STARTLE PROBE MODALITY: AN INVESTIGATION OF ETHNIC DIFFERENCES

By

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Major Department: Psychology

Ethnic differences in the startle response were assessed. Eyeblink reflexes for European Americans and African Americans were examined in response to acoustic (bursts of noise) and visual (flashes of light) startle probes while viewing 36 pictures representing pleasant, neutral, or unpleasant content. An effect of picture valence was obtained for both ethnic groups in response to both acoustic and visual startle probes. The ethnic groups did not differ in startle reflex probability, magnitude, or amplitude. Taken together, the results suggest that the startle response is a reliable measure of emotion for European Americans and African Americans whether elicited by acoustic or visual startle probes.

CHAPTER 1
INTRODUCTION

Imagine sitting at home alone, watching a horror movie. It is late at night. The sky is pitch black except for an intermittent flash of lightening. Raindrops are pounding against the window and tree branches are violently blowing in the wind. All of a sudden, a loud crash of thunder makes you literally jump out of your chair. For a brief moment, you experience a feeling of fear and your body prepares itself for anticipated action. The emotional experience accompanying the physical response serves as a warning that action may be required. Is there an intruder smashing your window? Should you run? Do you need to protect yourself? Your physical response and corresponding emotional state would likely be different if you were watching a comedy film, opposed to a horror movie, at the time the thunder crashed. The preexisting apprehension experienced while viewing a horror movie (in contrast to the relaxed, jovial state experienced while viewing a comedy) exaggerates the physical reaction elicited in response to a sudden, potentially threatening, stimulus. Thus, preexisting emotional states can influence subsequent physiological responses. A wealth of research exists examining emotional and physiological responses in humans. However, despite evidence suggesting ethnic differences in emotional experiences and physiological responses, research on the possibility of ethnic differences in the startle response, specifically, is lacking.

Research shows that emotional experiences are influenced by culture (Matsumoto, 1993). Cultures differ in terms of what is considered appropriate emotional expression (Matsumoto, 1990) as well as actual display of emotion (Ekman, 1971; Friesen, 1972, as cited by Matsumoto, 1993). Cultures also differ when judging faces and labeling which emotion they perceive (Matsumoto, 1993). In addition, studies show cultural differences in the subjective experience of emotion, including self-reported emotional experience (e.g., intensity, duration, and control of emotion); verbal and nonverbal expressions; and physiological sensations and reactions (Scherer et al., 1988; Matsumoto et al., 1988).

Investigating cultural differences by comparing samples from different countries is a common practice in cross-cultural research on emotion. Although important information is gained by examining international differences, exploring intranational differences is also a fruitful endeavor, especially in ethnically diverse nations such as the United States.

Emotion

Humans desire to attain pleasant things and to avoid unpleasant things. This hedonistic orientation is not merely a means of self-gratification, but is adaptive in that it functions to promote survival. In humans, the behaviors of moving toward positive things and moving away from negative things are accompanied by emotion (Bradley & Lang, 2000). In addition to reported feelings (e.g., happiness, sadness, fear, anger, and love), emotions possess a biological component, regarded by many theorists as a product of evolution (e.g., Davis & Lang, 2003; Frijda, 1986; Izard, 1977). Emotions function to promote survival and reproduction by signaling situations that require immediate attention, motivating adaptive behaviors, and serving as tools for communication (Leary, Koch, & Hechenbleikner, 2001). Researchers propose a two-factor motivational organization of emotion, suggesting that emotions are organized as responses to stimuli that are either generally positive (appetitive) or negative (aversive) in nature (Dickinson & Dearing, 1979; Konorski, 1967; Lang, Bradley, & Cuthbert, 1998). According to the motivational organization proposed by Lang et al. (1998), situations that promote survival (e.g., copulation) prime the activation of the appetitive system, whereas situations involving threat (e.g., attack) prime the activation of the defensive system.

To scientifically study emotions and the underlying motivational systems, they must be measurable. Emotions can be organized into three measurable systems: language (e.g., cries of distress, self-reported descriptions of feelings), physiological reactions (e.g., heart rate, skin conductance change, reflexes), and behaviors (e.g., approach, avoidance) (Lang, 1993). The elicitation of measurable behavioral responses (e.g., fleeing the room) is difficult, if not impossible, under the current ethical guidelines. Self-report data are often susceptible to social desirability, and people may not always be capable of accurately identifying and reporting their own emotional responses (especially physiological reactions such as subtle changes in facial muscle tension). Thus, poor levels of covariation between these systems often occur (Bradley & Lang, 2000). Although self-report data are useful, it may be helpful for researchers interested in the physiological correlates of emotion to employ physiological measures to acquire supplementary data that self-report measures alone are unable to provide.

Startle

When presented with a sudden threatening stimulus (e.g., a loud crash of thunder), the defensive system quickly responds with a startle response, or startle reflex, to protect the body from potential injury. The startle response consists of a behavioral repertoire, including: hunching of the shoulders, pulling the head down and forward, clenching of the fists, and quickly closing the eyes (i.e., blinking) (Hunt & Clarke, 1937). The eyeblink is the most stable component of the startle response (Bradley & Lang, 2000; Lang, Bradley, & Cuthbert, 1990) and can be measured by electrodes placed below the eye, over the orbicularis oculi (the muscle responsible for the eyeblink). Researchers conducting psychophysiological research often utilize the eyeblink as one measure of the startle reflex, and thus, as an indicator that the defensive system is engaged. The startle response serves as a defensive reflex that is heightened in situations providing evidence of threat or other potential harm (e.g., attack) and is inhibited (or decreased) in contexts promoting survival (e.g., sustenance) (Bradley, Cuthbert, & Lang, 1999). Thus, the startle reflex provides one useful physiological measure in the study of emotion.

Researchers use a number of measures to quantify the startle response. Startle probability provides information regarding the likelihood of a startle reflex. Startle magnitude provides a useful measure of startle size by averaging across all trials, even trials where no startle reflex occurred. However, a significant difference in startle magnitude between two groups may be caused by 1) the actual size of the startle response being larger in one group compared to the other, 2) the probability of a startle response being greater in one group compared to the other, or 3) both 1 and 2. In contrast to magnitude, which includes all trials, startle amplitude includes only trials where a valid startle response occurred. Amplitude provides information regarding the actual size of the startle response, controlling for possible differences in the probability of a response.

Affect and Startle

The viewing of emotionally laden stimuli (such as photographs from the International Affective Picture System) is accompanied by a motivational state commensurate with the affective content of the picture. For example, a stimulus that indicates potential threat produces a defensive motivational state, whereas a stimulus signifying pleasantness produces a positive, or appetitive, motivational state. The emotional reactions associated with each motivational state affect the degree to which the startle reflex is exhibited in response to a startle probe (e.g., a burst of noise, a bright light). That is, the affective valence (i.e., degree of pleasantness or unpleasantness) of the stimulus affects the elicited startle reflex in very predictable ways. Consistent with the previously mentioned motivational priming hypothesis proposed by Lang et al. (1998), the standard finding in psychophysiological research on the startle response is a linear trend corresponding to a relative decrease (or attenuation) of the startle response when attending to a pleasant stimulus, and a relative increase (or potentiation) of the startle response when attending to an unpleasant stimulus, as compared to a neutral stimulus (Bradley et al., 1999; Lang et al., 1990; Vrana, Spence, & Lang, 1988). This "affective modulation" of the startle response reflects not only the motivational system that is activated (the defensive system) by the startle probe itself but also the motivational system that is activated by the affective valence of the stimulus being attended to at the time the startle probe is presented.

A startle probe is, by definition, an unpleasant stimulus intended to evoke a sudden response from the defensive system. According to the affective-match hypothesis (Lang et al., 1990), if the affective valence of the stimulus that is being attended to (i.e., the foreground stimulus) matches that of the startle probe (i.e., unpleasant), the startle response elicited by that probe will be relatively augmented. Relative inhibition of the startle reflex occurs during an affective "mismatch"; that is, if the foreground stimulus is pleasant during the presentation of an unpleasant startle probe. For example, if a person is already reacting to an unpleasant stimulus, such as a horror movie, the reflex elicited by the presentation of a sudden burst of noise will be greater than if the person were reacting to a pleasant stimulus, such as a comedy film, at the moment of startle probe presentation. Affective modulation of the startle reflex is not, however, limited to the acoustic startle probe modality.

Startle Probe Modality

Various probes are used in psychophysiological research to elicit the startle response from human participants, including acoustic (e.g., bursts of white noise) (Lipp et al., 2003; Vrana, 1994), visual (e.g., flashes of bright light) (Bradley et al., 2000), and tactile (e.g., air puffs) (Hawk & Cook, 1997). Individual differences in startle reflex magnitude are found to be stable across startle probe modalities, in that people who respond with relatively large startle reflexes to an acoustic startle probe also respond with relatively large startle reflexes to a visual startle probe (Bradley et al., 2000). Previous research finds that startle responses elicited by an acoustic probe are consistently larger than responses elicited by a visual probe. This difference has been attributed to differences in probe intensity as opposed to differences in modality (Bradley et al., 2000). Regardless of the rated aversiveness of the probe, affective modulation of the startle response is consistently shown regardless of the modality of the startle probe, with larger reflexes elicited when viewing unpleasant compared to pleasant pictures (Bradley et al., 2000; Lang, Bradley, & Cuthbert, 1990).

Ethnic Differences in Physiology

As previously mentioned, studies have shown ethnic differences in the perceived appropriateness (Matsumoto, 1990), display (Ekman, 1971; Friesen, 1972, as cited by Matsumoto, 1993), and subjective experience (Scherer et al., 1988; Matsumoto et al., 1988) of emotion. In addition, there is an extant literature revealing ethnic differences in physiological responding, specifically between African Americans and European Americans. Studies show that African Americans have lower skin conductance levels than European Americans (Bernstein, 1965; Johnson & Corah, 1963; Johnson & Landon, 1965; Juniper & Dykman, 1967; Malmo, 1965) and also higher rates of hypertension (Adams, 1932; Anderson, 1989; Haffner et al., 1990; Pappas, Gergen, & Carroll, 1990; Winkleby, Fortmann, & Rockhill, 1993). Recently, Brown, Bradley, and Lang (2002) found ethnic differences in the startle response to an acoustic probe.

The results of Brown et al. (2002) showed an ethnic difference in startle magnitude (size of the startle response averaged across all trials, including those trials where no startle occurs) as well as the probability of a startle response. However, their data showed no ethnic difference in the size of the startle response averaged across only those trials where a startle occurs (amplitude) or in affective modulation (the standard valence effect occurs for each ethnic group). Thus, when a startle response did occur, there was no difference in the size of the response between African Americans and European Americans; however, African Americans startled less often than European Americans in response to an acoustic startle probe.

Rationale for Current Study

The startle reflex is a useful tool for studying emotion. As mentioned above, studies show that startle responses are consistent across probe modalities (i.e., people who exhibit a relatively large startle response to an acoustic probe also exhibit a relatively large response to a visual startle probe) (Bradley et al., 2000). Also, affective modulation occurs across startle probe modalities (Bradley et al., 2000; Lang et al., 1990). Although previous research finds systematic differences in a number of physiological measures between different ethnic groups, a recent search of PsycInfo and PubMed resulted in no entries pertaining to the investigation of ethnic differences in the startle response. Based on the lack of entries in the literature, researchers appear to study the startle reflex without addressing possible differences between ethnic groups. This oversight may be problematic, especially for researchers collecting data from an ethnically diverse sample. Systematic differences between ethnic groups in startle may confound results if not properly taken into consideration.

Recent findings of Brown et al. (2002) showing ethnic differences in startle reflex probability and magnitude between African Americans and European Americans in response to an acoustic startle probe beg the question of why these differences occur. One possible explanation is a difference in hearing between ethnic groups. Research suggests that African Americans are less likely than European Americans to recognize the symptoms and risks associated with excessive noise exposure (Crandell, Mills, & Gauthier, 2004), and thus may be more likely to engage in behaviors that might lead to hearing impairment. A classic sign of noise induced hearing loss is a permanent decrease in hearing sensitivity in the frequency range of 3000-6000Hz (Henderson, Hamernik, Dosanjh et al., as cited by Crandell et al., 2004). Because this is the frequency range of the typical acoustic startle probe, hearing differences may account for differences in startle reflex probability and magnitude, in that African Americans may be less sensitive to an acoustic startle probe compared to European Americans. In addition to why the ethnic difference occurs, the replicability of the effect, the generalizability of the effect to other startle probe modalities, and the generalizability of the startle reflex as an indicator of emotion across ethnic groups (and across startle probe modalities) require further examination.

Research Question

The current study attempts to answer the following questions: 1) Are the ethnic differences previously found by Brown et al. (2002) in the probability and magnitude of the startle response specific to the acoustic startle probe modality or the results of more general ethnic differences in defensive responding? 2) Does affective modulation of startle reflex magnitude occur for African American as well as European American participants in response to both acoustic and visual startle probes?

Hypotheses

Ethnic Differences in Startle

If the ethnic differences in startle probability and magnitude in response to an acoustic startle probe found by Brown et al. (2002) are specific to the auditory modality (e.g., due to hearing differences), ethnic differences in the startle reflex are expected in response to an acoustic startle probe but not in response to a visual startle probe. However, if the previously found ethnic differences are indicative of more general ethnic differences in basic defensive responding, ethnic differences are expected in startle reflexes elicited by both an acoustic and a visual startle probe.

Affective Modulation

Based on previous research examining affective modulation in response to startle probes presented through different modalities (e.g., acoustic and visual), replication of the standard affective modulation effect on startle magnitude is expected for both an acoustic and a visual startle probe for both European Americans and African Americans.

CHAPTER 2
METHOD

Participants

Participants were 16 African American (9 female and 7 male) and 16 European American (7 female and 9 male) Introductory Psychology students at the University of Florida. One European American female was paid for her participation in the study while all other students received partial course credit for their participation. The mean age of participants was 18.91 years and all of the students were between 18 and 21 years of age.

Materials and Design

Stimuli

The International Affective Picture System (or IAPS) is a standardized collection of over 700 pictures selected as affect-inducing stimuli (Lang, Bradley, & Cuthbert, 2001). Research shows that the IAPS serves this purpose well, providing photographic images that produce the desired range of emotional reactions, with varying degrees of intensity (Lang et al., 1993). The IAPS contains photographs depicting people, animals, nature, and objects, previously rated for valence (i.e., degree of pleasantness or unpleasantness) and arousal (i.e., intensity of activation).

Thirty-six pictures were selected from the IAPS (Lang et al., 2001) for the current study. Pictures were chosen, based on their standardized ratings, to represent three affective valence categories (i.e., pleasant, neutral, unpleasant). The pleasant category was comprised of erotic pictures, including pictures of heterosexual couples and other (i.e., opposite) sex nudes. Neutral pictures included both indoor and outdoor scenes or objects. The unpleasant category consisted of pictures depicting physical threat, including attacking animals and attacking humans. Each of the three valence categories included 12 different pictures.[1]

Two different orders of picture presentation were constructed to control for possible effects resulting from viewing pictures in a particular sequence. Each order was arranged in blocks of six, such that there were two exemplars from each of the three stimulus valence categories in each block of six, resulting in one picture from each content category in each block. That is, each block of six pictures contained two erotic pictures (one couple and one other sex nude), two neutral pictures (one inside and one outside neutral scene or object), and two unpleasant threat pictures (one animal attack and one human attack). Each order included identical pictures; however, arrangement occurred so that pictures would not immediately precede or follow the same pictures across blocks. Within each order, the other sex nudes were either of females (viewed by male participants) or of males (viewed by female participants), providing a total of four different picture combinations (i.e., order 1 for males, order 1 for females, order 2 for males, order 2 for females). Each participant was presented with only one picture order. Digitized versions of the IAPS pictures were projected by an LCD projector onto a large (70” x 56”) screen, which was positioned approximately 6 feet in front the participant. Picture onset was nearly instantaneous, and each picture was presented for 6 seconds. Between each picture presentation (i.e., trial), an inter-trial interval (ITI) period (ranging

[1] IAPS numbers used in this study were: Pleasant: 4002, 4669, 4290, 4652, 4687, 4220, 4310, 4611, 4180, 4658, 4250, 4672 (pictures 4002, 4290, 4220, 4310, 4180, 4250 were erotic pictures of females shown to male participants; pictures 4531, 4520, 4534, 4536, 4533, 4535 were erotic male pictures shown to female participants); Neutral: 7710, 5950, 7283, 5900, 7490, 5500, 7207, 5731, 7170, 5740, 5920, 7237; Unpleasant: 6212, 1050, 1220, 6350, 6313, 1270, 6243, 1280, 1301, 6230, 1930, 6570.

in length from 8s to 16s) occurred when the screen was blank. All pictures were displayed in 32-bit color.

Startle Probes

The acoustic startle probe consisted of a 50-ms, 95dB burst of white noise, produce by a Coulbourn S81-02 white-noise generator. The stimulus was then gated through a Coulbourn S82-24 amplifier and presented to the participant over TDH-49 headphones. The headphones covered both ears of the participant, providing equal noise intensity to both ears. The visual startle stimulus consisted of a flash of light generated by the simultaneous firing of three professional photography flashguns. The three flashguns were positioned approximately 6 ft in front of the participant, and were not directed toward the participant. The startle probe was presented between 2.5 and 3.5s after each picture onset, as well as during 14 of the inter-trial intervals. During picture viewing, 18 acoustic startle probes were presented (6 per valence) and 18 visual startle probes were presented (6 per valence). Within each block of six pictures, three acoustic and three visual startle probes occurred. Either an acoustic or a visual startle probe was presented during each picture, with the constraint that if an acoustic probe was presented during a particular picture in order 1, a visual probe was presented during that same picture in order 2 (and vice versa). Participants received a total of seven acoustic and seven visual startle probes during inter-trial intervals.

Hearing Test

To examine hearing differences as a possible explanation for the ethnic differences found by Brown et al. (2002), a hearing test was conducted on each participant using a GSI-17 Audiometer (Grason-Stadler, Inc., Madison, WI). Participants' hearing thresholds were measured in decibels (dB) for 10 different frequencies ranging from 250 Hz-8000 Hz.

Questionnaires

A pre-experimental questionnaire, comprised of the Personal Need for Structure Scale (Thompson, Naccarato, & Parker, 1989, as cited in Neuberg & Newsom, 1993) and the Interaction and Audience Anxiousness Scale (Leary, 1983) was completed by all participants (see Appendixes A and B, respectively). However, these measures were not relevant to the current investigation and are not mentioned further. A post-experimental questionnaire (see Appendix C), including basic demographic questions and items assessing the participant's subjective experience, was administered at the conclusion of the experimental session. Of specific interest to the current study were items assessing the pleasantness of the startle probes. Items asked participants to "rate the pleasantness of noises heard over headphones while watching pictures during the course of the experiment" and to "rate the pleasantness of flashes of light seen while watching pictures during the course of the experiment". Each of these items was scored on a 7-point scale, 1 = unpleasant, 7 = pleasant. All questionnaires are included in the Appendix.

Startle Eyeblink Measurement and Reduction

The eyeblink component of the startle response was measured by placing two 4mm In Vivo Metric (Healdsburg, CA) miniature electrodes over the inferior orbicularis oculi, using the placement recommended by Fridlund and Cacioppo (1986). Physiological data were acquired using an IBM-compatible computer running VPM version 11.2 data acquisition and reduction software (Cook, 2000). The raw electromyography (EMG) signal was amplified (x30,000), and frequencies below 90 Hz and above 250 Hz were filtered with a Coulbourn S75-01 bioamplifier. The raw signal was rectified and integrated with a Coulbourn S76-01 contour-following integrator, with a time constant of 200ms. Activity in the orbicularis oculi muscle was sampled at 20 Hz during baseline and picture viewing, with an increase in sampling rate to 1,000 Hz for 50 ms before the onset of the startle probe and for 250 ms after probe onset. The eyeblink data were reduced off-line by using a program that scored each trial for magnitude in analog-to-digital (A/D) units, using an algorithm devised by Globisch, Hamm, Schneider, and Vaitl (1993). Corrugator (frowning muscle) EMG activity was also measured in the experimental sessions but is not relevant to the current hypotheses and therefore is not reported.

Procedure

Participants were run individually. Participants sat in a recliner in a 9' x 13' dimly lit room. After providing informed consent and completing the pre-experimental questionnaire, a brief hearing test was administered. Participants were notified that a set of earphones would be placed over their ears and a variety of tones would be heard. They were instructed, in accordance with the instruction manual accompanying the GSI-17 Audiometer, to indicate when a tone was heard by raising the hand corresponding to the ear in which the tone was heard, and then lowering the hand when the tone was no longer heard. Participants were familiarized with the tone by receiving a sample tone at 1000 Hz and 40 dB. Hearing threshold was determined by presenting the tone for 1-2 seconds and increasing the volume level by 5 dB after each failure of the participant to respond. The threshold is the minimum volume setting at which the participant indicates that the tone is audible. The setting level (in dB) was then recorded as the hearing threshold. The testing procedure was repeated for each tone frequency setting, 250 Hz, 500 Hz, 1000 Hz, 1500 Hz, 2000 Hz, 3000 Hz, 4000 Hz, 6000 Hz, and 8000 Hz, for the left ear and then for the right ear.

Participants were then prepared for physiological recording. The skin under the eye was cleansed with water and a tissue to remove any makeup, oil, etc. that might impede the electrical signal. Electrolyte gel was placed inside the electrode cups as well as gently rubbed on the skin of the participant. Electrodes were then placed on the participant. Participants were instructed to attend to each picture throughout its duration and to remain as still as possible. A set of headphones was placed over the participants' ears and was worn throughout the picture-viewing period to provide a channel for administering the acoustic startle probe. The lighting was dimmed, the door closed, and the participant was alone while viewing the pictures. The picture viewing session lasted approximately 17 minutes, after which the electrodes were removed from the participant and a post-experimental questionnaire was administered. Participants were subsequently debriefed, thanked for their participation, and dismissed.

Analyses

Analyses were conducted to assess effects of startle probe modality, picture valence, and ethnicity on magnitude, probability, and amplitude of the startle response. A 2 (startle probe modality: acoustic, visual) X 3 (picture valence: pleasant, neutral, unpleasant) X 2 (ethnicity: African American, European American) mixed-model ANOVA was conducted in which startle probe modality and picture valence were within subject factors and ethnicity was a between subjects factor. Because only those startle responses occurring while pictures were presented were of interest, startles occurring during inter-trial intervals were not analyzed. In cases where a significant effect of affective valence occurred, pairwise comparisons were subsequently conducted to determine the pattern of differences between the three levels (pleasant, neutral, unpleasant). All pairwise analyses were Bonferroni corrected for multiple comparisons. Based on the recommendations of Vasey and Thayer (1987) regarding within subject psychophysiological data, the multivariate Wilks' Lambda test statistic is reported for all analyses including within subject variables. All means for magnitude and amplitude are reported in A/D units. All means for probability are expressed as a ratio of the number of trials during which a startle response occurred divided by the total number of trials. Data from three participants were excluded from analyses including startle probe modality as a factor due to startle responses that could not be used. Fourteen participants were excluded from analyses involving startle amplitude due to either startle responses that could not be used or lack of a startle response. Startle responses were determined to be unusable if the onset of the eyeblink occurred longer than 150ms after the presentation of the startle probe.

Effects of participant ethnicity on hearing threshold were assessed by conducting a mixed-model analysis of variance (ANOVA), with participant ethnicity as a between subjects factor and tone frequency as a within subject factor. Because only the higher frequencies (3000, 4000, 6000, and 8000 Hz) are pertinent to the acoustic startle response (W. K. Berg, personal communication, January, 2004), only analyses involving these frequencies are reported.

CHAPTER 3
RESULTS

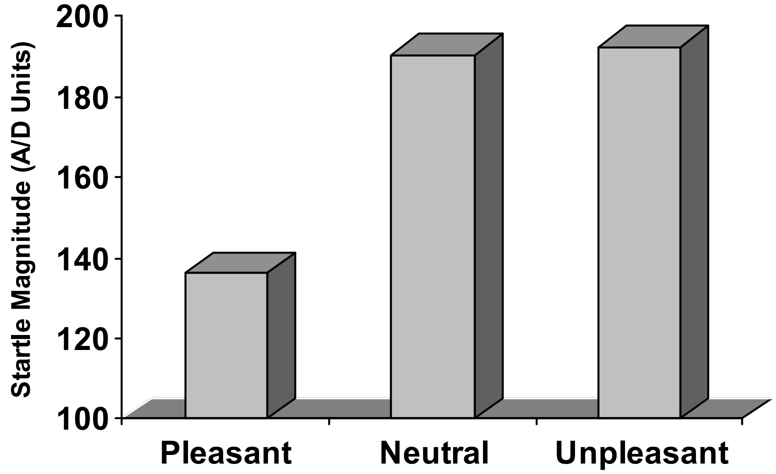
Magnitude

Probe Modality

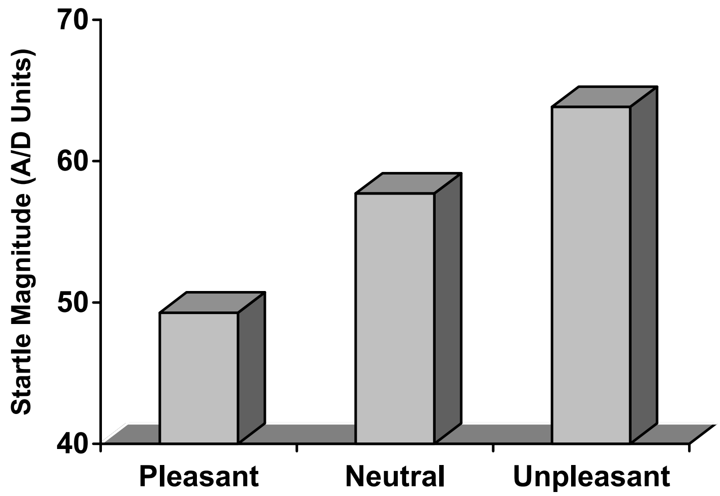
Consistent with the results of previous studies (e.g., Bradley et al., 2000), startle magnitude was affected by the modality of the startle probe, $F\ (1, 27) = 14.10$, $p = .001$, eta-squared = .343, in that a response elicited by an acoustic probe ($M = 180.52$, $SD = 199.14$) was greater than one elicited by a visual probe ($M = 56.39$, $SD = 73.88$).

Valence

The magnitude of the startle reflex was modulated by the affective valence of the picture stimulus, $F\ (2, 26) = 7.60$, $p < .01$, eta-squared = .369. The size of the startle response was different depending on whether the participant was viewing a pleasant picture, neutral picture, or unpleasant picture at the time the startle probe was presented. Picture valence and startle probe modality interacted to produce an effect on startle magnitude, $F\ (2, 26) = 3.66$, $p < .05$, eta-squared = .220. The nature of this interaction was examined more closely by analyzing the effect of picture valence on startle magnitude separately for acoustic and visual startle probes. Replicating previous findings, results revealed a significant effect of picture valence on blink magnitude for the acoustic startle probe, $F\ (2, 30) = 6.83$, $p < .005$, eta-squared = .313. Figure 3-1 (top panel) illustrates the pattern of startle reflex magnitude obtained in response to an acoustic startle probe while viewing affective pictures.



Acoustic Startle Probe



Visual Startle Probe

Figure 3-1. Top panel: Startle blink magnitude when elicited by an acoustic startle probe, while viewing pleasant, neutral, or unpleasant pictures. Bottom panel: Startle blink magnitude when elicited by a visual startle probe, while viewing pleasant, neutral, or unpleasant pictures.

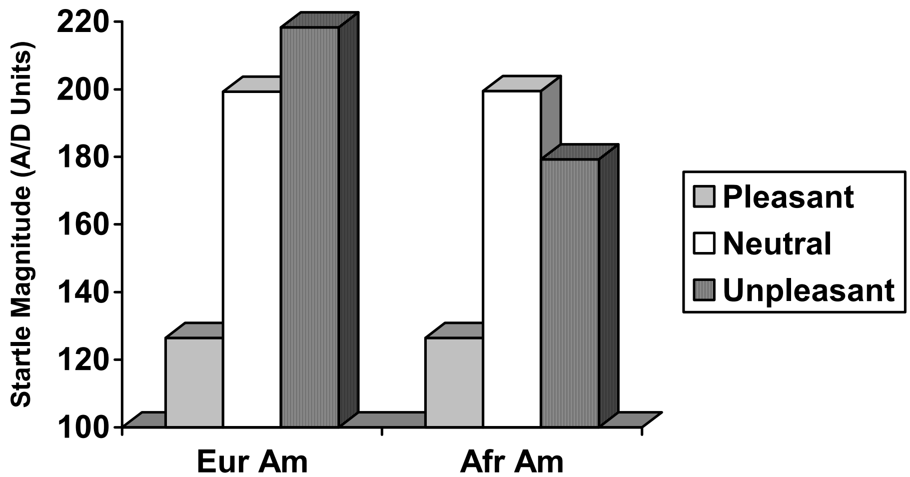
Planned pairwise analyses revealed that larger blinks were elicited by an acoustic probe when viewing unpleasant (*M* = 192.36, *SD* = 199.98) compared to pleasant (*M* =

136.09, *SD* = 173.68) pictures, *p* < .01, and smaller blinks were elicited when viewing pleasant (*M* = 136.09, *SD* = 173.68) compared to neutral (*M* = 190.30, *SD* = 204.68) pictures, *p* < .01. No difference in blink magnitude was found when viewing neutral (*M* = 190.30, *SD* = 204.68) compared to unpleasant (*M* = 192.36, *SD* = 199.98) pictures, *p* = ns, when elicited by an acoustic probe.

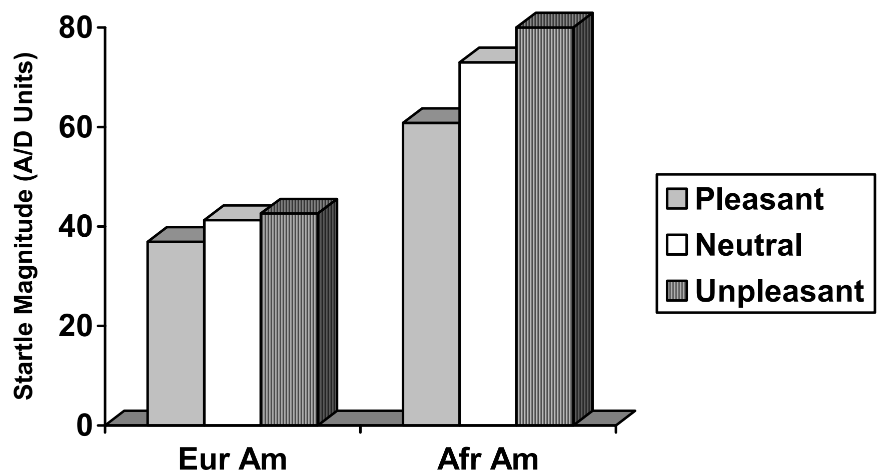
Results also revealed a significant effect of picture valence on blink magnitude for the visual startle probe, F (2, 27) = 4.11, p < .05, eta-squared = .233. Figure 3-1 (bottom panel) illustrates the pattern of startle reflex magnitude obtained in response to a visual startle probe. Planned pairwise comparisons revealed that larger blinks were elicited when viewing unpleasant (*M* = 63.84, *SD* = 75.49) compared to pleasant (*M* = 49.28, *SD* = 67.33) pictures, *p* < .05. No differences in blink magnitude were found when viewing pleasant (*M* = 49.28, *SD* = 67.33) compared to neutral (*M* = 57.70, *SD* = 87.43) pictures, *p* = ns, or when viewing neutral (*M* = 57.70, *SD* = 87.43) compared to unpleasant (*M* = 63.84, *SD* = 75.49) pictures, *p* = ns.

Ethnicity

In contrast to results found by Brown et al. (2002), the magnitude of the startle response did not differ between African American participants (*M* = 120.45, *SD* = 168.10) and European American participants (*M* = 116.45, *SD* = 174.00), *F* (1, 27) < 1, *p* = ns, eta-squared = .000. Ethnicity did not interact with picture valence, *F* (2, 26) = 1.19, *p* = ns, eta-squared = .084, or startle probe modality, *F* (1, 27) <1, *p* = ns, eta-squared = .026, to affect startle magnitude. The three way interaction between picture valence, startle probe modality, and ethnicity was also not significant for startle magnitude, *F* (2, 26) = 1.24, *p* = ns, eta-squared = .087. Thus, the ethnicity of the participant did not affect the pattern of affective modulation obtained in response to either an acoustic or a visual startle probe. Figure 3-2 illustrates the patterns of startle reflex magnitude obtained from European American and African American participants in response to acoustic (top panel) and visual (bottom panel) startle probes.



Acoustic Startle Probe



Visual Startle Probe

Figure 3-2. Startle blink magnitude obtained from European American and African American participants in response to acoustic (top panel) and visual (bottom panel) startle probes.

Probability

Probe Modality

Replicating previous studies, the probability of a startle response was significantly affected by startle probe modality, F (1, 27) = 19.42, $p < .001$, eta-squared = .418. The likelihood of an occurrence of a startle response elicited by an acoustic probe (M = .77, SD = .30) was greater than the likelihood of an occurrence of a startle response elicited by a visual probe (M = .46, SD = .35).

Valence

The picture valence affected the probability of an occurrence of a startle response, F (2, 26) = 3.26, p = .05, eta-squared = .201. Figure 3-3 depicts the pattern of startle response probability obtained while viewing affective pictures. Pairwise comparisons revealed that the likelihood of a startle response was greater when viewing unpleasant (M = .66, SD = .26), compared to pleasant (M = .58, SD = .30) pictures, $p < .05$. No differences occurred, in terms of probability, between startles elicited while viewing pleasant pictures (M = .59, SD =.29) compared to neutral pictures (M = .60, SD = .27), p = ns, or neutral pictures (M = .60, SD = .27) compared to unpleasant pictures (M = .66, SD = .26), p = ns Startle probe modality and picture valence did not interact to produce an effect on startle response probability, F (2, 26) = 2.71, p = ns, eta-squared = .172.

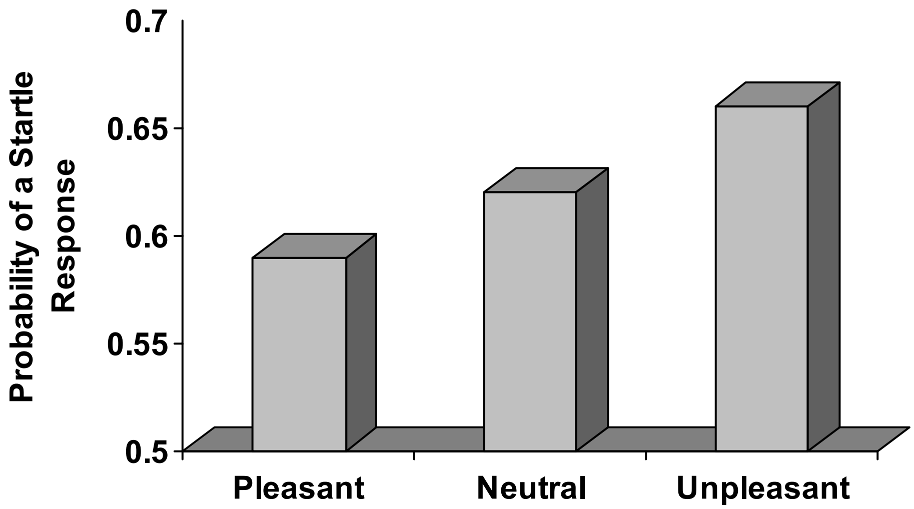


Figure 3-3. The probability of a startle response, averaged across acoustic and visual startle probe modalities, while viewing pleasant, neutral, or unpleasant pictures.

Ethnicity

Results did not show a significant difference between African American participants (*M* = .611, *SD* = .37) and European American participants (*M* = .614, SD = .38) in the probability of a startle response, F (1, 27) < 1, p = ns, eta-squared = .000. Participant ethnicity did not interact with picture valence, F (2, 26) < 1, p = ns, eta-squared = .053, or probe modality, F (1, 27) < 1, p = ns, eta-squared = .028, to affect the probability of a startle response. The three-way interaction between picture valence, probe modality, and participant ethnicity was also not significant for probability, F (2, 26) < 1, p = ns, eta-squared = .067.

Amplitude

Recall that startle amplitude is calculated by averaging startle size over trials where a startle response occurred. Thus, amplitude is an indication of startle size, controlling for probability.

Probe Modality

The modality of the startle probe affected the amplitude of the startle response, F (1, 16) = 9.55, $p < .01$, eta-squared = .374. Eye-blinks elicited by acoustic startle probes were larger (M = 254.27, SD = 212.73) than those elicited by visual startle probes (M = 108.97, SD = 69.15).

Valence

The affective valence of the picture stimulus significantly affected the amplitude of the startle response, F (2, 15) = 6.94, $p < .01$, eta-squared = .481. Figure 3-4 illustrates the pattern of startle reflex amplitude, across startle probes, obtained while viewing affective pictures. Pairwise analyses revealed larger blinks were elicited while viewing unpleasant (M = 194.15, SD = 127.42) compared with pleasant (M = 150.04, SD = 114.59) pictures, $p < .01$. Smaller blinks were elicited while viewing pleasant (M = 150.04, SD = 114.59) compared with neutral (M = 200.67, SD = 134.89) pictures, $p < .01$. Startle responses while viewing neutral pictures (M = 200.67, SD = 134.89) did not differ in amplitude compared with responses while viewing unpleasant (M = 194.15, SD = 127.42) pictures, p = ns Picture valence and startle probe modality did not interact to affect startle amplitude, F (2, 15) = 2.71, p = ns, eta-squared = .266.

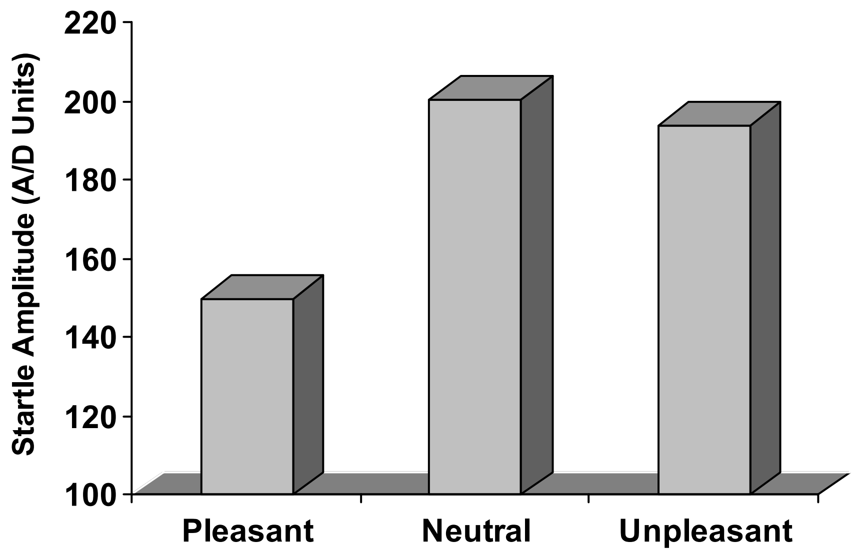


Figure 3-4. Startle blink amplitude, averaged across acoustic and visual startle probe modalities, while viewing pleasant, neutral, or unpleasant pictures.

Ethnicity

African American participants (*M* = 196.61, *SD* = 122.76) and European American participants (*M* = 166.63, *SD* = 122.76) did not differ in startle amplitude, F (1, 16) < 1, p = n.s, eta-squared = .017. Participant ethnicity did not interact with picture valence, F (2, 15) = 2.72, p = ns, eta-squared = .266, or probe modality, F (1, 16) < 1, p = ns, eta-squared = .005, to affect startle amplitude. The three-way interaction between picture valence, probe modality, and participant ethnicity was also not significant for amplitude, F (2, 32) < 1, p = ns, eta-squared = .042.

Tests of Alternative Explanations

Hearing

Because the acoustic startle probe was presented through headphones to both the left and right ears simultaneously, the hearing data were averaged across both ears. Results showed that ethnicity had no effect on hearing threshold, F (1, 30) < 1, p = ns, eta-squared = .016. The average decibel level at which a tone in the frequency range of 3000-8000 Hz was audible (i.e., hearing threshold) was not significantly different between African American (*M* = 7.89, *SD* = 4.17) and European American (*M* = 7.58, *SD* = 4.17) participants. Mean hearing thresholds for each ethnic group at each frequency level are reported in Figure 3-5.

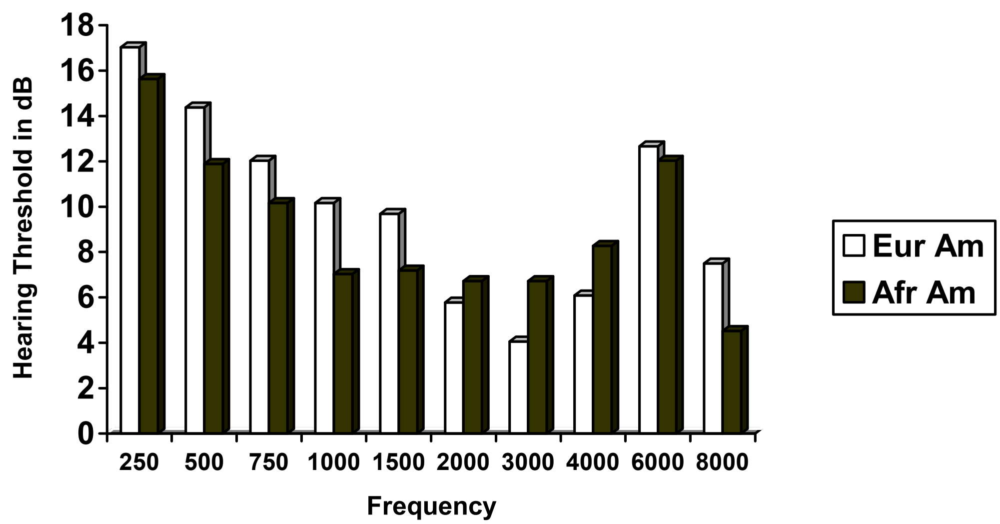


Figure 3-5. Mean hearing thresholds for each ethnic group at each frequency level.

Subjective Ratings of Startle Probes

A 2 (startle probe modality: acoustic, visual) X 2 (ethnicity: African American, European American) mixed-model ANOVA was conducted on the subjective ratings of the pleasantness of the startle probes, with startle probe modality as a within subjects factor and participant ethnicity as a between subjects factor. Results revealed that acoustic startle probes (*M* = 2.16, *SD* = .88) were consistently rated as more unpleasant than visual startle probes (*M* = 3.00, *SD* = 1.05), F (1, 30) = 16.01, $p < .0001$, eta-squared = .348. In addition, African Americans (*M* = 2.31, *SD* = .72) rated the startle probes in general as more unpleasant, compared with European Americans (*M* = 2.84, *SD* = .72), F (1, 30) = 4.29, $p < .05$, eta-squared = .125. Probe modality and participant ethnicity did not interact to affect subjective ratings of the startle probes, F (1, 30) = 1.08, *p* = ns, eta-squared = .035.

CHAPTER 4
DISCUSSION

It was hypothesized that if the ethnic differences in probability and magnitude previously found by Brown et al. (2002) were due to general ethnic differences in defensive responding, their results would be replicated in response to an acoustic as well as a visual startle probe. If, however, the ethnic differences previously found by Brown et al. were somehow specific to an acoustic startle probe (perhaps due to hearing differences), replication of the previously found results with an acoustic startle probe but not with a visual probe was expected. In contrast to expectations, the current study did not show any ethnic differences in the startle response in terms of magnitude, probability, or amplitude. Not only did no ethnic differences occur in the startle reflex in response to a visual probe, but replication of Brown et al., (2002) of ethnic differences in probability and magnitude was also not attained in response to an acoustic probe.

One possible explanation for the ethnic differences in startle found by Brown et al. (2002) is a difference in hearing between the two ethnic groups. For an acoustic startle probe to be effective, it must be heard. Thus, the quality of auditory processing might affect the probability and size of the startle response. Individuals with optimal auditory processing capability would likely exhibit a greater probability of startle as well as enhanced startle size compared to individuals with suboptimal auditory processing capability. However, results showed no difference in ability to hear between African American and European American participants, suggesting that differences in hearing did not contribute to the differences in acoustically elicited startle previously found by Brown et al. (2002). The failure to replicate previously found ethnic differences in response to an acoustic startle probe initiates the exploration of possible explanations that may account for the incongruity of results.

If one ethnic group rated the startle probes as more unpleasant compared to the ratings of the other ethnic group (indicating a more aversive experience), differences in the size and/or probability of a startle response may be attributable to differences in subjective experience. African American participants did, in fact, indicate that the startle probes were more unpleasant than the European American participants did; however, results showed no ethnic differences in actual startle size or probability. Moreover, the ethnic difference in subjective ratings does not offer an explanation for the findings of Brown et al. (2002). The current study found that African American participants, compared with European American participants, found the startle probes to be more unpleasant. If subjective experience directly affected the startle response, it would be expected that African American participants would actually exhibit greater startle probability and enhanced startle size compared to European Americans. However, the direction of means of the subjective ratings is counter to what would be expected if subjective experience directly affected the startle response.

There are differences that exist between the Brown et al. (2002) study and the current study that may be offered as possible explanations for the incongruity of the results regarding ethnic differences in the probability and magnitude of startle. First, the picture sets were different. Although both sets of pictures are from the IAPS collection and both include pictures representing pleasant, neutral, and unpleasant valences, picture content was not identical in the two studies. For example, almost two thirds of the pictures in the Brown et al. study were of people, and included depictions of mutilated bodies in addition to threat in the unpleasant valence category. Only half of the pictures in the current study depicts people (the other half is comprised of animals, objects, and scenes), and the unpleasant valence category does not include any depictions of mutilated bodies, but only threat. The current study attempted to replicate previously found ethnic differences in startle reflex magnitude and probability in response to an acoustic probe and investigate whether ethnic differences extend to another startle probe modality. Therefore, the picture set used was similar to the picture set utilized by Bradley et al. (2000) in their study revealing the stability of individual differences in startle response size across startle probe modalities. Future research is needed to investigate the possible effects of specific picture content on ethnic differences in startle. Specifically, an investigation of ethnic differences in the startle response across probe modalities utilizing the stimulus picture set from the Brown et al. study may be helpful in shedding light on whether ethnic differences in startle are dependent on specific picture stimuli.

Second, the ethnicity of the experimenter(s) is different. In the Brown et al. (2002) study, some participants interacted with both an African American and a European American female experimenter, while others interacted with either an African American or a European American female experimenter. In the current study, participants interacted only with a European American female experimenter. Because participant ethnicity was examined as a source of possible differences, it seems possible that the ethnicity of the experimenter might also affect the participants' reactions. The effect of the experimenter's ethnicity, however, was examined in the Brown et al. study and did not have any effect on participants' startle response. Therefore, the difference in experimenter ethnicity seems an unlikely explanation for the inconsistent findings.

Third, the sample is different. In addition to the sample in the Brown et al. (2002) study being over two and half times larger than that of the current study, it is possible that only a subpopulation of African Americans exhibit decreased startle probability and magnitude compared to European Americans. Research investigating the startle reflex in animal samples in response to an acoustic startle probe has found differences in startle size among inbred strains of mice (Willott et al., 2003) and rats (Conti & Printz, 2003). In addition, differences in startle magnitude have been found in rats with predispositions for different types of defensive behavior (e.g., passive "freezing" responses, aggressive behavior) (Popova et al., 2000). Together, these results suggest that responsiveness to a startle probe may be influenced by a genetic component. Thus, it is possible that a subpopulation of African Americans display the pattern of startle response found by Brown et al. (i.e., decrease in startle response probability and magnitude), but members of that subpopulation were not included in adequate number in the current sample.

According to the motivational priming organization proposed by Lang et al. (1998), situations that promote survival (e.g., copulation) prime the activation of the appetitive system, whereas situations involving threat (e.g., attack) prime the activation of the defensive system. The motivational priming organization predicts that startle reflex size will be enhanced when the foreground stimulus (e.g., a picture) is unpleasant and inhibited when the foreground stimulus is pleasant. In addition, the affective match hypothesis proposed by Lang et al. (1990) proposes that the differentiation in startle reflex size is based on whether the affective valence of the stimulus is matched or mismatched with the affective valence of the startle probe. This position suggests that affective modulation of the startle response is dependent on the affective match or mismatch of the stimulus and the startle probe, not the modality of the probe itself. Thus, affective modulation should occur regardless of whether the startle probe is acoustic or visual. Based on the motivational priming organization and the affective match hypothesis, it was expected that affective modulation would occur for a visual as well as an acoustic startle probe. Due to the recently obtained ethnic differences in startle probability and magnitude, it was deemed prudent to systematically test for ethnic differences in affective modulation. However, because there was no explicit reason to believe that ethnic differences would occur, it was predicted that affective modulation would occur for both ethnic groups.

As expected, replication of the standard affective modulation effect for both ethnic groups and for both startle probe modalities was attained, with larger startle reflex magnitude elicited when viewing unpleasant, compared to pleasant, pictures. Because startle magnitude is an indication of the emotional state of the individual at the time of the startle probe presentation, results suggest that the startle response is a reliable measure of emotion across ethnic groups.

CHAPTER 5
CONCLUSION

Until recently, researchers studying the startle response have not acknowledged the possibility of ethnic differences, or at least have not reported systematically testing for such differences. In light of the current findings, the possibility of ethnic differences in the startle response is still unclear and future research is needed to further investigate this line of study. Taken together, the current results suggest that the startle response is a reliable measure of emotion for both European Americans and African Americans whether elicited by an acoustic or a visual startle probe

APPENDIX A
PERSONAL NEED FOR STRUCTURE SCALE

Read each of the following statements and decide how much you agree with each according to your attitudes, beliefs, and experiences. It is important for you to realize that there are no "right" or "wrong" answers to these questions. People are different, and we are interested in how you feel. Please respond according to the following 6-point scale.

1 = strongly disagree
2 = moderately disagree
3 = slightly disagree
4 = slightly agree
5 = moderately agree
6 = strongly agree

___ 1. It upsets me to go into a situation without knowing what I can expect from it.
___ 2. I'm not bothered by things that interrupt my daily routine.
___ 3. I enjoy having a clear and structured mode of life.
___ 4. I like to have a place for everything and everything in its place.
___ 5. I enjoy being spontaneous.
___ 6. I find that a well-ordered life with regular hours makes my life tedious.
___ 7. I don't like situations that are uncertain.
___ 8. I hate to change my plans at the last minute.
___ 9. I have to be with people who are unpredictable.
___ 10. I find that a consistent routine enables me to enjoy life more.
___ 11. I enjoy the exhilaration of being in unpredictable situations.
___ 12. I become uncomfortable when the rules in a situation are not clear.

APPENDIX B
INTERACTION AND AUDIENCE ANXIOUSNESS SCALE

For the next 15 items, read each of the following statements carefully and indicate how characteristic it is of you according to the following scale:

1 = Not at all characteristic of me.
2 = Slightly characteristic of me.
3 = Moderately characteristic of me.
4 = Very characteristic of me.
5 = Extremely characteristic of me.

Please answer each question as accurately and honestly as you can.

_____ 1. I often feel nervous in casual get-togethers.
_____ 2. I usually feel uncomfortable when I'm in a group of people I don't know.
_____ 3. I am usually at ease when speaking to a member of the opposite sex.
_____ 4. I get nervous when I must talk to a teacher or a boss.
_____ 5. Parties often make me feel anxious and uncomfortable.
_____ 6. I am probably less shy in social interactions than most people.
_____ 7. I sometimes feel tense when talking to people of my own sex if I don't know them very well.
_____ 8. I would be nervous if I was being interviewed for a job.
_____ 9. I wish I had more confidence in social situations.
____ 10. I seldom feel anxious in social situations.
____ 11. In general, I am a shy person.
____ 12. I often feel nervous when talking to an attractive member of the opposite sex.
____ 13. I often feel nervous when calling someone I don't know very well on the telephone.
____ 14. I get nervous when I speak to someone in a position of authority.
____ 15. I usually feel relaxed around other people, even people who are quite different from me.

APPENDIX C
POST-EXPERIMENTAL QUESTIONNAIRE

Age:

Date: Were you born in the U.S.? Yes No

Year in school:

Do you consider yourself an American? Yes No

Gender (circle one): Female Male

Sexual orientation: Bisexual Gay/Lesbian Heterosexual

Ethnicity: Asian Biracial Black Hispanic White
Other: _______________

Height: Weight:

Handedness: Left Right Ambidextrous

Are any of your biological relatives left-handed? Specify.

Did you ever switch handedness preferences? If so, explain:

If you are a woman, what are the approximate dates of your last menstrual period?

Do you wear glasses or contact lenses? Yes No

Were you wearing them during the experiment? Yes No

Do you have hearing problems? Yes No If so, please describe:

Do you have a chronic illness? Yes No If so, please explain:

Do you have a current illness? Yes No If so, please explain:

Do you take any special medication (for example, birth control pills, allergy medication, anti-anxiety medicine, anti-psychotic medicine, stress relievers)? Yes No
If so, please explain:

Are you currently on any form of over-the-counter medication (for example, aspirin, Tylenol, Advil, allergy medicine)? Yes No
If so, please explain:

Have you used any recreational drugs within the last 48 hours? Yes No
If so, please specify:

Is there any pre-existing state you are in which could have affected your response to the slides (for example, extreme excitement, sadness, happiness)?

Do you get anxious in small spaces? Yes No

Rate pleasantness of sensors under eyes:

1 2 3 4 5 6 7
UNPLEASANT PLEASANT

Rate pleasantness of noises heard over headphones while watching pictures during the course of the experiment

1 2 3 4 5 6 7
UNPLEASANT PLEASANT

Estimate the number of noises heard over the headphones during the course of the experiment:

Rate confidence of this estimate

1 2 3 4 5 6 7
NOT VERY CONFIDENT VERY CONFIDENT

Rate pleasantness of flashes of light seen while watching pictures during the course of the experiment

1 2 3 4 5 6 7
UNPLEASANT PLEASANT

Estimate the number of flashes seen during the course of the experiment:

Rate confidence of this estimate:

1 2 3 4 5 6 7

NOT VERY CONFIDENT VERY CONFIDENT

Was there any regularity in the pattern when noises were presented? Yes No
If so, please explain:

Was there any regularity in the pattern when flashes were presented? Yes No
If so, please explain:

Rate how much the noises over the headphones made you startle:

1	2	3	4	5	6	7
NOT VERY MUCH						VERY MUCH

Rate how much the flashes of light made you startle:

1	2	3	4	5	6	7
NOT VERY MUCH						VERY MUCH

What were you thinking about between picture presentations?

Could you see the pictures on the screen? Yes No

Please rate each of the following types of pictures in terms of how pleasant or unpleasant you found them. Use this scale 1= Very Unpleasant, 4 = Neutral, 7 = Very Pleasant

Violence _______ Erotica ______ Household objects/scenes _______
Animals ______

Did you have trouble staying awake during the study? Yes No

Did you fall asleep at any time during the study? Yes No

What do you think was our hypothesis for this experiment?

Please add any additional comments you have about any aspect of the laboratory, the experiment, or your experimenter:

LIST OF REFERENCES

Adams, J. M. (1932). Some racial differences in blood pressure and morbidity in groups of white and colored workmen. *The American Journal of the Medical Science, 184*, 342.

Anderson, N. B. (1989). Racial differences in stress-induced cardiovascular reactivity and hypertension: Current status and substantive issues. *Psychological Bulletin, 105,* 89-105.

Bernstein, A. S. (1965). Race and examiner as significant influences on basal skin impedance. *Journal of Personality & Social Psychology, 1,* 346-349.

Bradley, M. M, Cuthbert, B. N., & Lang, P. J. (1999). Affect and the startle reflex. In M. E. Dawson, A. M. Schell, & A. H. Bohmelt (Eds.) *Startle modification: Implications for neuroscience, cognitive science, and clinical science.* Cambridge University Press.

Bradley, M. M., & Lang, P. J. (2000). Measuring emotion: Behavior, feeling, and physiology. In R. Lane & L. Nadel (Eds),*Cognitive Neuroscience of Emotion, Series in affective science*. Oxford University Press, New York, NY. p. 242-276.

Bradley, M. M., Safi, F., Soler-Baillo, J., & Lang, P. J. (2000, October). Startle modality and size: Is a big startler always a big startler? Poster presented at the 40th meeting of the Society for Psychophysiological Research, San Diego, CA.

Brown, L. M., Bradley, M. M., & Lang, P. J. (2002, October). The role of ethnicity in affective reactions to ingroup and outgroup pictures. Presented at a symposium entitled What Has Psychophysiology Revealed About Ethnicity and Emotion? chaired by Jeanne L. Tsai at the 42nd meeting of the Society for Psychophysiological Research, Washington, DC.

Conti, L. H., & Printz, M. P. (2003). Rat strain-dependent effects of repeated stress on the acoustic startle response. *Behavioural Brain Research, 144*, 11-18.

Cook, E. W., III. (2000). *VPM reference manual*. Birmingham, AL: Author.

Crandell, C., Mills, T. L., & Gauthier, R. (2004). Knowledge, behaviors, and attitudes about hearing loss and hearing protection among racial/ethnically diverse young adults. *Journal of the National Medical Association, 96*, 176-185

Davis, M. & Lang, P. J. (2003). Emotion. In M. Gallagher & R. J. Nelson (Eds.), *Handbook of psychology: Vol. 3. Biological psychology*. New York: Wiley.

Dickinson, A. & Dearing M. F. (1979) Appetitive-aversive interactions and inhibitory processes. In A. Dickinson & R. A. Boakes (Eds) *Mechanisms of Learning and Motivation*. Hillside, NJ, Erlbaum, pp 203-231.

Ekman, P. (1971). Universals and cultural differences in facial expressions of emotion. In J. Cole (Ed.), *Nebraska Symposium on Motivation*. Lincoln: University of Nebraska Press.

Fridlund, A. J., & Cacioppo, J. T. (1986). Guidelines for human electromyographic research. *Psychophysiology, 23*, 567-589.

Frijda, N. H. (1986). *The emotions*. New York: Cambridge University Press.

Globisch, J., Hamm, A., Schneider, R., & Vaitl, D. (1993). A computer program for scoring reflex eyeblink and electrodermal responses written in Pascal. *Psychophysiology, 39*, S30.

Haffner, S. M., Mitchell, B. D., Stern, M. P., Hazuda, H. P., & Patterson, J. K. (1990). Decreased prevalence of hypertension in Mexican-Americans. *Hypertension, 16*, 225-34.

Hawk, L. W. & Cook, E. W. (1997). Affective modulation of tactile startle. *Psychophysiology, 34*, 23-31.

Hunt, W. A., & Clarke, F. M. (1937). The startle pattern in children and identical twins. *Journal of Experimental Psychology, 21*, 359-362.

Izard, C. (1977). *Human emotions*. New York: Plenum Press.

Johnson, L. C. & Corah, N. L. (1963). Racial differences in skin resistance. *Science, 139*, 766-767.

Johnson, L. C. & Landon, M. M. (1965). Eccrine sweat gland activity and racial differences in resting skin conductance. *Psychophysiology, 1*, 322-329.

Juniper, K. & Dykman, R. A. (1967). Skin resistance, sweat gland counts, salivary flow and gastric secretion: Age, race, and sex differences, and intercorrelations. *Psychophysiology, 4*, 216-222.

Konorski, J. (1967). *Integrative activity of the brain: An interdisciplinary approach*. Chicago: University of Chicago Press.

Lang, P. J. (1993). The three system approach to emotion. In N. Birbaumer & A. Ohman (Eds), *The Organization of Emotion* (pp. 18-30). Toronto: Hogrefe-Huber.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1990). Emotion, attention, and the startle reflex. *Psychological Review, 97*, 377-395.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1998). Emotion, motivation, and anxiety: Brain mechanisms and psychophysiology. *Biological Psychiatry, 44*, 1248-1263.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2001). International affective picture system (IAPS). National Institutes of Mental Health (NIMH) Center for the Study of Emotion and Attention. University of Florida, Gainesville, FL.

Lang, P. J., Greenwald, M. K., Bradley, M. M., Hamm, A. O. (1993) Looking at pictures: Affective, facial, visceral, and behavioral reactions. *Psychophysiology, 30*, 261-273.

Leary, M. R. (1983). Social anxiousness: The construct and its measurement. *Journal of Personality Assessment, 47*, 66-75.

Leary, M. R., Koch, E. J., & Hechenbleikner, N. R. (2001). Emotional responses to interpersonal rejection. In M. R. Leary (Ed.), *Interpersonal Rejection* (pp.145-166). New York: Oxford University Press.

Lipp, O. V., Neumann, D. L., Pretorius, N. R., & McHugh, M. J. (2003). Attentional blink modulation during sustained and after discrete lead stimuli presented in three sensory modalities. *Psychophysiology, 40,* 285-290.

Malmo, R. B. (1965). Physiological gradients and behavior. *Psychological Bulletin*, *64*, 225-34.

Matsumoto, D. (1990). Cultural similarities and differences in display rules. *Motivation and Emotion, 14*, 195-214.

Matsumoto, D. (1993). Ethnic differences in affect intensity, emotion judgments, display rule attitudes, and self-reported emotional expression in an American sample. *Motivation and Emotion, 17*, 107-123.

Matsumoto, D., Kudoh, T., Scherer, K., & Wallbott, H. (1988). Emotion antecedents and reactions in the U.S. and Japan. *Journal of Cross-Cultural Psychology*, *19*, 267-286.

Neuberg, S. L., & Newsom, J. T. (1993). Personal need for structure: Individual differences in the desire for simpler structure. *Journal of Personality and Social Psychology, 65*, 113-131.

Pappas, P., Gergen, P. J., & Carroll, M. (1990). Hypertension prevalence and the status of awareness, treatment, and control in the Hispanic Health and Nutrition Examination Survey (HHANES), 1982-84. *American Journal of Public Health, 80*, 1431-1436.

Popova, N. K., Barykina, N. N., Plyusnina, T. A., Alekhina, T. A., Kolpakov, V. G. (2000). Expression of the startle reaction in rats genetically predisposed towards different types of defensive behavior. *Neuroscience and Behavioral Physiology, 30*, 321-325.

Scherer, K., Matsumoto, D., Wallbott, H., & Kudoh, T. (1988). Emotional experience in cultural context: A comparison between Europe, Japan, and the U.S.A. In K. Scherer (Ed.), *Facets of emotion: Recent research*. Hillsdale, NJ: Erlbaum.

Vasey, M. W., & Thayer, J. F. (1987). The continuing problem of false positives in repeated measures ANOVA in psychophysiology: A multivariate solution. *Psychophysiology*, *24*, 479-186.

Vrana, S. R. (1994). Startle reflex response during sensory modality specific disgust, anger, and neutral imagery. *Journal of Psychophysiology, 8*, 211-218.

Vrana, S. R., Spence, E. L., & Lang, P. J. (1988). The startle probe response: A new measure of emotion? *Journal of Abnormal Psychology, 97*, 487-491.

Willott, J. F., Tanner, L., O'Steen, J., Johnson, K. R., Bogue, M. A., & Gagnon, L. (2003). Acoustic startle and prepulse inhibition in 40 inbred strains of mice. *Behavioral Neuroscience, 117*, 716-727.

Winkleby, M. A., Fortmann, S. P., & Rockhill, B. (1993). Health-related risk factors in a sample of Hispanics and whites matched on sociodemographic characteristics. The Stanford Five-City Project. *American Journal of Epidemiology, 137*, 1365-1375.

BIOGRAPHICAL SKETCH

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