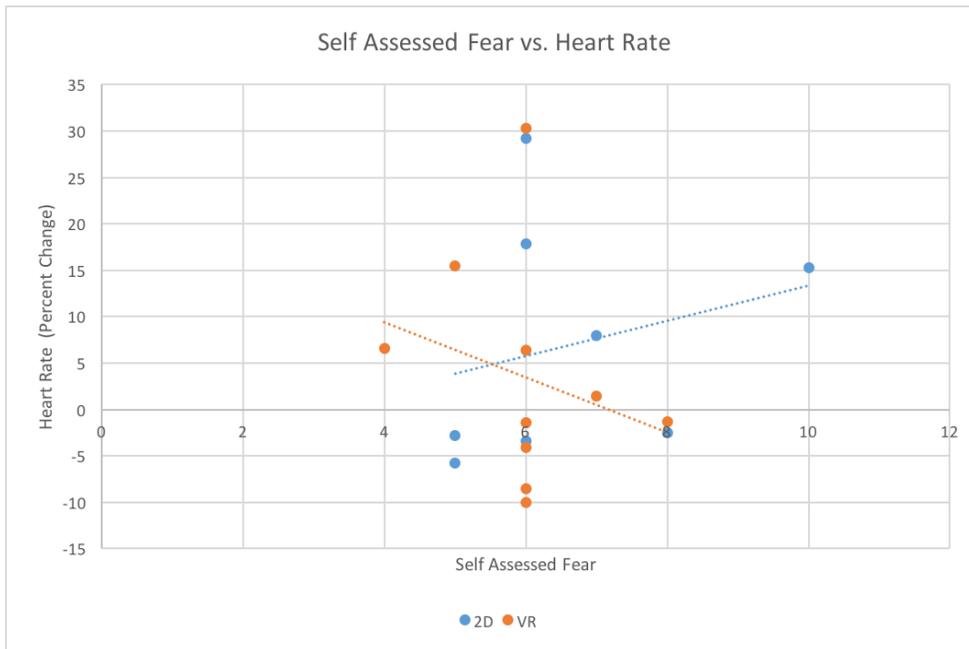


Figure 5

The self assessed fear is shown against calculated percent change for experimental beta waves. A negative correlation was found in 2D, while a positive correlation was found in VR.

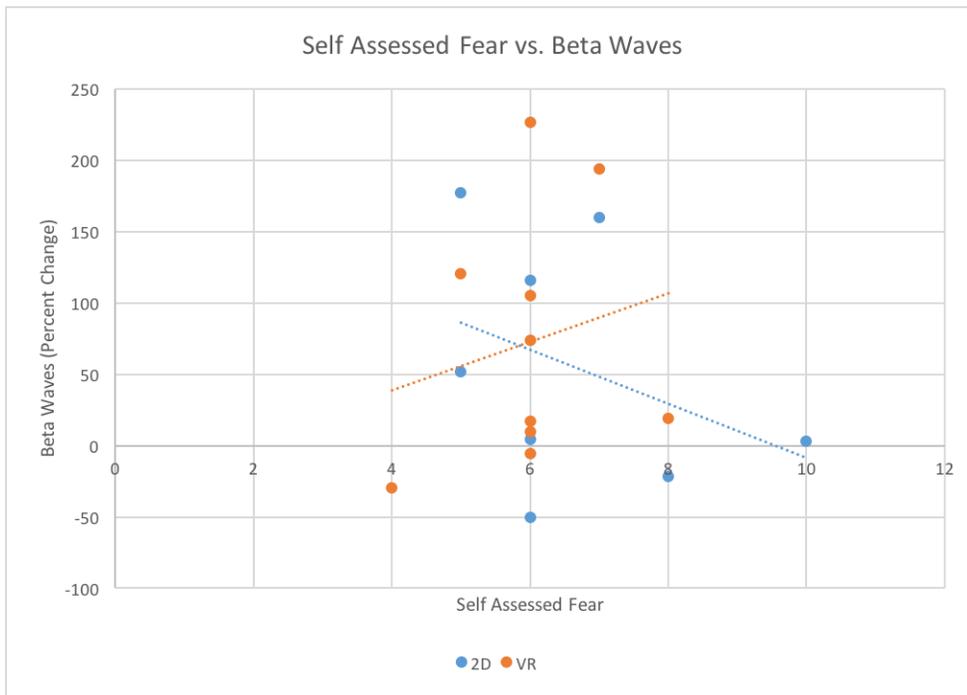


Figure 6

The self assessed fear is shown against the calculated percent change of EDA in both VR and 2D. There was neither a positive or negative correlation in either 2D or VR for EDA.

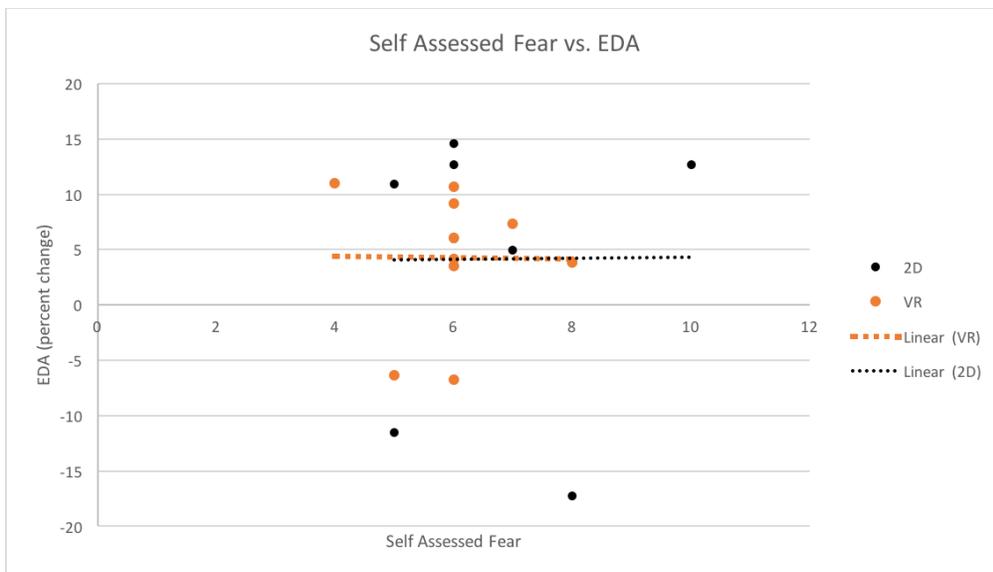


Figure 7

Self assessed fear is shown against the percent change for respiration for both 2D and VR. A positive correlation was found for 2D, while a negative correlation was shown for VR.

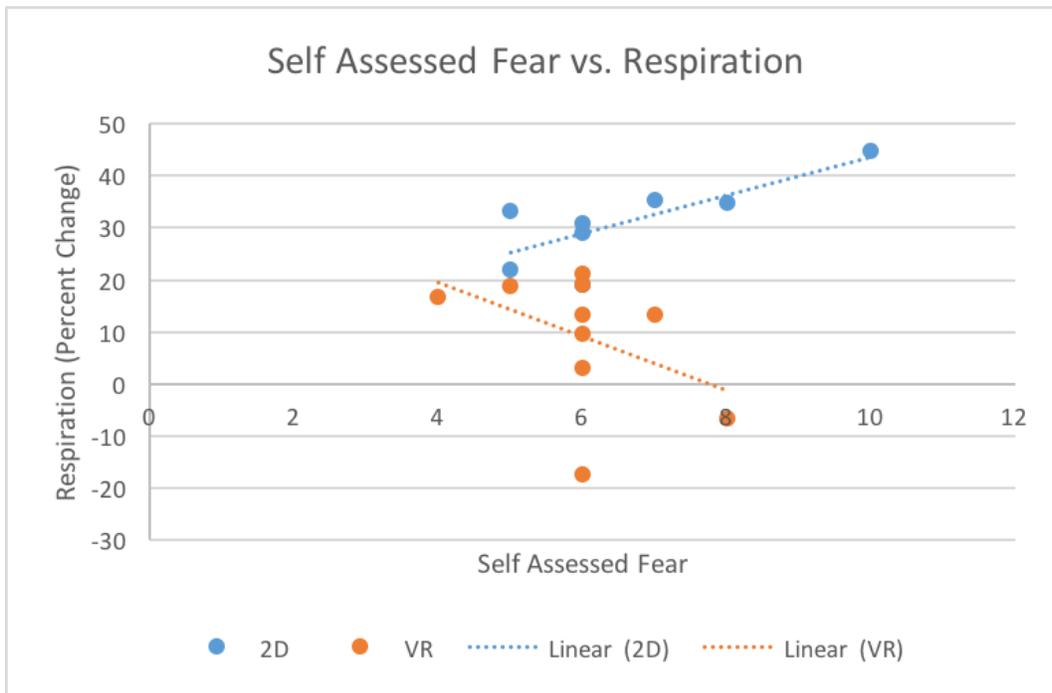


Figure 8

Average percent change in heart rate for both types of media along with standard deviations. 2D media showed an increase of 6.97% from the baseline as compared to the increase of 3.49% due to VR. There was no significant difference found ( $p=0.56$ ).

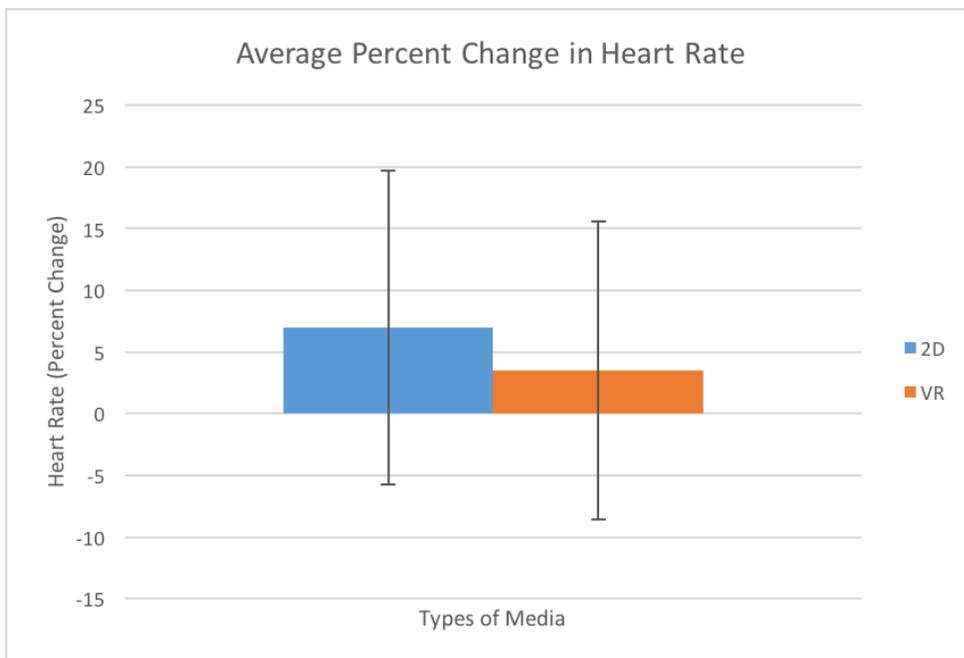


Figure 9

Average percent change in beta waves for both types of media and standard deviations. VR showed a greater increase of 72.96% from the baseline as compared to 2D's 55.12%. However, these results were not statistically significant ( $p=0.67$ ).

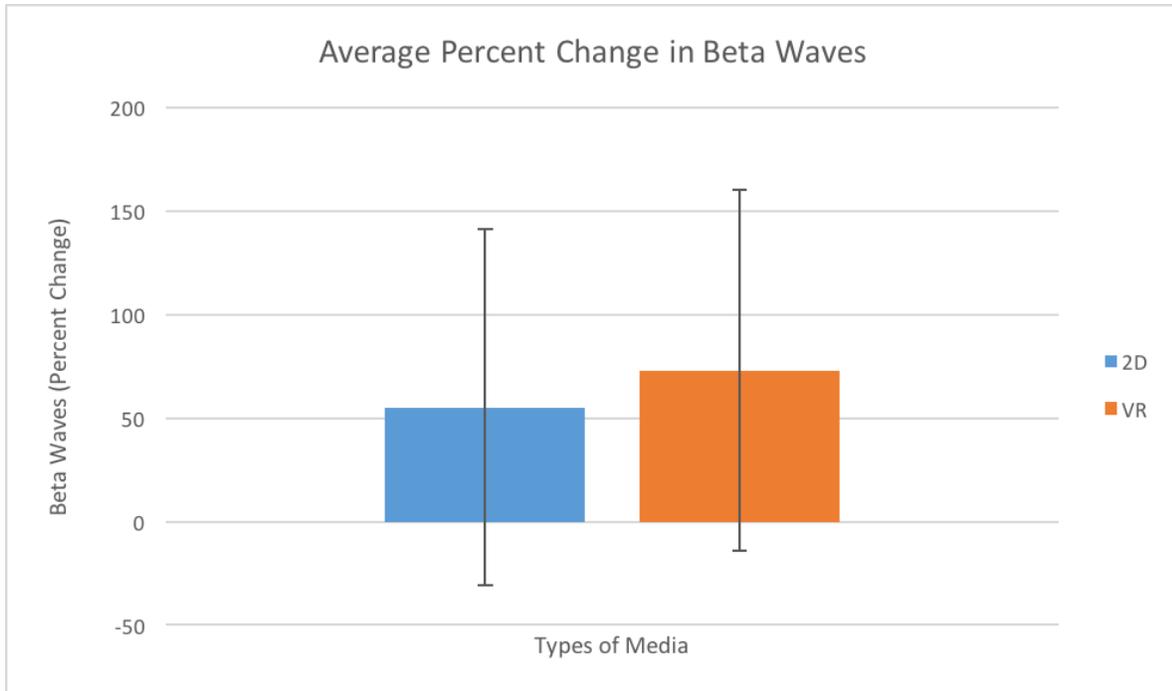


Figure 10

EDA percent change averages for both medias and their standard deviations. VR had a greater increase of 4.2% from the baseline as compared to 2D's 1.57% increase. The results were not statistically significant ( $p=0.55$ ).

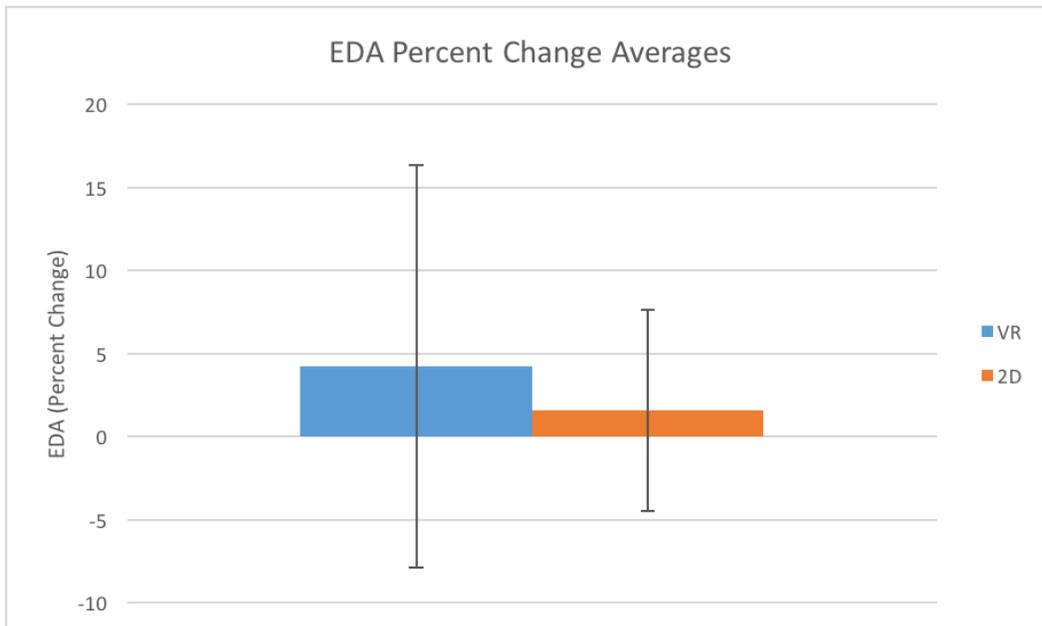


Figure 11

Respiration percent change averages for both medias and their standard deviations. Respiration percent change was greatest in 2D with an increase of 31.18% versus VR's increase of 9.07% from the baseline. This was statistically significant ( $p=0.0005$ ).

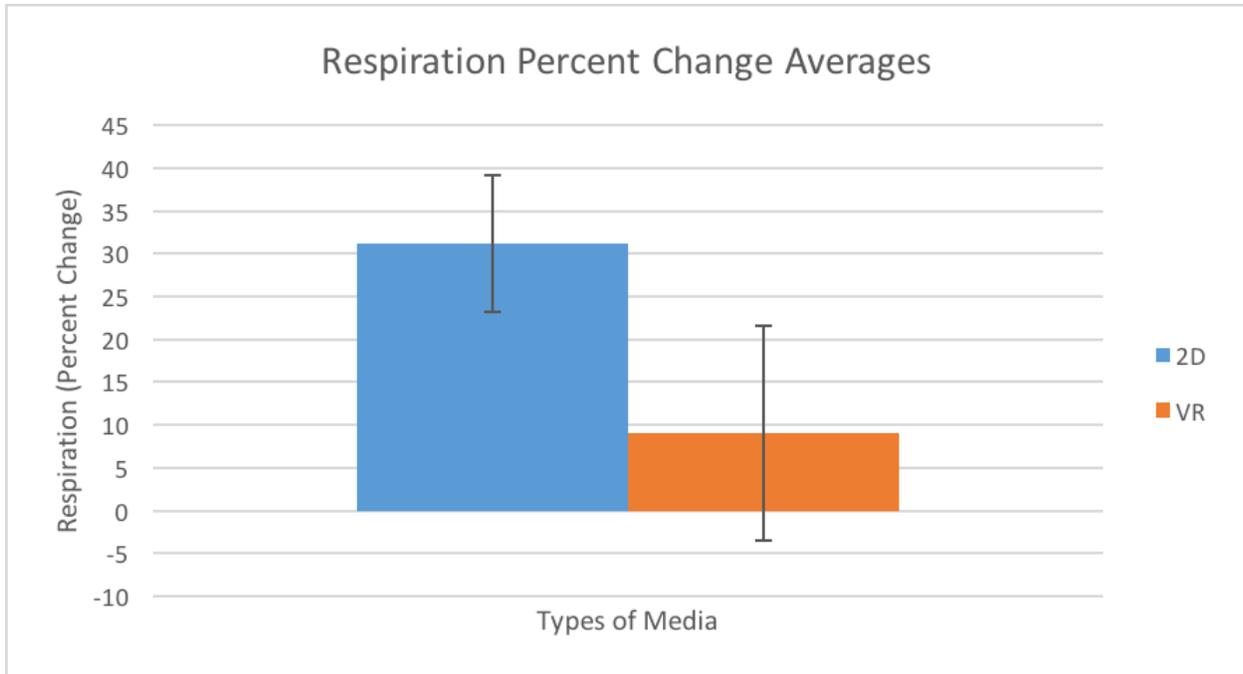
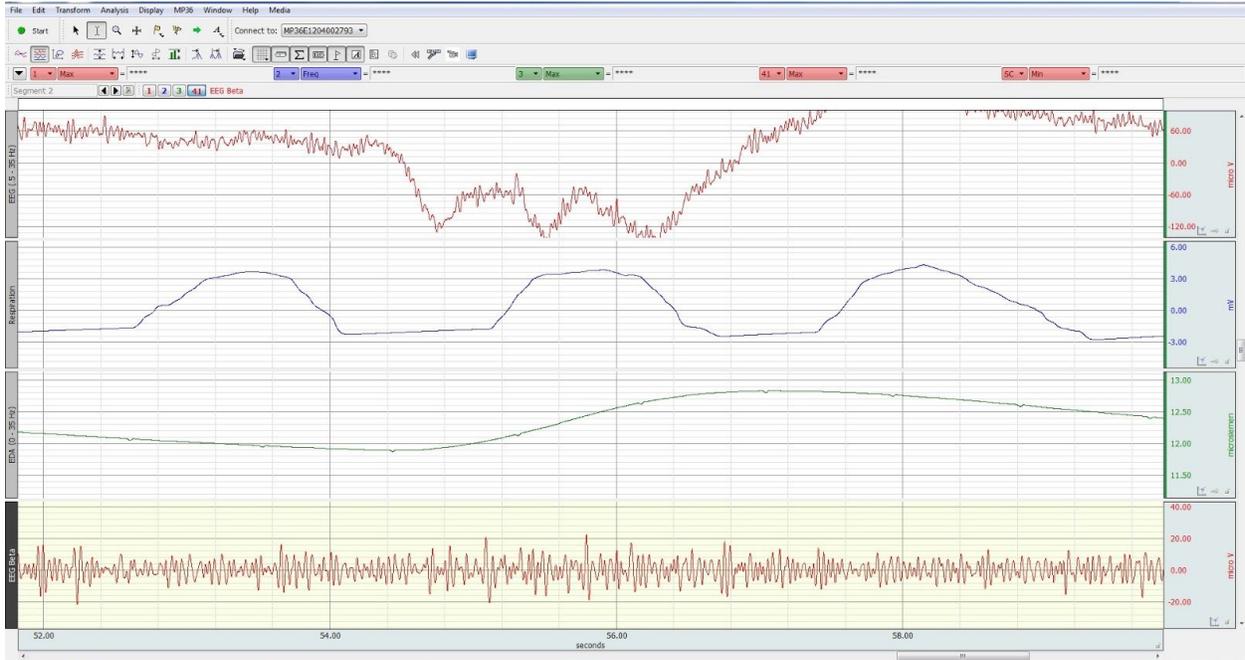


Figure 12

Subject 15's physiological reaction at the time of the virtual reality jump scare. The top reading shows EEG total measurements that were not analyzed in this study. The next line showed choppy and incomplete respirations. EDA data followed, showing a rise in sweat conduction. EEG beta waves was the last graph that showed a mild increase in activity. A similar albeit less extreme version was expected in 2D data.



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## Appendix A

University of Wisconsin - Madison  
Research Participant Information and Consent Form

Title of Study: **The Effects of Video Formats on Physiological Responses**

Principal Investigators: Holly Kometer, Stephanie Luedtke, Kyle Stanuch, Samantha Walczuk, and Jenna Wettstein

Description of the Research:

You are invited to participate in a research study that will analyze the physiological responses to emotional video clips. The clips will be shown in two forms. You have been asked to participate because you are enrolled in Physiology 435. The purpose of the research is to investigate whether there are differences in physiological responses related to how visual media is presented to a viewer. This study will invite the participation of all students enrolled in Physiology 435. This research will take place within a Physiology 435 laboratory within the Medical Sciences Center.

What will my participation involve?

If you decide to participate in this research study, you will be asked to watch two emotion evoking clips. The participant must consent to having their respirations, pulse, perspiration levels, and brain activity measured. Your participation will last approximately 10 to 15 minutes. After the semester is completed, the study will hopefully be published. It will be available to read on the Journal of Advanced Student Science.

No compensation will be granted for your complete and voluntary participation. If you do not wish to participate in the study, please return this blank form.

Are there any risks to me?

I, undersigned participant, agree to indemnify and hold harmless The University of Wisconsin-Madison and any of its agents, employees, or representatives for any injury or loss suffered by me due to my participation in the activities associated with the Physiology 435 laboratory project. I hereby agree that I have been fully advised of the nature and extent of the activity that may take place and represent to you that I am physically and mentally able to participate in the activity without special accommodations or additional supervision. I understand that the activity may present the risk of injury, or even death, to me, and I have been fully advised of those possibilities. I represent to you that I fully assume the risk of any such injury or death, and I hold you, your agents, employees, and representatives harmless from any liability or death to me while engaged in this activity that is caused or contributed to by my conduct or any other participants. If I am not able to be consulted for any reason in the case of an

emergency or necessity arising during the course of the activity or as a result of the activity, I authorize you to arrange for such medical and hospital treatment as you may deem to be advisable for my health and well-being. The electrodes may cause irritation to skin.

Are there any benefits to me?

There is no benefit to the participant.

How will my confidentiality be protected?

While there may be printed reports as a result of this study, your name and any identifying information will not be used. Group characteristics will be reported. If individual statistics are mentioned, the participants will be referred to as subjects, followed by a number. No identifying information about participants will be used in any reported or publicly presented work.

Whom should I contact if I have questions?

Stephanie Luedtke: sluedtke2@wisc.edu

Samantha Walczuk: walczuk@wisc.edu

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

Your participation is completely voluntary. If you decided 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 (Print): \_\_\_\_\_

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date