# Psychophysiological Responses to Visual Fear Stimuli

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*The aim of the current research was to examine the effect of different types of fearful stimuli on heart rate and skin conductance. Our independent variable was the presentation of fearful stimuli in the form of movie clips. The clips were composed of suspenseful, gory, and shocking stimuli. Our dependent variables were heart rate and galvanic skin response recordings. Undergraduate students (n = 10) were used in the study (7 women, 3 men). Of the 3 movies investigated, we proposed that both heart rate and galvanic skin response would be lowest while viewing gory stimuli and highest while viewing shocking stimuli. This trend was present, however the results were not statistically significant. Future research ideas are suggested.*

There has been much research conducted in the field of psychophysiology involving the effect of fear on the sympathetic nervous system. Specifically, heart rate and galvanic skin response (GSR) have been used to examine the various levels of the "fight or flight" reaction. It has been shown that when subjects view pictures depicting threat, violent death, or erotica, there are reports of strong emotional arousal, large skin conductance response, and pronounced cardiac changes (Bradley, Codispoti, Cuthbert, & Lang, 2001). These findings led the current research to examine similar effects when subjects viewed fear-inducing clips from popular movies.

The current research demonstrates that subjects can decipher between potentially threatening and nonthreatening stimuli quickly, effortlessly, and without elaborate cognitive processing (Öhman, 1993). This process is highly advantageous and may be critical for survival (Azevedo, et al., 2005). There are individuals who experience high volumes of stress in their everyday lives (i.e., firefighters, police officers, physicians, etc.). Continuous activation of the autonomic nervous system can have long-lasting effects. According to Hans Seyle's General Adaptation Syndrome, the body goes through three stages after the activation of the autonomic nervous system: alarm, resistance, and exhaustion. During the stage of exhaustion, the body's ability to deal with stress runs out and its immune system suffers. Deciphering the cues and biological effects of the fear response will allow researchers to develop adaptive defense strategies for these individuals. Moreover, understanding the fear response will allow researchers to improve treatment for individuals with phobias and other fear-related illnesses. The findings from this research can be applied to other studies involving panic disorder, anxiety, phobias, and fear conditioning.

Prior research from Fredrikson and Öhman (1979) investigated the effect of fear-relevant stimuli on the sympathetic nervous system. Participants were shown a series of colored slides that were projected onto a screen. The slides consisted of various pictures of snakes, spiders, flowers, and mushrooms. The snake and spider pictures were considered fear-relevant, whereas the flower and mushroom pictures were considered fear-irrelevant. Skin conductance, heart rate,

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and finger pulse volume were measured. The habituation, acquisition, and extinction of fear responses were observed. A relationship was found between fear-relevant stimuli, heart rate, and skin conductance during habituation trials. Unlike skin conductance and heart rate, finger pulse volume appeared to be unaffected. The fear-relevant stimuli were also associated with the activation of the sympathetic nervous system during acquisition and extinction trials. Finger pulse volume and skin conductance were the two measurements affected by the stimuli during these trials. Heart rate appeared to be unaffected by the fear-relevant stimuli. Nevertheless, heart rate reflected parasympathetic activity and, according to Fredrikson and Öhman, heart rate acceleration due to sympathetic activation might be masked by the increased vagal tone that decelerates the heart. In general though, Fredrikson and Öhman found that the heart rate responses were larger and longer lasting following fear-relevant stimuli as opposed to neutral stimuli. Furthermore, they found that the fear-related stimuli do not necessarily need to remain present in order for their effects to be felt.

Another study, conducted by Globisch, Hamm, Esteves, and Öhman (1999), examined the effect of fear on heart rate and skin conductance. Globisch et al. investigated the startle reflex modulation and autonomic response patterns in subjects with high and low levels of animal fear. Fear-relevant and fear-irrelevant pictures were shown to the participants. Similar to Fredrikson and Öhman (1979), subjects were shown pictures of both snakes/spiders and pictures of neutral/pleasant stimuli. Electrodermal activity, heart rate activity, and blood pressure were continuously recorded during the presentation of the stimuli. Globisch et al. found that the fear-relevant pictures initiated a sympathetically dominated autonomic response in participants assigned to the high-fear group. High-fear subjects had significantly larger skin conductance response magnitudes to the snake/spider slides relative to neutral stimuli. Low-fear subjects also showed larger skin conductance values to the snake/spider slides when compared to the neutral stimuli. Nevertheless, this increase was much smaller than that of the high-fear subjects. Globisch et al. also found that heart rate acceleration was present in high-fear subjects during the presentation of the snake/spider pictures, while heart rate deceleration was present in non-fearful subjects. Furthermore, the presentation of the snake/spider pictures evoked a significant increase in arterial pressure in fearful subjects. This was not the case for participants in the control group. Fear-potentiated startle appears to be associated with strong sympathetic activation (i.e., increased sweat gland activity and cardiac acceleration) during the presentation of fearful stimuli. Moreover, minimal stimulus input was needed to activate these fear responses. Globisch et al. demonstrated that fear-specific startle potentiation started very early during picture processing and persisted, regardless of whether the threat cue was present or absent. Globisch et al. further demonstrated that once the fear network is activated, autonomic emotional processing is engaged. As a result, the fear response cannot be terminated immediately after the extinction of the feared stimulus (Fredrikson & Öhman, 1979; Zajonc, 1980). In regards to the current study, some subjects may have previously viewed the particular movie clips used. Past studies suggest that the subjects should still demonstrate an autonomic response to the stimuli.

The "fight or flight" response was also investigated in a study conducted by Azevedo, et al. (2005). They explored the effects of adverse emotional stimuli on human subjects in hopes of inducing "freezing" behavior and heart rate deceleration. Freezing behavior is also known as "attentive immobility," which is when an individual suddenly becomes motionless as a response to a source of danger; hence, it may be considered a precursor to the "fight or flight" response. Previous studies (Bradley et al., 2001, 2003; Hebb, 1946; Stevens & Gerzog-Thomas, 1977) have shown that when presented with pictures of injured and mutilated people, subjects reacted with fear to signs of another's injuries. Participants were male undergraduate and graduate volunteers. Avezedo et al. recorded both postural sway and heart rate in their study. They found that the presentation of fearful pictures significantly reduced the subjects' body sway and increased their muscle stiffness. Moreover, heart rate was shown to decelerate with the viewing of the fear-relevant pictures. Specifically, heart rate decelerated with the presentation of the gory stimuli.

The aim of the current research was to examine the effect of different types of fearful stimuli on heart rate and skin conductance. Our independent variable was the presentation of visual fear stimuli in the form of movie clips. The clips were composed of suspenseful, gory, and shocking stimuli. Our dependent variables were heart rate and GSR recordings. Of the three movies investigated, we proposed that both heart rate and GSR would be lowest while viewing gory stimuli and highest while viewing shocking stimuli.

## Method

### Participants

Undergraduate students ($n$ = 10) from Bowling Green State University participated in this study. Seven of the students were women and three were men. The mean age of the participants was 21.3 years. The students were randomly chosen from a volunteer database. Participants were informed that the experiment would last approximately 30 min. Participants were also told that the research was aimed at examining heart rate and skin conductance while they viewed a series of movie clips.

### Materials

**Heart rate and GSR.** The primary pieces of equipment used for this study were the EKG/ECG and GSR transducer by BIOPAC Systems Inc. The BIOPAC Student Lab software Version 3.0 was also used. Additional BIOPAC materials include disposable electrodes (three per subject), three electrode leads, and a BIOPAC unit that was connected to a computer. A reclining chair was used for participants to sit in during the visual presentation. A television and VCR was also used for the presentation of the visual stimuli.

**Film stimuli.** Three film segments (containing gory, shocking, and suspenseful content) were obtained for this study. These film segments were selected by having a group of undergraduate students in a psychophysiology class rate nine film segments according to their level of gore, shock, and suspense. *Gory* was defined as covered or stained with blood, full of or characterized by bloodshed, mutilation, and violence. *Shocking* was defined as to strike with great surprise and emotional disturbance. *Suspenseful* was defined as something that causes anxiety or apprehension resulting from an uncertain, undecided, or mysterious situation. The definitions used were obtained from the American Heritage Dictionary (2000). The three movie segments that received the highest rating in each category were selected for the current study. The three movies used in the current study were *Saw* (gore), *Fatal Attraction* (shocking), and *Silence of the Lambs* (suspenseful). Each movie clip lasted for approximately 5 min.

### Procedure

To begin the procedure, one of the experimenters placed three disposable electrodes on the participant. Using a lead II configuration, one electrode was placed on the participant's right anterior forearm at the wrist. Another electrode was placed on the medial surface of the participant's left leg, just above the anklebone. The last electrode was placed on the medial surface of the participant's right leg, just above the anklebone. The galvanic skin resistance sensors were placed on the top of the forefinger and middle finger of the participant's left hand. Following the placement of the electrodes and skin sensors, the participant was instructed to relax for 5 min prior to calibration.

**TABLE 1**

**The Mean Difference Scores for Heart Rate and GSR**

| Difference scores | Heart Rate (HR) | Galvanic Skin Response (GSR) |
|---|---|---|
| Gory–Baseline | 8.24 BPM | 0.05 Δ uMho |
| Shocking–Baseline | 11.67 BPM | 0.07 Δ uMho |
| Suspenseful–Baseline | 11.19 BPM | -0.69 Δ uMho |

Calibration was necessary to check the accuracy of the EKG/ECG machine and GSR transducer. Equipment calibration took place while the participant was in a relaxed state.

The first 30 s of recording was used to collect each participant's baseline values. The baseline values were obtained by averaging both the heart rate values and the galvanic skin response values across the 30-s interval.

After the baseline period concluded, participants viewed the three video segments, each lasting 5 min. In order to ensure that we were collecting valid data, the order of the video segments was counterbalanced for each participant. For each movie segment, we obtained the overall mean amplitude for both heart rate and GSR. We used these mean values to describe heart rate and GSR for each movie segment. Between each movie clip, the VCR was stopped and the EKG/ECG and GSR recordings were paused for 1 min. This time allowed participants to return to their baseline values before beginning the next video segment.

## Results

The mean heart rate (HR) for the baseline condition was 78.51 BPM (beats per minute). The gory segment had the second lowest heart rate ($M = 86.74$ BPM). The shocking segment had the highest heart rate ($M = 90.18$ BPM) and the suspenseful segment had the second highest heart rate ($M = 89.70$ BPM). A single factor ANOVA was conducted with heart rate as the dependent variable. An alpha level of .05 was used for all statistical tests. We used three difference scores (fear level minus baseline level) for each type of fear stimulus. The mean difference scores for both heart rate and GSR are shown in Table 1. As predicted, the lowest mean value for heart rate was found with the presentation of the gory stimuli, while the highest mean value for heart rate was found with the presentation of the shocking stimuli. Nevertheless, there was not a statistically significant difference between the heart rate scores and each of the fear levels, $F(2, 27) = 0.35$, $p > .05$. The mean heart rate and GSR values for

**TABLE 2**

**The Mean Values for Heart Rate and GSR for Baseline and the Three Video Clips**

| | Heart Rate (HR) | Galvanic Skin Response (GSR) |
|---|---|---|
| Baseline | 78.51 BPM | - 0.72 Δ uMho |
| Gory (Saw) | 86.74 BPM | - 0.68 Δ uMho |
| Shocking (Fatal Attraction) | 90.18 BPM | - 0.66 Δ uMho |
| Suspenseful (Silence of the Lambs) | 89.70 BPM | - 0.69 Δ uMho |

baseline and the three video clips are shown in Table 2. A single factor ANOVA with GSR as the other dependent variable was not performed. Negative numbers were obtained for the GSR data and it is assumed that this was due to equipment malfunction.

## Discussion

Of the three movies investigated, we hypothesized that both heart rate and GSR would be lowest (other than baseline) while viewing gory stimuli and highest while viewing shocking stimuli. After conducting a single factor ANOVA, we found that this trend was present, however our results were not statistically significant at an alpha level of .05. With the exception of the baseline value, heart rate was lowest during the gory segment and highest during the shocking segment. In accordance with Azevedo et al. (2005), the presentation of stimuli involving blood, injuries, or mutilation appeared to have a slowing effect on heart rate. Hamm, Cuthbert, Globisch, and Vaitl (1997) pointed out that subjects within their study demonstrated strong sympathetic activation as well. However, Hamm et al. found cardiac acceleration present during the observation of fearful pictures. These pictures did not involve any blood, injuries, or mutilation, but rather other fear-relevant stimuli. Also, similar to Globisch et al. (1999), we found that most fear-relevant stimuli initiated a sympathetically dominated autonomic response based on the increases in heart rate and skin conductance.

If this study were to be replicated in the future, a number of things should be taken into consideration. First and foremost, it would be beneficial to have more participants. With more participants, the reliability of the statistics would increase and could potentially lead to significant results. Also, with more participants it would be possible to examine gender differences in regards to fear responses. Moreover, skin conductance did not appear to be a very effective measurement. We believe that the GSR transducer was malfunctioning at the time of data collection. Heart rate seems to be a much better measurement to use when looking at autonomic nervous system activation. Therefore, it may be more efficient to use heart rate and another measure of sympathetic activity in the future. Information gathered by this research re-emphasizes that participants can decipher between potentially threatening and nonthreatening stimuli quickly, effortlessly, and without elaborative cognitive processing (Öhman, 1993). Understanding the fear response will allow researchers to develop defense strategies for individuals in high-stress environments. By understanding the fear response, researchers will also be able to develop new treatment options for individuals with a phobia, panic, or anxiety disorder.

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