AUTONOMIC PATTERNS OF EMOTION ACROSS MULTIPLE CONTEXTS

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Dissertation submitted to the faculty of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of
Doctor of Philosophy
In
Psychology

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May 13th, 2015
Blacksburg, VA

Keywords: autonomic specificity, context, method, task influences, emotion

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ABSTRACT

Research on the autonomic specificity of emotion has spanned several decades. Even though considerable evidence exists for supporting autonomic specificity for discrete emotion states (Kreibig, 2010), there is still an active debate, and conflicting explanations, for these findings (Quigley & Barrett, 2014). There have been several studies employing multivariate pattern classification analytic techniques and calls for those types of studies are still prevalent (Kragel & LaBar, 2014). Although many studies have explored the autonomic specificity of emotions, few have explored what effects the induction methods, themselves, have had in inducing the autonomic change. Autonomic specificity of induction methods might be a meaningful, and confounding, phenomenon in this literature. Based on this unknown variable, the current experiment was designed to see if methods for emotion elicitation could be meaningfully captured by these same pattern classification techniques. This was accomplished using three separate emotion-elicitation methods to elicit five separate emotions. A sample of 64 college-aged students watched film clips, read imagery scripts, and recalled personal memories for five discrete emotions. Using discriminant analysis, the evidence from the current study lent less support for autonomic specificity of emotion than past experiments, and lends some support for providing future exploration into autonomic change that is related to methods for induction. Potential confounds and task fatigue effects are discussed.

DEDICATION

I dedicate this project to my wife, Jialeou. She has been wonderful through all of the adversity (both internally and externally generated) that have plagued my graduate education. Without her love and support this document likely would not exist.

ACKNOWLEDGEMENTS

I would like to thank my advisor, Dr. Bruce Friedman, for his theoretical and methodological guidance during my research development. His research passions and intellectual contributions have laid much of the foundation upon which this project was constructed. I would also like to acknowledge Chad Stephens and Israel Christie for their trailblazing work in this area. I would like to thank all of the undergraduate research assistants who assisted me through aspects of study design, execution, and data analysis. In particular, I would like to acknowledge John Leonard for his assistance with designing my tasks and Hyeri Choi for her countless hours of tedious data cleaning. Lastly, I would like to thank all of my committee members for molding my unwieldy and underdeveloped research proposal into a more meaningful and fruitful product.

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The structure, function, and discreteness of emotions have been debated for more than a century. These debates have provided a prolific body of research to address these topics; however, there is still a notable divide in agreement between competing views. Several different models currently exist for explaining how emotions are represented in the peripheral and central nervous systems. One of the more enduring conceptualizations is the discrete emotion theory (e.g., Ekman, 1992). This theory describes emotions as phenomena that can be best captured as discrete, separable, categories.

Many different methods have been employed to test these models via subjective report, behavioral measures, and biological expression. Considering the importance of somatovisceral concomitants in emotion expression for most emotion theories, research on autonomic variables holds unique implications for supporting particular perspectives. Research over the last few decades has generated findings that vary in support for discrete models of emotion. Studies designed to test the relationship between autonomic specificity in emotion states face many inherent methodological challenges (Quigley, Lindquist, & Barrett 2014). These methodological challenges in elicitation, paired with the variability in univariate and multivariate analyses, have likely led to many of the disparate findings in the literature.

The current study was designed to address the degree of autonomic specificity in emotion expression using a well-replicated pattern classification approach, while also employing the same analytic technique to assess for induction-method demand-based autonomic specificity. By using three different emotion induction tasks, and employing pattern classification techniques to measure multivariate autonomic change due to both emotion- and task-based demands, both methodological and statistical shortcomings were addressed. Three different emotion induction tasks: film viewing, standardized imagery, and autobiographical recall, were used to elicit emotion responses. The film clips, imagery scripts, and autobiographical recall tasks were chosen to target five emotions that have both demonstrated reliable autonomic differences in past specificity research.

The Structure of Affective Space

Charles Darwin, arguably the most appreciated researcher in the life sciences, speculated about the origin of emotions in his 1872 book, *The Expressions of Emotions in Man and Animals*. From this text, many theorists have interpreted emotions as having evolved to be fundamentally distinct from each other in measurable ways (Shariff & Tracy, 2011; Ekman, 1992). His original theorizing, paired with William James' (1884) position on emotion discreteness, have contributed to over a century's worth of literature fleshing out the empirically testable components of this idea (see Reisenzein, 2014; Friedman, 2010, for reviews). The 1970s and 80s saw a prolific and varied body of work spurred by Paul Ekman, Bob Levenson, Walter Friesen, Carol Izard and others which further solidified the fundaments of this view. Although research emerging from developmental and animal models resulted in divergences as to what constituted as the "basic" discrete emotions (e.g., Panksepp 2007, Izard, 2007), this approach has still effectively furthered the understanding of emotions as discrete, separable units.

Travelling along the same timeline, there have been alternate emotion theories that have conflicted with many of Darwin's and James' original propositions (e.g., Wundt, 1896; Watson & Tellgen, 1985, Russell, 1980). It has even been claimed that the discrete emotion theorists have altogether been misinterpreting Darwin's suppositions that emotion expressions are selective adaptations, but are just vestigial phenomena (Barrett, 2011). Emphasizing the duration of these contrasting views, this ongoing debate was even recently referred to as "The Hundred-Year Emotion War" (Lindquist, et al., 2013). Many theorists adhering to non-discrete theories of emotion tend to represent the structure of emotion space in a bidimensional model. The labels of these dimensions often vary, but commonly have been named valence and activation (Russell, 2003), approach and avoidance or withdrawal (Gray, 1972; Lang & Davis, 2006), and positive and negative activation (Watson & Tellegen, 1985), just to mention a few. Although there are often additional definable characteristics that inform emotions' placement on these scales such as how the emotions are categorically ascribed (Barrett, 2006), or whether the dimensional planes are nonlinear depending on stimulus novelty (Norris, Gollan, Berntson, & Cacioppo, 2010), the basic structures of dimensional emotion theories are mostly consistent.

The discrete emotions approach, although slightly variable according to supporting theorists, often contends that discrete emotions are unique in terms of distinct qualities, their hard-wired genetic origins, and functional relevance (Levenson, 2011; Izard, 2007). Others contend that there may be as many as twelve identifying components to their discriminability (Ekman & Cordero, 2011). The overarching conceptualization is that emotions are functional adaptations to situations that were regularly encountered in the environment, and that once enacted, the emotion will organize a host of biobehavioral systems for a coordinated response (Ekman, 1992). Much of the empirical work designed on this view has demonstrated what have been argued as unique signatures for independent emotions. These signatures may be facial expressions (e.g., Izard, 1994), autonomic expressions (e.g., Ekman, Levenson, & Friesen, 1983), and judgments, just to mention a few. While some of these propositions have ample support, others are more difficult to test, have produced inconsistent results, or have not been adequately assessed.

The last two decades have seen a surplus of reviews and meta-analyses which have conflicted with the discrete emotions theory at various levels. It has been asserted that there is insufficient evidence to support universal facial expressions (Nelson & Russell, 2013;

Fernandez-Dols, 2013), unique peripheral nervous system expression (Cacioppo et al., 2000), unique brain circuitry (Lindquist et al., 2012), and coherence between expressions and subjective experience (Reisenzein, Studtmann, & Horstmann, 2013; but see Friedman, Stephens & Thayer, 2014). However, meta-analyses supporting unique brain circuitry (Vytal & Hamann, 2010) and coherently organized discrete emotion expressions as packaged by cognition, physiology, behavior and other variables (Lench et al., 2011) provide additional supporting evidence for the discrete emotions theories.

Although there have been many recent attempts to both review (Barrett, 2012; Kreibig, 2010) and meta-analyze (Vytal & Hamann, 2010; Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012) pertinent research findings for distinct networks or patterns of biological responses for emotions, the field does not appear to be any closer to embracing a shared stance on the fundamental nature of emotions. Instead of fully embracing one approach, others have argued that these approaches are asking the wrong questions (Mason & Capitano, 2012) , are actually compatible and approaching the question from different levels of analysis (Panksepp, 2007), or that a potential merger is possible (Christie & Friedman, 2004). Since peripheral physiology is largely considered to underlie the “felt” component of emotional experience, research in autonomic nervous system function is of particular importance to this issue. Considerable research over several decades has addressed autonomic specificity by employing various methods, measurement techniques, and statistical approaches.

Research on autonomic specificity

William James’ presented one of the earliest conceptualizations of emotions as having “distinct bodily expressions” both within, and across, persons (1884). However, conflicting evidence was provided in Schacter & Singer’s (1962) classic research involving autonomic arousal and emotional suggestibility, which provided evidence supporting possible states of undifferentiated autonomic arousal leading to differing emotional states. Although there were clear theoretical and methodological flaws in this study (Plutchick & Ax, 1967) in addition to failed attempts to replicate these findings (Marshall & Zimbardo, 1979), the cognitive movement in psychology was largely founded upon this study's results and there was a subsequent dearth of research exploring autonomic differentiation in emotion states.

After a long delay, the last few decades have produced a rather substantial body of research for testing these competing theories. Some of the earlier and more notable studies were those performed by Ekman, Friesen and Levenson which employed methods of directed facial action or personal recall of past experiences to elicit discrete emotion states (Ekman, Friesen & Levenson, 1983; Levenson, 1988). The results from these series of studies largely demonstrated a significant degree of autonomic specificity for particular emotion states. These papers also indicated that many of the previous attempts that were unable to find autonomic patterns in ANS responses were largely because of methodological faults. Although these studies have been oft cited and viewed by many experts as definitive evidence for discrete biological patterning, there have been methodological concerns and failed replications that have drawn attention to alternate explanations.

Even though the aforementioned studies on autonomic specificity of emotion were influential, conceptual and empirical challenges continue to conflict with the idea of discrete emotions. Researchers supporting the alternative perspective of emotion structure argue that there is valence-specific autonomic patterning (Lang et al., 1990); negative emotion states tend to have larger increases in autonomic activation per unit of activation compared to positive emotions. Another notable point of dissention was raised by Lang and colleagues (1990) who drew attention to how fear behaviors can vary from freezing to vigilance or even flight. The variety of behaviors captured by an apparently singular emotion state would all require different physiological demands to accompany behavioral activation.

Meta-analyses of all research on psychophysiological differentiation of emotion responses conducted before the year 2000 demonstrated more support for valence-specific than for multiple discrete patterns of responses across many different emotions (Cacioppo et al., 1997; 2000). The meta-analysis, overall, found no univariate support for discrete autonomic states for discrete emotions, but found five of the twenty-two observed variables to be greater for negative emotions than positive ones. They also did not find the discrete emotion, disgust, to consistently differ from the control conditions on any autonomic measure (Cacioppo et al., 2000).

It should be noted that the aforementioned meta-analyses only included a single positive emotion (i.e., happiness), and only applied univariate analyses. A more extensive and recent review of the literature found a more convincing case for autonomic differentiation of discrete emotions, and included several positive emotions into the analyses (Kreibig, 2010). Regardless, reconceptualization of these findings in a different theoretical framework has still been argued to demonstrate little support for autonomic differentiation (Quigley & Barrett, 2014). For a more complete recounting of research exploring autonomic specificity of emotion (with general support for specificity in discrete emotions), see reviews by Friedman (2010) and Kreibig (2010).

Previous Statistical Approaches and the Specificity Question

Many studies that have assessed unique autonomic differentiation of emotions have only used univariate analyses to explore discreteness of autonomic responses. Cacioppo and colleague’s (2000) meta-analysis, which found little convincing support for autonomic differentiation of basic emotion states, only used univariate analyses for differentiating emotion states. This approach inherently contains challenges because of several different factors. Inducing emotions from different types of stimuli (e.g., visual vs. auditory vs. tactile) might uniquely affect a particular element of autonomic function via different effort demands of the tasks. Additionally, different foci of emotions (e.g., anger-in vs. anger-out) might elicit different demands on the system. Although the authors of the meta-analysis admittedly comment that multivariate patterns could still exist, they did not focus on addressing that aspect of autonomic differentiation in their analyses.

Since the release of the first meta-analysis by Cacioppo and colleagues (1997), several studies have demonstrated some level of autonomic support for discrete emotion states using multivariate data analytic techniques. Nyklicek and colleagues (1997) used music excerpts to elicit four emotion responses, and found distinct multivariate patterns in autonomic activity. Follow-up studies employing film clips or other music excerpts also demonstrated continued support for multivariate patterns in emotion responses (e.g., Christie & Friedman, 2004; Stephens, Christie, & Friedman, 2010). These studies employed pattern classification analysis, which is better-equipped for assessing gross patterns of physiological responsivity across an entire system. These analyses also add a complexity to analysis that might have greater success in circumventing some of the aforementioned problems that arise from methodological differences in elicitation, which univariate analyses are more sensitive to.

Emotion Induction Selection

Testing and comparing emotion induction techniques is a challenging problem for a host of reasons. Emotions are often short-lived phenomena that are variable in their duration, intensity, and expression both between and within persons. They also can vary in terms of their object (e.g., happy with self, happy for others). Many different variables can affect how emotions are induced and how long they endure. The manipulations that are most used in research are film clips, personalized recall, real-life manipulations, picture viewing, and standardized imagery (Kreibig, 2010). These manipulations have shown variability in their effectiveness, and likely have variable effects on emotion expression. There has been evidence that emotions can differ according to the ecological validity and the object that the emotion is directed at (Stemmler, Heldmann, Pauls, & Scherer, 2001). For example, different subforms of anger, as indicated by motivational direction, can strongly influence some autonomic responses (e.g., heart rate and alpha-adrenergic responses). Different methods for inducing anxiety (e.g., threat of shock vs. speech preparation) might show similar discrepancies in autonomic expression. Few studies in autonomic specificity attend to this distinction or note that the differences in response may be a product of those discrepancies.

Another persistent and notable issue in emotion research is the duration that the emotion lasts in the laboratory. This has important implications for data analysis, since several autonomic variables require lengthy durations to provide enough usable data points to avoid statistical violations. The most frequently used durations for emotion studies are responses averaged over thirty- to sixty-second intervals. However, averaging over ½ to ten-second intervals, and from 120- to 300-second intervals are also common (Kreibig, 2010). Some of these challenges are even more relevant because of the phasic nature of some emotions. For example, sadness tends to last for much longer durations than surprise, so comparisons between them are tricky.

Eliciting and measuring the autonomic characteristics is by no means free from these challenges. Autonomic assessment studies, in general, add a host of new challenges and demands to the study of emotion. A near century of research and methodological improvements have still not prevented basic mistakes from being repeated, and even the most simple factors such as duration of baseline periods are not viewed with consensus. These variables will invariably lead to measurement inconsistency and lack of replication across studies and labs. It is not surprising that such inconsistency has been observed across emotions, especially when applying univariate analyses (e.g., Cacioppo et al. 1997; 2001).

Despite the widely-known aforementioned issues that plague the measurement and elicitation of emotion, few studies exploring the autonomic specificity of emotions adjust for the stimulus demand characteristics of the induction methods employed in emotion studies. The constant, and unyielding, debate between those who support the autonomic differentiation of emotions (Kagel & LaBar, 2014; Lench, Flores, & Bench, 2011), and those who oppose it (Quigley & Barrett, 2014; Lindquist et al., 2013) requires additional, and more thoughtful, studies to further isolate the situation-based demands on autonomic activity during emotion expression. Despite some noted evidence that context is an important factor in how a particular emotion will manifest, physiologically, few steps have been taken to assess context as an important contributor to physiological specificity in emotion (Stemmler, 1989; Stemmler et al., 2001).

Overview of the Experiment

The current experiment is an extension of a long line of studies designed to explore the degree of autonomic differentiation in emotions. Nyklicek and colleagues (1997) employed multivariate pattern classification analyses to reliably predict differences in a small number of emotion states based on music clips that targeted particular emotion states. Christie and Friedman (2004) replicated these results with a more discrete set of emotions, diverse set of physiological variables, and via a different emotion induction (i.e., film clips). Stephens, Christie, and Friedman (2010) replicated the findings of both of these studies, while additionally using a cluster analytic approach to test for pronounced individual response stereotypy (IRS) within emotion expressions. The findings did not indicate notable IRS, and therefore lent more support for the discrete emotions approach. Stephens et al.'s (2010) study has since been replicated (Kragel & LaBar, 2013) and a recent call for additional multivariate pattern classification studies in the autonomic specificity of emotion has recently been made (Kragel & LaBar, 2014).

These studies, however, have only used these classification techniques to differentiate discrete emotions from each other. None has turned around the focus to assess whether the induction methods used to elicit emotions can reliably be classified by the physiology variables. This approach can shed insight into whether the induction methods are reliably eliciting predictable change in physiology. Additionally, these aforementioned studies have not collapsed multiple inductions into the same analyses to test whether discrete emotions are still reliably predicted when elicited by multiple inductions.

Considerable evidence has already been accumulated to differentiate emotions by use of music and film clips in pattern classification analyses. Autobiographical memories and imagery scripts have received less attention, even though they have historically been some of the more commonly used stimuli for emotion induction (see Kreibig, 2010). The multivariate studies containing these induction methods used small sets of emotions (2-3) and a limited range of physiology variables (e.g., Sinha & Parsons, 1996; Rainville et al., 2006).

The current study was designed to address autonomic specificity in emotion responses, and explore possible task-based specificity in autonomic responses. The current study employed film clips, imagery scripts, and autobiographical personal recall to elicit five separate emotions (fear, sadness, amusement, contentment, and a neutral condition) while an array of autonomic indices were collected. Based on autonomic measures used in several of the aforementioned studies, the current study measured cardiac, vascular, and dermal activity, as well as arterial oxygen saturation.

Hypotheses

It was anticipated that autonomic specificity of emotion would be evident through pattern classification analysis of emotions when each method of induction was separately classifying emotion categories. No a priori hypotheses were made in regard to anticipated classification rates when emotions were collapsed across induction methods for classification. It was also hypothesized that when emotions were combined within each induction method, that classification rates would still yield greater than chance levels of classification based on induction method alone.

Method

Subjects

Sixty-four college students (28 female; mean age = 19.31, SD=1.42) were recruited through Virginia Polytechnic Institute and State University psychology department's SONA online research system to serve as subjects in the study. Eligibility requirements were posted on the advertisement page of the SONA site. The requirements were as follows: right-handed, aged 18-26, non-smokers, with no history of neurological and cardiovascular disease. The study took place as a one-part laboratory session. As offered by various psychology classes at the University, the subjects were provided with extra credit for completing the session. The subjects were also instructed to abstain from alcohol for twenty-four hours, caffeine for six hours, food for two hours, and vigorous exercise for two hours before their laboratory visit. Institutional review board (IRB) approval was attained from Virginia Tech in order to conduct this study; the approval code for the protocol was #14-253. Two subjects were excluded from all analyses involving physiology variables due to equipment malfunctions. Other missing data were present for several of the physiology variables due to four subjects possessing irregular cardiac rhythms, persistent equipment issues with the blood pressure monitor dropping signals, and excessively sweaty hands for the skin conductance measure.

Materials

Film Clips

The study contained standardized film clips that have previously been shown to elicit discrete emotions (Gross & Levenson, 1995). The clips varied in length from 60 to 209 seconds. Descriptions of the film clips are as follows:

Amusement (2:01)
Bill Cosby Stand-Up (1983).

Contentment (1:21)
Waves crashing on shore (noncommercial).

Fear (1:22)
From The Shining (1980).
Chase scene in dark basement.

Sadness (2:51)
From The Champ (1979).
Boy cries at father's death.

Neutral (1:30)
Lines of random color, length, and orientation (noncommercial).

"Washout" Clip (1:00)
Repeating colored vertical "screen test" bars (noncommercial).

Imagery Scripts

Five imagery scripts selected from previous research were employed in the study (Appendices A-E; Fiorito & Simons, 1994). The imagery scripts were chosen for each of the emotion conditions (i.e., fear, contentment, sadness, amusement, and neutral). The contentment script was selected from a script designed to elicit a "mild positive" emotion.

Personal Recall Scripts

The scripts contained personal recall of autobiographical emotional experiences to elicit emotional states. The subjects were required to recall strong emotional memories in order to initiate the responses. The directions were based on previous studies that have employed this method (Rainville et al., 2006; Prkachin et al., 1999, 2001). Amusement, contentment, sadness, and fear were selected. The subjects were also instructed to select a standard morning to recall for a neutral task. The subjects were previously instructed to come to the lab with four vivid autobiographical emotional episodes; one for each emotion. The subjects were instructed to close his/her eyes and try to relive the target memory as vividly as possible.

Questionnaires

The Toronto Alexithymia Scale (TAS; Bagby, Parker, & Taylor, 1994): Tests ability to identify/communicate one's own emotions (Appendix F). In the current sample the Cronbach's alpha was .74. The mean score was 43.7 (SD = 7.2) and was normally distributed, which was consistent with past research.

Health History Questionnaire (HHQ): Gathers information on health problems that could potentially conflict with the results of study (Appendix G).

Mind-Body Laboratory Recent History Questionnaire (MBLRHQ): Gathers information on recency of caffeine and alcohol consumption, recency of exercise, and recency of eating (Appendix H).

Affect Self-Report Questionnaire(s) (ASR; adopted from Rottenberg, Ray, & Gross, 2007): Measures subjective affective response to tasks in the study. (Appendices I-K).

Physiological Recording Equipment

An array of autonomic measures were collected. Cardiovascular activity, blood-oxygen level, and sweat gland production were assessed via electrocardiography (ECG), blood pressure (BP), pulse plethysmography (PPG) and skin conductance (SC). ECG and SC were acquired using CONMED disposable, pre-gelled stress-testing spot electrodes. The ECG signal was acquired by two thoracic electrodes in a modified lead II configuration. SC was acquired by two electrodes placed on the thenar and hypothenar areas on the palm of the left hand. The ECG signal was transmitted to an ECG 100C amplifier (BIOPAC Systems Inc, Goleta, CA), the SC to a DA100C amplifier (BIOPAC Systems Inc, Goleta, CA), and PPG to a PPG100C amplifier (BIOPAC Systems Inc, Goleta, CA) .

The ECG, PPG and SC signals were interfaced through an MP150 data acquisition system (BIOPAC Systems Inc, Goleta, CA). Blood pressure was recorded using a MedWave Fusion semi-continuous non-invasive BP monitoring system (MedWave Inc., Danvers, MA). The analog data were then sent to a DA100C amplifier (BIOPAC Systems Inc, Goleta CA) and ultimately transmitted to a Dell desktop computer in the adjoining room. All incoming electrophysiological signals were received by the software program, Biopac Acqknowledge v4.3 (BIOPAC Systems, Inc, Goleta, CA). All raw signals were digitized at 1,000 Hz. Artifact detection was performed by visual inspection with software assistance using Biopac Acqnowledge 4.3 and Kubios HRV Analysis Software.

Data Reduction

Cardiovascular measures in this study were derived from ECG and BP. Heart rate (HR) and its inverse, interbeat intervals (IBIs), were derived from the ECG signal. Heart rate variability (HRV) measures were calculated from the IBIs. HRV is often assessed in both temporal and frequency domains, but recent evidence suggests that the most commonly used temporal metric, the root mean square of successive differences (rMSSD; Penttila et al., 2001), is likely capturing more than just vagally-mediated variability in the beat-to-beat rate changes (McGinley, Lee & Friedman, 2014). Spectral frequency bands were calculated via Fast Fourier Transformation (FFT). The high-frequency (HF-HRV) component of the waveform (0.15-0.40 Hz), a reliable indicator of parasympathetic influence on the heart, was of specific interest (Task Force, 1996). HF-HRV has been offered as a reliable indicator of vagal influence on the cardiac cycle for short duration recordings, such as the ones contained within the current study (Task Force, 1996). From the PPG signal, oxygen saturation was extracted as a continuous variable through the duration of the study. Pulse oximetry is a method in which a light-emitting diode passes two wavelengths of light through the finger to a photodetector on the other side. The resultant measure is a change of absorbance of the wavelengths due to pulsing arterial blood. The output is provided as a percent of oxygen saturation (PulseOx).

From the BP signal, systolic (SBP), diastolic (DBP), and mean arterial pressure (MAP) were calculated. SBP was taken as the peak value of the waveform for each cardiac cycle, while DBP was measured as the nadir. MAP was calculated using SBP and DBP. The formula used was MAP = 2/3 DBP + 1/3 SBP (Nyklicek, Thayer, & Van Doornen, 1997). The BP reading from the Fusion unit produced a reading every 12-15 beats of the heart. This signal was acquired via a sensor placed over the radial artery on the left wrist. These readings have been validated against readings from radial artery catheters (Belani, Buckley, & Poliac, 1999).

Since the length of emotion tasks were quite variable, only the last minute of each emotion task was used in all analyses. This follows the statistical approach employed by Stephens and colleagues (2010). Mean values over that minute were computed for each physiological variable and then change scores were created by subtracting baseline values from task values. Several physiological variables are known to have skewed distributions, so preliminary analyses indicated the HF-HRV and PulseOx were non-normally distributed. Therefore, each was log-transformed to create a normal distribution.

Procedure

Subjects who enrolled through SONA to participate in the study were instructed to come to the lab with four distinct and vivid memories corresponding to times that they felt: 1) fear, 2) contentment, 3) sadness, and 4) humor. All experimental sessions were held in the Mind-Body Lab. The subjects were required to read and sign an informed consent form that was approved by Virginia Tech's Institutional Review Board. After informed consent was acquired, the subjects had electrodes, transducers, and the blood pressure sensor attached to them by a gender-matched researcher or research assistant.

The subjects were instructed to complete several of the questionnaires (i.e., HHQ, TAS, and MBLHHQ), during which a period of physiological recording took place to ensure that the equipment was functioning properly. After completing the questionnaires, the subjects were then further instructed as to the nature of the tasks. They were told that "each of the tasks is designed to elicit an emotion. Please pay close attention to whatever emotions arise, and try your best not to regulate them." Bose QuietComfort 15 Acoustic Noise Cancelling Headphones were then placed over the subject's ears, the researcher left the room, and the tasks began. A one-minute vanilla baseline of a minimally-engaging light-show screensaver was presented on the computer monitor in front of the subject. Following the baseline, a prompt appeared on the screen instructing the subject to "sit quietly and try to relive the (*emotion*) memory that you have chosen as vividly as possible. Try to maximize the emotion until the end of the task." After ninety seconds passed, a tone was presented through the headphones signifying the end of the task. Next on the monitor, the self-report affect questionnaire for the preceding task was presented for one-minute (Appendix J). Following the completion of the questionnaire, there was a prompt on the monitor instructing the subjects to "sit quietly with your eyes closed and clear your minds of all thoughts, feelings, and memories." This series of instructions and task presentations was similar to the ones employed in Gross & Levenson (1995), Christie & Friedman (2004), in Stephens et al. (2010). The same sequence and instructions were presented for each emotion recall task.

After this "washout" period, another one-minute light-show vanilla baseline task began. The same sequence of tasks that applied to the personal recall phase of the experimental session was applied to the film clips; meaning, that there were one minute baselines, followed by a film clip, followed by a self-report Questionnaire (Appendix I) and a one minute washout period.

After the washout period following the film clip, a third one-minute light-show vanilla baseline task began followed by an imagery script. The imagery scripts for each emotion can be found in Appendices A-E. Each imagery script was followed by the ASR Questionnaire (Appendix J) and a one-minute washout period.

The personal recall, film clip, and imagery tasks were counterbalanced with the constraint that positively and negatively valenced tasks alternated. Also, the order in which the personal recall, film clips, and imagery scripts were delivered was counterbalanced so that none of the task types was presented back-to-back (e.g., there were never two films presented in a row). The subjects were randomly assigned to one of the orders.

Data Analytic Plan

Pattern Classification of Emotion Categories

Pattern classification procedures were conducted by using discriminant function analysis (DFA) to classify cases based on multiple independent variables (IVs) added into the model at one time. The approach mostly functioned as a manipulation check to assess whether subjective assessment of the emotion conditions reliably predicted the actual emotion conditions.
Hit rates were provided by the classification of the DFA.

The same pattern classification approach was employed substituting physiology variables for the self-report variables. This approach mirrored the ones undertaken in other multivariate studies of autonomic specificity (Nyklicek, Thayer, & Van Doornen, 1997; Christie & Friedman, 2004; Rainville, Bechara, Naqvi, & Damasio, 2006; Stephens, Christie & Friedman, 2010). In those studies, and in this one, physiology variables were defined as IVs and the emotions were defined as grouping variables (see Figure 1).

Some of the assumptions of DFA are that there must be multiple groups (or categories) that are natural, clearly differentiated from other groups, and defined before data collection. This follows the logic in argument for discrete emotions theory. DFA also holds the assumption that each case only belongs to one group. Lastly, it holds that the sizes of the sizes of the grouping variable should be at least 3-5 the number of the IVs (Huberty, 1994). To test whether classification accuracy was significantly greater than chance, Press's Q test was used (Ho, 2013).

Pattern Classification for Comparison of Induction Techniques

Using hit rates via pattern classification analysis allows for comparison of induction techniques. All emotions were collapsed and the induction techniques (i.e., film clips, imagery scripts, and personal recall) were defined as the grouping variable in the subsequent DFAs. The physiology variables were defined as IVs and hit rates were derived from the pattern classification to assess whether the physiology could predict induction method. Using ANS variables in pattern classification informs what percentage of observations were correctly classified into the predicted emotion conditions during each type of emotion manipulation/condition (see figure 2).

Univariate Analyses of Autonomic Change

Although this was primarily designed as a multivariate study, paired t-tests were run to collect information on univariate change elicited by each task.

RESULTS

Pattern Classification of Emotion Categories with Self-Report Variables

Through DFA, cases were correctly classified into the actual emotion for the self-report variables at high hit rates. While collapsing all induction techniques together in the analyses, the correct hit rates ranged from 68.6% for neutral to 92.7% for sadness (Table 1). The hit rates for each emotion were significantly greater than chance (all p-values were <.005; Table 2). When the induction methods were run in separate analyses with the self-report variables, film's hit rates ranged from 76.6% to 93.8%, imagery's from 68.8% to 93.8% and recall's from 70.3% to 95.3% (see Tables 3-5). All of these hit rates for the predicted emotion conditions were at significantly greater than chance levels (at p-values <.005; see Table 6). The means and standard deviations for the self-report scores to each task can be found in Tables 7-10.

Univariate Analyses of Autonomic Changes

Paired t-tests conducted with the mean of each physiology variable at baseline and during the emotion task is presented in Tables 11-16. These univariate analyses mostly yielded insignificant changes, with some notable exceptions. SCL yielded the most significant changes. These SCL changes were seen with the fear film ($t\ (1,60) = 2.98$, $p = .004$), contentment film ($t\ (1, 59) = -2.15$, $p = .036$), fear imagery ($t\ (1, 59) = -3.71$, $p < .001$), contentment imagery (t

(1,60) = 2.86, p = .006), sadness imagery (t (1,60) = -3.31, p = .002), neutral imagery (t (1,69) = -2.15, p = .036) and neutral recall (t (1,60) = -3.85, p < .001). SBP only yielded significant changes in contentment recall (t (1,47) = 2.35, p = .023) and sadness recall (t (1,49) = 2.20, p = .033). DBP yielded similar significant directional changes with these two tasks. PulseOx only displayed a change in the amusement film (t (1,60) = 2.35, p = .022). IBI only registered a significant change with the fear film (t (1,56) = -2.34, p = .023). HF-HRV only significantly changed for the contentment film (t (1,56) = -2.01, p = .049).

Pattern Classification of Emotion Categories with Autonomic Variables

Through DFA, cases were correctly classified into the actual emotion for the physiology variables with relatively low hit rates. While collapsing all induction techniques together in the analyses, the correct hit rates ranged from 16.8% for sadness to 29.8% for fear (Table 17). The overall hit rate was still significant (at $p <.025$), but most of that was driven by the modest hit rates of fear and contentment (see Table 18). When the induction methods were run in separate analyses with the physiology variables, the hit rates were still mostly low. Film's hit rates ranged from 13.3% for sadness to 47.8% for fear, imagery's from 10.6% for sadness to 47.6% for contentment and recall's from 13.3% for fear to 35.6% for contentment (see Tables 19-21). Table 22 shows that the overall significance tests still yielded greater than chance rates for film and imagery (at $p < .005$) and recall (at $p < .05$). However, these statistics are once again carried by the effects of one or two emotions in each induction.

Pattern Classification of Induction Methods with Autonomic Variables

The next set of classification analyses collapsed all emotions into each induction technique. The physiology variables were used as IVs and predicted hit rates ranging from 37.8% for the recall tasks to 44.1% for the film tasks (see Table 23). Table 24 shows that the overall classification rate, as well as the film and imagery classification rates, were all significant (at $p < .005$). The recall classification, however, was not significant ($p > .05$).

When the emotions were run in separate analyses, fear showed hit rates that ranged from 42.2% for recall to 65.2% for film; contentment ranged from 28.9% for film to 59.5% for imagery; sadness ranged from 33.3% for film to 46.8% for imagery; amusement from 38.1% for recall to 53.3% for film; and neutral from 39.0% for film to 42.9% for imagery (see Tables 25-29). Table 30 shows that the overall classification rates within each separate emotion analysis were significant for 3 of the 5 emotions (at $p<.01$; i.e., fear, contentment, and amusement).

DISCUSSION

The findings from the current study do not support autonomic differentiation of emotions as clearly as past studies employing similar manipulations. Although the hit rates from the pattern classification analyses of the self-report variables indicated as high of, or even higher, percentages than past studies, there were clear coherence issues between self-report scores and autonomic patterns. Past studies classifying five or more different emotions via multiple autonomic measures typically yielded at least 37.4% classification accuracy (see Kragel & LaBar, 2014 for a review). The best rate of classification accuracy in the current study was with films at only 29.7%.

The low classification accuracy is curious for several reasons. The sample of the current study was similar to most others in this line of research (i.e., Stephens, Nyklicek et al., 1997; Christie & Friedman, 2004; Rainville et al., 2006; Stephens, Christie, & Friedman, 2010; Kragel & LaBar, 2013). All of these studies used a healthy sample, with all using primarily college-aged students. The current study, however, included more subjects than the aforementioned studies (i.e., 64 subjects), ostensibly lending more power than the previous studies which varied from

20-50 subjects. Methodologically, this study was also similar to many of the aforementioned designs. There was an array of autonomic measures used, and multiple emotions induced. Most of these studies also used mean values extracted from the final minute of the tasks.

There were several notable differences, however. The current study used a more diverse set of autonomic measures than some studies (e.g., Nyklicek et al., 1997; Rainville et al., 2006), but still a narrower set than others (e.g., Stephens, Christie, & Friedman, 2010). Although there was the added benefit of having an assessment of vascular activity, there was a notable lack of respiratory and sympathetically-mediated cardiac indices which were informative measures in past studies. Indeed, various respiratory parameters were some of the more meaningful indicators (e.g., Nyklicek et al., 1997; Rainville et al., 2006; Kragel & LaBar, 2013). On a univariate level the current study was lacking because of the few significant findings. The SCL and IBI changes that were significant (especially for the fear and contentment film clips), however, were in the same direction as the ones observed in past studies in this lab (e.g., Christie & Friedman, 2004). The general lack of significant directional changes in autonomic variables made comparisons challenging since most studies used film and/or music clips, and the one study that used autobiographical recall (i.e., Rainville et al., 2006), only shared ECG-derived variables. Lastly, the current study was the only one in this series of similar investigations that used three separate induction methods.

Although the use of three induction methods was likely taxing, it has been shown to be important. Concordance between cognitive, behavioral, and physiological variables has been important for lending support for the discrete emotions perspective. However, variance due to variability in methods has long been known to affect the comparability of results across studies (Campbell & Fiske, 1959). In this seminal paper, it was recommended that for true discriminant validity, multiple methods must be used. The comparison of findings across studies depends on many selection factors that multivariate designs can help reduce, but certainly not eliminate (Nesselroade & Jones, 1991).

The classification findings based on the methods of induction were overall better than chance levels. The 41.7% classification hit rate was better than chance levels of 33.3%, however, this is still much lower than the rates in studies which have focused on classifying just three emotions. These studies have correctly classified 66% to 69% of cases correctly (Sinha & Parsons, 1996; Kreibig et al., 2007). This indicates that the task demands of the induction technique are likely meaningful in dictating some reliable autonomic change, but not as much as the emotion, itself.

There were some emotions, however, whose autonomic activity did appear to be somewhat reliably predicted by the method of induction. Specifically, fear conditions had a 51.9% chance of being correctly classified by method of induction. This fits with past research which has found that inductions that seemingly replicate real-life fear simulations cause different response patterns than imagery-based inductions (Stemmler, Heldmann, Pauls, & Scherer, 2001). Different response systems found for fear also supports researchers who have emphasized different modes of defense system activation (Lang & Bradley, 2010). Fear has the most evolutionary potency among emotions and, therefore, it is not surprising that this emotion yielded the most identifiable responses.

When looking at the univariate autonomic trends for emotion inductions, there appears be consistent directional changes in some autonomic measures for imagery and recall tasks. Notably, SCL significantly (or at least trended in the direction of) decreased for all emotions. This is a curious finding, especially considering the general trend towards increased SCL for emotions like amusement and fear in other inductions and studies. Emotions induced by scripted imagery, and to some degree autobiographical recall, might be less ecologically valid than films (Rottenberg, Ray, & Gross, 2007).

Past literature has long assumed a rather low coherence rate between physiology and self-report (Lang, 1968; Reisenzein, Studtmann, & Horstmann, 2013). Even though recent evidence has shown slightly higher rates of coherence (Stephens, Friedman, & Thayer, 2014), there have been no published studies which have explored time-dependent coherence between self-report affect and autonomic expression for possible effects of task fatigue. The current study employed 15 different emotion inductions along with 15 baseline and 15 washout clips. The total duration of the study took approximately 1.5 hours. Based on simple arousal curves demonstrating attentional capacity (Eysenck, 1982), subjects were likely experiencing high levels of resource fatigue. Although no data were collected to assess this effect, much anecodotal evidence supports this supposition. It is likely, then, that even though the subjects still reliably indicated the appropriate subjective emotional response, that their physiological response was muted due to fatigue. These likely fatigue-based task effects probably dampened the number of correct hit rates in the discriminative analyses of both the emotion- and the induction-focused analyses.

Correct classification of hit rates was successful for the film and imagery tasks, but not for the recall tasks. The significant differences in classification rates for the induction methods used makes sense for a variety of reasons. The inductions selected to elicit emotions in the current study were meaningfully varied across a variety of stimulus characteristics. The significance in differentiating induction methods across emotions is supported when these stimulus characteristics as defined by Rottenberg and colleagues (2007) are further explored. For example, film clips are especially sensitive to the characteristic of emotional intensity.

Standardized imagery tends to be weaker on this characteristic (especially when viewed across persons), while autobiographical recall tends to have great variability on this dimension across persons, but average intensity is typically less than film. The stimuli all hold relative complexity in that they need to be maintained and there is likely multi-modal involvement of the senses. Compared to a bitter taste (to elicit disgust) or the image of gun pointed at the viewer (to elicit fear), all three of manipulations need active and continuous involvement of the subject which is relatively complex. Standardization, which refers to the controlled and consistent presentation of a stimulus across subjects, is very high for the film clips and imagery because each subject clearly encounters the same stimulus. Autobiographical recall on the other hand, is dependent on individual experience and is therefore low on standardization.

Each of the induction methods in the current study were primarily selected for the temporal considerations. Even though film clips are variable in their temporal element, they all can at least be selected to meet a desired minimum length. Imagery and recall can have predefined lengths and therefore are very high on consistency, although they still might be variable as to the time in which each individual subject experiences the emotion most intensely during this window.

Although film clips are typically the most robust elicitors of emotion, imagery-induced emotion (either by standardized imagery or by memory) has long been used as an emotion elicitor (Lang, 1968). Imagining an action or emotion has been shown to activate similar neural circuitry as the execution of the action or emotion, itself. There is even convincing evidence that imaging actions can lead to similar somatic activity as when the action is performed (see Lang, 1979 for a review). However, the ability of the imager to generate these images is a strong modulating variable.

Another important consideration is that this study, and ones in its likeness, have been designed from a nomothetic framework. Nomothetic approaches emphasize group-aggregated data, and generally are used to extrapolate to principles applied across persons. Idiographic approaches, on the other hand, can be of importance for isolating theoretical issues or relationships that are not captured from nomothetic-based analyses. For the current topic an idiographic might be just as meaningful/fruitful. Since research subjects might vastly differ in not only their biologically hardwired responses in emotion conditions, but also in their reactions to various stimuli, their self-report tendencies, baseline physiological states, and other variables (Nesselroade & Ford, 1987). It is likely that coherence would be higher in idiographic designs. Idiosyncratic responses between persons likely would have diluted the success of pattern classifications. Although idiographic approaches have been employed to assess autonomic patterns over time (e.g., Friedman & Santucci, 2003), they have not been used in the autonomic emotion context. Using a dynamical systems interpretation of emotion, self-report of affect has been assessed in this framework via P-technique factor analysis (Faith & Thayer, 2001). This approach could usefully be adopted to study emotion with autonomic instead of self-report variables. The idiographic approach might also be used to effectively separate those who vary in their competency to perform various tasks (e.g., identify with the characters in films, generate clear visual imagery, recall distinct memories, etc.). It has been advocated that the ideal approach for studying individual differences is through complementary nomothetic and idiographic techniques (Lamiell, 1981).

Limitations

There are several elements of this study which likely limited the robustness of tested effects. First, as already mentioned, fatigue effects likely caused notably lower hit rates as recent studies of a similar vein produced substantially higher classification hit rates (e.g., Rainville et al., 2006; Stephens, Christie, & Friedman, 2010; Kagel & LaBar, 2013). Second, although statistically useful to take only the last minute of each emotion task, it is possible that the intensity of the emotion subsided in some of the tasks and therefore was not meaningfully captured by physiology during that final minute. The longer tasks of the amusement and sadness film clips, along with 90 second imagery scripts and personal recall scenarios are notable here. The film clips have notably been acknowledged as having some of the poorest temporal resolution of emotion-eliciting methods (Rottenberg, Ray, & Gross, 2007). Since emotions can often be transitory, and since fatigue effects were likely experienced across participants, the tasks of longer durations might have had attenuated physiological reactivity during the last minute of recording. Third, there was no prior visualization training issued to aid in subjects' abilities to engage in imagery or personal recall scenarios. Although many studies have employed these two methods for emotion elicitation purposes (see Kreibig, 2010), the success of these manipulations has been mixed (Lang, Levin, Miller, & Kozak, 1983). Past research has shown these tasks to be more effective elicitors with prior training (Miller at el., 1987). Also, it is possible that the late adolescents/young adults were not the ideal population to partake in these tasks requiring prefrontal neural circuitry which is still developing for them. Fourth, the lack of additional physiological measures, such as impedance cardiography and respiration, might have limited the discriminant analysis's ability to meaningfully capture the change associated with each emotion. For example, respiration rate might have been an effective measure to aid in capturing amusement (Herring, Burleson, Roberts, & Devine, 2011). Additionally, respiratory variables were included in several of the previous experiments of multivariate autonomic differentiation (e.g., Nyklicek, Thayer, & Van Doornen, 1997; Rainville, Bechara, Naqvi, & Damasio, 2006).

Fifth, there was no collection of baseline affect or mood data, so the influences that this may have had on the tasks could not be accounted for. Sixth, although it was deemed useful to counterbalance positive and negative emotion states, it might have been an unnatural transition for some subjects which could have led to carryover effects of preceding emotion states. Seventh, subjects attended the lab at various points over a seven-hour window, and therefore the effects of circadian influences on physiological functions were variable. Lastly, the methods by which the imagery and autobiographical recall were issued were very similar on a host of characteristics. Since the subjects read the instructions for both, and followed by closing their eyes to generate the visual images and emotions associated with the tasks, the task demands might have been too similar to meaningfully extract task-related differences.

Another point that should be noted is that the type of emotional states sought to be elicited are rare in natural, everyday, life. There are few situations across persons in daily life in which intense, pure, emotional states are elicited. It is much more common that elicited emotion states are of low intensity and mixed valence. These less intense, and more mixed, emotional states tend to differ in their physiological expression (Kreibig, Samson, & Gross, 2013). It is also rare that persons will rapidly switch from one discrete emotion state to another as was required in this study. Additionally, long-duration emotion states are likely to vary and are subjective to active and automatic regulatory processes which could vastly alter their behavioral and physiological expression (Quigley & Barrett, 2014). Overall, these lab-induced emotions will have an artificial quality when compared to more organically elicited emotion states (Wilhelm & Grossman, 2010).

Future Directions

A logical extension of this research is to actively avoid counterbalancing tasks in order to measure how fatigue affects coherence between subjective assessment of emotion state and corresponding physiology. Measuring coherence between physiology and self-report at different time intervals might yield informative results for ideal durations of studies on emotion. Although this study was effective in demonstrating that induction techniques reliably can be tied to autonomic activity, this line of work should be taken a step farther. An effective pursuit in research exploring the autonomic specificity of emotion would be to create designs that better able researchers to statistically parse out variance explained by method of induction effects, leaving more focus on the emotion-dependent changes in physiology. Considering the potential fatigue-based confounds, focusing on differentiating just two emotions via multiple induction methods might be a more useful pursuit that would likely recruit less demand on the subjects.

CONCLUSION

Pattern classification of discrete emotions is still a meaningful pursuit with much still left to investigate. The current investigation yielded low, but significant, rates of pattern classification for discrete emotions as a whole. Pattern classification results related to induction method were also meaningful for substantiating a future area to explore in relation to stimulus-demand characteristics for inducing autonomic change. Future studies in this area should be cognizant of the stimulus-specific effects in recruiting autonomic responses.

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Figure 1
Pattern Classification Analysis for Emotions

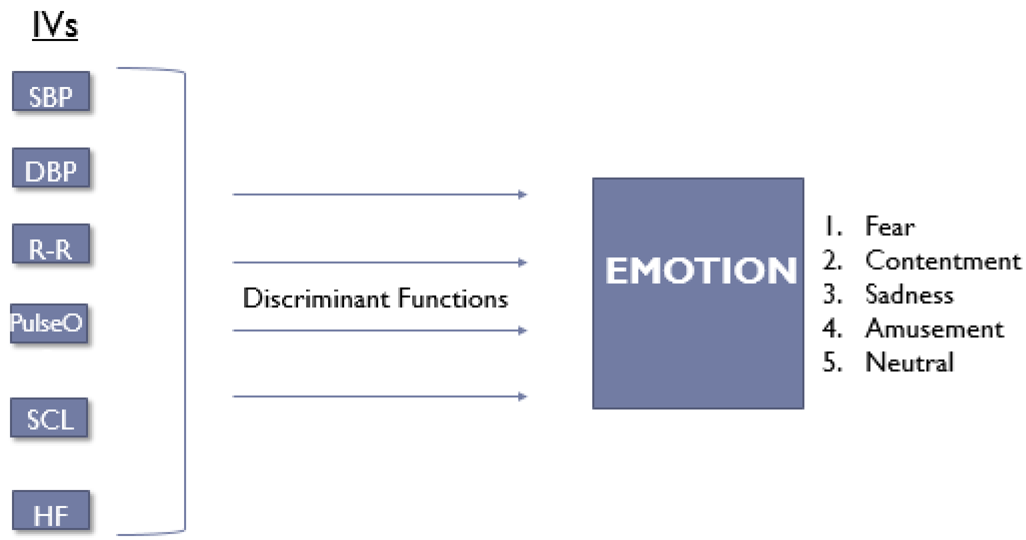

Figure 2
Pattern Classification Analysis for Induction Methods

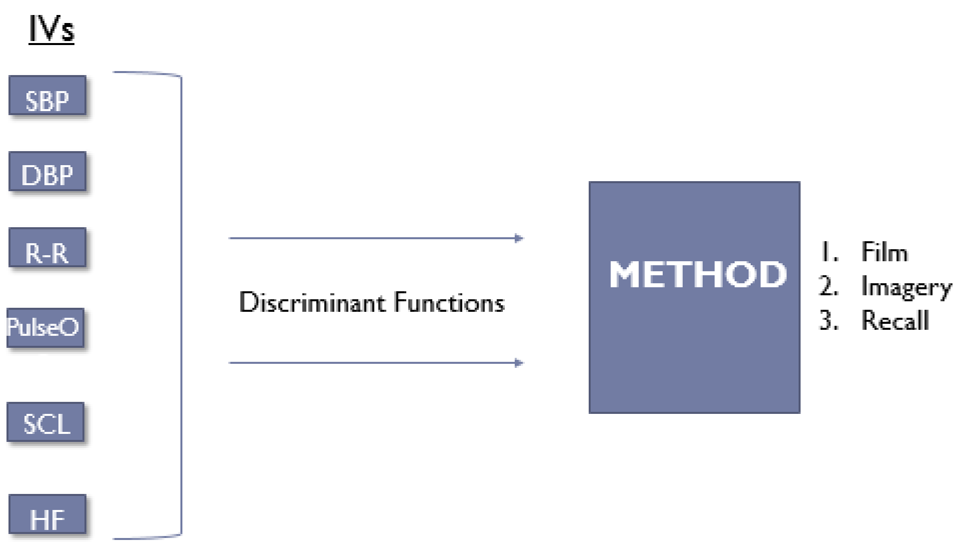

Table 1
Pattern Classification Matrix of Emotions (Combining all Induction Methods) using Self-Report Variables

		Predicted Emotion Condition					Total
		Fear	Con	Sad	Amu	Neu	
Actual Emotion Condition	Fear	**162 (84.4)**	0 (0.0)	17 (8.9)	10 (5.2)	3 (1.6)	192 (100.0)
	Con	3 (1.6)	**146 (76.0)**	3 (1.6)	28 (14.6)	12 (6.3)	192 (100.0)
	Sad	7 (1.6)	0 (0.0)	**178 (92.7)**	4 (2.1)	3 (1.6)	192 (100.0)
	Amu	0 (0.0)	8 (4.2)	7 (3.6)	**174 (90.6)**	3 (1.6)	192 (100.0)
	Neu	12 (6.3)	35 (18.3)	2 (1.0)	11 (5.8)	**131 (68.6)**	192 (100.0)

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 2
Significance Tests for Emotion Classification using Self-Report Variables

All Tasks	N	Observed	Expected	χ^2	p
Fear	192	162	38.4	497.3	<.005
Con	192	146	38.4	376.9	<.005
Sad	192	178	38.4	634.4	<.005
Amu	192	174	38.4	598.5	<.005
Neu	191	131	38.2	279.1	<.005
Overall	959	791	191.8	2339.9	<.005

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 3
Pattern Classification Matrix of Emotions (with Film) using Self-Report Variables

		Predicted Emotion Condition					Total
		Fear	Con	Sad	Amu	Neu	
Actual Emotion Condition	Fear	**56 (87.5)**	0 (0.0)	2 (3.12)	6 (9.38)	0 (0.0)	64 (100.0)
	Con	3 (4.69)	**49 (76.6)**	2 (3.12)	8 (12.5)	2 (3.12)	64 (100.0)
	Sad	2 (3.12)	2 (3.12)	**60 (93.8)**	0 (0.0)	0 (0.0)	64 (100.0)
	Amu	0 (0.0)	3 (4.69)	1 (1.56)	**60 (93.8)**	0 (1.56)	64 (100.0)
	Neu	5 (7.81)	5 (7.81)	0 (0.0)	3 (4.69)	**51 (79.7)**	64 (100.0)

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 4
Pattern Classification Matrix of Emotions (with Imagery) using Self-Report Variables

		Predicted Emotion Condition					Total
		Fear	Con	Sad	Amu	Neu	
Actual Emotion Condition	Fear	**55 (85.9)**	0 (0.0)	6 (9.4)	3 (4.7)	0 (0.0)	64 (100.0)
	Con	1 (1.6)	**48 (75.0)**	0 (0.0)	5 (7.8)	10 (15.6)	64 (100.0)
	Sad	3 (4.7)	0 (0.0)	**60 (93.8)**	1 (1.6)	0 (0.0)	64 (100.0)
	Amu	0 (0.0)	4 (6.3)	3 (4.7)	**55 (85.9)**	2 (3.1)	64 (100.0)
	Neu	0 (0.0)	12 (18.8)	0 (0.0)	8 (12.5)	**44 (68.8)**	64 (100.0)

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 5
Pattern Classification Matrix of Emotions (with Recall) using Self-Report Variables

		Predicted Emotion Condition					Total
		Fear	Con	Sad	Amu	Neu	
Actual Emotion Condition	Fear	**59** **(92.2)**	0 (0.0)	4 (6.3)	0 (0.0)	1 (1.6)	64 (100.0)
	Con	0 (0.0)	**45** **(70.3)**	1 (1.6)	12 (18.8)	6 (9.4)	64 (100.0)
	Sad	7 (10.9)	0 (0.0)	**57** **(89.1)**	0 (0.0)	0 (0.0)	64 (100.0)
	Amu	0 (0.0)	2 (3.1)	0 (0.0)	**61** **(95.3)**	1 (1.6)	64 (100.0)
	Neu	3 (4.8)	5 (7.9)	2 (3.2)	2 (3.2)	**51** **(81.0)**	64 (100.0)

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 6
Significance Tests for Emotion Classification (by Induction Method) using Self-Report Variables

Film	N	Observed	Expected	χ^2	p
Fear	64	56	12.8	182.3	<.005
Con	64	49	12.8	128.0	<.005
Sad	64	60	12.8	217.6	<.005
Amu	64	60	12.8	217.6	<.005
Neu	64	51	12.8	142.5	<.005
Overall	320	276	64	877.8	<.005
Imagery	N	Observed	Expected	χ^2	P
Fear	64	55	12.8	173.9	<.005
Con	64	48	12.8	121.0	<.005
Sad	64	60	12.8	217.6	<.005
Amu	64	55	12.8	173.9	<.005
Neu	64	44	12.8	95.1	<.005
Overall	320	262	64	765.7	<.005
Recall	N	Observed	Expected	χ^2	P
Fear	64	59	12.8	208.4	<.005
Con	64	45	12.8	101.3	<.005
Sad	64	57	12.8	190.8	<.005
Amu	64	61	12.8	226.9	<.005
Neu	63	51	12.8	142.5	<.005
Overall	320	273	64	853.1	<.005

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 7
Means and Standard Deviations (Induction Methods Combined) of Self-Report Variables

			Condition				
			Fear	Con	Sad	Amu	Neu
Variable	Fear	Mean	5.59	0.39	1.88	0.91	1.73
		StdDev	2.03	1.11	2.29	1.64	1.32
	Contentment	Mean	0.38	6.18	0.37	2.87	2.06
		StdDev	1.04	1.75	1.19	2.17	1.40
	Sadness	Mean	2.45	0.32	6.21	0.44	1.22
		StdDev	2.53	0.87	1.86	1.08	1.39
	Amusement	Mean	0.08	4.61	0.54	5.92	1.35
		StdDev	0.40	2.28	1.23	1.73	1.13
	Neutral	Mean	0.60	3.61	0.45	1.69	4.85
		StdDev	1.50	2.76	1.13	1.88	1.98

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 8
Means and Standard Deviations of Self-Report Variables for Film Tasks

			Condition				
			Fear	Con	Sad	Amu	Neu
Variable	Fear	Mean	5.73	0.34	1.72	0.0	1.55
		StdDev	1.48	1.00	2.1	0.0	2.17
	Contentment	Mean	0.7	5.56	0.53	4.88	1.3
		StdDev	1.45	2.13	1.17	2.07	1.76
	Sadness	Mean	0.84	0.42	6.17	0.27	0.19
		StdDev	1.56	1.39	1.92	0.95	0.66
	Amusement	Mean	1.48	2.33	0.92	6.42	1.06
		StdDev	2.05	2.07	1.5	1.49	1.64
	Neutral	Mean	1.39	1.97	0.3	1.39	5.45
		StdDev	1.06	1.46	0.83	1.12	2.11

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 9
Means and Standard Deviations of Self-Report Variables for Imagery Tasks

			Condition				
			Fear	Con	Sad	Amu	Neu
Variable	Fear	Mean	5.33	0.41	3.59	0.08	0.03
		StdDev	2.12	1.09	2.62	0.37	0.18
	Contentment	Mean	0.3	6.31	0.2	3.75	5.84
		StdDev	0.99	1.42	0.69	2.39	1.98
	Sadness	Mean	1.66	0.19	5.86	1.17	0.5
		StdDev	2.23	0.69	2.14	1.68	1.28
	Amusement	Mean	0.7	2.66	0.3	4.97	2.44
		StdDev	1.23	2.08	0.83	1.93	1.93
	Neutral	Mean	1.66	2.14	1.75	1.3	4.47
		StdDev	1.42	1.23	1.42	1.23	1.84

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 10
Means and Standard Deviations of Self-Report Variables for Recall Tasks

			Condition				
			Fear	Con	Sad	Amu	Neu
Variable	Fear	Mean	5.72	0.38	2.03	0.17	0.22
		StdDev	1.99	1.05	2.46	0.58	0.83
	Contentment	Mean	0.17	6.66	0.22	5.2	3.68
		StdDev	0.7	1.46	0.6	2.15	2.37
	Sadness	Mean	3.13	0.48	6.61	0.19	0.65
		StdDev	2.41	1.37	1.36	0.5	1.3
	Amusement	Mean	0.53	3.61	0.11	6.38	1.57
		StdDev	1.4	2.18	0.48	2.37	1.81
	Neutral	Mean	2.14	2.06	1.61	1.36	4.62
		StdDev	1.37	1.5	1.36	1.044	1.88

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 11
Means and Standard Deviations and Paired T-Tests of SCL

		Mean	Std. Dev.	T	df	p-value
Film	Fear	0.55	1.37	2.98	60	**.004**
	Con	-0.33	1.18	-2.15	59	**.036**
	Sad	0.10	1.41	0.56	60	.575
	Amu	0.16	1.35	0.91	60	.366
	Neu	-0.09	1.04	-0.66	59	.509
Imagery	Fear	-0.37	0.77	-3.71	59	**.000**
	Con	-0.36	0.98	2.86	60	**.006**
	Sad	-0.30	0.70	-3.31	60	**.002**
	Amu	-0.13	1.01	-0.97	60	.336
	Neu	-0.23	0.86	-2.15	59	**.036**
Recall	Fear	-0.14	0.75	-1.48	60	.144
	Con	-0.13	1.21	-1.21	60	.230
	Sad	-0.20	1.11	-1.43	60	.158
	Amu	-0.00	0.88	-0.03	60	.979
	Neu	-0.34	0.69	-3.85	60	**.000**

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 12
Means and Standard Deviations of SBP

		Mean	Std. Dev.	T	df	p-value
Film	Fear	0.63	5.73	.777	49	.441
	Con	0.86	7.34	.815	47	.419
	Sad	-0.12	7.81	-.112	49	.911
	Amu	-0.65	5.92	-.766	47	.448
	Neu	-0.10	5.71	-.121	44	.904
Imagery	Fear	-0.04	6.13	-.048	44	.962
	Con	-0.72	5.69	-.867	46	.391
	Sad	0.98	4.83	1.435	49	.158
	Amu	0.91	6.85	.941	49	,352
	Neu	0.63	6.47	.671	46	.506
Recall	Fear	0.39	5.73	.486	49	.629
	Con	1.85	5.46	2.349	47	**.023**
	Sad	1.94	6.24	2.196	49	**.033**
	Amu	0.95	4.77	1.383	47	.173
	Neu	-0.61	6.46	-.648	46	.520

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 13
Means and Standard Deviations of DBP

		Mean	Std. Dev.	T	df	p-value
Film	Fear	0.07	4.39	.16	49	.908
	Con	1.15	5.57	1.43	47	.160
	Sad	0.26	5.99	.31	49	.761
	Amu	-0.10	5.01	-.13	47	.89
	Neu	-0.50	4.80	-.70	44	.490
Imagery	Fear	-0.15	4.55	-.22	44	.823
	Con	-0.22	4.13	-.37	46	.713
	Sad	0.69	3.68	1.33	49	.191
	Amu	-0.19	5.18	-.26	49	.799
	Neu	0.55	4.54	.83	46	.412
Recall	Fear	0.53	3.91	.95	49	.346
	Con	2.17	4.26	3.52	47	**.001**
	Sad	1.82	5.04	2.56	49	**.014**
	Amu	0.88	4.41	1.39	47	.173
	Neu	-0.63	5.29	-.81	46	.422

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 14
Means and Standard Deviations of PulseOx

		Mean	Std. Dev.	T	df	p-value
Film	Fear	0.42	2.48	1.33	60	.188
	Con	0.19	1.90	0.78	58	.436
	Sad	0.16	1.62	0.77	59	.446
	Amu	0.46	1.52	2.35	60	**.022**
	Neu	0.24	2.24	0.82	57	.414
Imagery	Fear	-0.27	1.64	-1.26	59	.211
	Con	0.20	1.70	0.91	60	.369
	Sad	-0.08	1.37	-0.45	58	.656
	Amu	-0.03	1.40	-0.14	58	.887
	Neu	-0.11	1.46	-0.57	55	.573
Recall	Fear	0.22	1.62	1.05	57	.300
	Con	0.05	1.00	0.39	57	.696
	Sad	-0.08	2.59	-0.24	58	.810
	Amu	-0.00	2.14	-0.00	57	1.000
	Neu	-0.01	2.43	-0.01	56	.990

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 15
Means and Standard Deviations of IBIs

		Mean	Std. Dev.	T	df	p-value
Film	Fear	-26.32	85.08	-2.34	56	**.023**
	Con	-2.94	62.19	-0.36	56	.722
	Sad	15.42	60.30	1.91	55	.061
	Amu	13.58	62.30	1.65	56	.105
	Neu	8.95	49.49	1.35	55	.181
Imagery	Fear	6.61	46.11	1.08	56	.284
	Con	7.16	54.27	0.99	55	.328
	Sad	-5.32	56.84	-0.71	56	.483
	Amu	-7.91	47.91	-1.25	56	.218
	Neu	6.56	51.49	0.97	57	.336
Recall	Fear	2.26	48.54	0.35	56	.727
	Con	-0.67	56.61	-0.09	57	.929
	Sad	17.01	73.56	1.75	56	.086
	Amu	-4.52	47.31	-0.72	56	.474
	Neu	2.57	59.82	0.32	54	.751

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 16
Means and Standard Deviations of Log-Transformed HF HRV

		Mean	Std. Dev.	T	df	p-value
Film	Fear	0.17	0.80	1.62	56	.111
	Con	-0.27	1.01	-2.01	56	**.049**
	Sad	0.00	0.67	-0.03	55	.973
	Amu	0.06	0.92	0.50	56	.616
	Neu	-0.18	1.00	-1.36	55	.179
Imagery	Fear	-0.12	0.77	-1.18	56	.245
	Con	0.10	0.86	0.83	55	.409
	Sad	-0.11	0.73	-1.17	56	.246
	Amu	-0.20	0.84	-1.77	56	.082
	Neu	0.09	0.71	0.98	57	.332
Recall	Fear	-0.08	0.77	-0.82	56	.416
	Con	-0.08	0.75	-0.80	57	.425
	Sad	0.04	0.80	0.35	56	.725
	Amu	-0.09	0.78	-0.83	56	.412
	Neu	-0.13	0.97	-0.98	54	.332

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 17
Pattern Classification Matrix of Emotions (Combining all Induction Methods) using ANS Variables

		Predicted Emotion Condition					Total
		Fear	Con	Sad	Amu	Neu	
Actual Emotion Condition	Fear	**39 (29.8)**	22 (16.8)	15 (11.5)	31 (23.7)	24 (18.3)	131 (100.0)
	Con	23 (17.4)	**38 (28.8)**	24 (18.2)	20 (15.2)	27 (20.5)	132 (100.0)
	Sad	29 (21.2)	39 (28.5)	**23 (16.8)**	21 (15.3)	25 (18.2)	137 (100.0)
	Amu	34 (25.8)	31 (23.5)	17 (12.9)	**32 (24.2)**	18 (13.6)	132 (100.0)
	Neu	17 (13.8)	30 (24.4)	20 (16.3)	32 (26.0)	**24 (19.5)**	123 (100.0)

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 18
Significance Tests for Classification of Emotions using ANS variables (Induction Methods Combined)

All Tasks	N	Observed	Expected	χ^2	p
Fear	131	39	26.2	7.8	<.01
Con	132	38	26.4	6.4	<.025
Sad	137	23	27.4	0.0	>.05
Amu	132	32	26.4	1.5	>.05
Neu	123	18	24.6	0.0	>.05
Overall	655	156	131	6.0	<.025

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 19
Pattern Classification Matrix of Emotions (Films Tasks) using ANS Variables

		Predicted Emotion Condition					Total
		Fear	Con	Sad	Amu	Neu	
Actual Emotion Condition	Fear	**22 (47.8)**	6 (13.0)	5 (10.9)	5 (10.9)	8 (17.4)	46 (100.0)
	Con	9 (10.0)	**21 (46.7)**	1 (2.2)	7 (15.6)	7 (15.6)	45 (100.0)
	Sad	12 (26.7)	14 (31.1)	**6 (13.3)**	6 (13.3)	7 (15.6)	45 (100.0)
	Amu	14 (31.1)	12 (26.7)	7 (15.6)	**8 (17.8)**	4 (8.9)	45 (100.0)
	Neu	7 (17.1)	13 (31.7)	7 (17.1)	5 (12.2)	**9 (22.0)**	41 (100.0)

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 20
Pattern Classification Matrix of Emotions (Imagery Tasks) using ANS Variables

		Predicted Emotion Condition					Total
		Fear	Con	Sad	Amu	Neu	
Actual Emotion Condition	Fear	**9** **(22.5)**	10 (25.0)	6 (15.0)	9 (22.5)	6 (15.0)	40 (100.0)
	Con	6 (14.3)	**20** **(47.6)**	1 (2.4)	9 (21.4)	6 (14.3)	42 (100.0)
	Sad	3 (6.4)	11 (23.4)	**5** **(10.6)**	19 (40.4)	9 (19.1)	47 (100.0)
	Amu	8 (17.8)	9 (20.0)	3 (6.7)	**18** **(40.0)**	7 (15.6)	45 (100.0)
	Neu	4 (9.5)	13 (31.0)	4 (9.5)	11 (26.2)	**10** **(23.8)**	42 (100.0)

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 21
Pattern Classification Matrix of Emotions (Recall Tasks) using ANS Variables

		Predicted Emotion Condition					Total
		Fear	Con	Sad	Amu	Neu	
Actual Emotion Condition	Fear	**6 (13.3)**	6 (13.3)	4 (8.9)	13 (28.9)	16 (35.6)	45 (100.0)
	Con	3 (6.7)	**16 (35.6)**	9 (20.0)	8 (17.8)	9 (20.0)	45 (100.0)
	Sad	3 (6.7)	12 (26.7)	**10 (22.2)**	8 (17.8)	12 (26.7)	45 (100.0)
	Amu	5 (11.9)	10 (23.8)	7 (16.7)	**11 (26.2)**	9 (21.4)	42 (100.0)
	Neu	8 (20.0)	5 (12.5)	9 (22.5)	5 (12.5)	**13 (32.5)**	40 (100.0)

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 22
Significance Tests for Classification of Emotions using ANS variables (Induction Methods Separated)

Film	N	Observed	Expected	χ^2	p
Fear	46	22	9.2	22.3	<.005
Con	45	21	9	20.0	<.005
Sad	45	6	9	0.0	>.05
Amu	45	8	9	0.0	>.05
Neu	41	9	8.2	0.1	>.05
Overall	222	66	44.4	13.1	<.005
Imagery	**N**	**Observed**	**Expected**	χ^2	**P**
Fear	40	9	8	0.2	>.05
Con	42	20	8.4	20.0	<.005
Sad	47	5	9.4	0.0	>.05
Amu	45	18	9	11.3	<.005
Neu	42	10	8.4	0.4	<.05
Overall	216	62	43.2	10.2	<.005
Recall	**N**	**Observed**	**Expected**	χ^2	**p**
Fear	45	6	9	0.0	>.05
Con	45	16	9	6.8	<.01
Sad	45	10	9	0.1	>.05
Amu	42	11	8.4	0.6	>.05
Neu	40	13	8	2.2	>.05
Overall	217	56	43.4	4.6	<.05

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 23
Pattern Classification Matrix of all Methods (Emotions Combined) using ANS Variables

		Predicted Emotion Condition			Total
		Film	Imagery	Recall	
Actual Manipulation	Film	**98 (44.1)**	71 (32.0)	53 (23.9)	222
	Imagery	59 (27.3)	**93 (43.1)**	64 (29.6)	216
	Recall	66 (30.4)	69 (31.8)	**82 (37.8)**	217

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 24
Significance Tests for Classification of Tasks using ANS Variables (Emotions Combined)

All Emotions	N	Observed	Expected	χ^2	p
Film	222	98	74	11.68	<.005
Imagery	216	93	72	9.19	<.005
Recall	217	82	72.3	1.94	>.05
Overall	655	273	218.3	20.53	<.005

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 25
Pattern Classification Matrix of Fear Manipulations with ANS Variables

		Predicted Emotion Condition			Total
		Film	Imagery	Recall	
Actual Manipulation	Film	**30 (65.2)**	5 (10.9)	11 (23.9)	46 (100.0)
	Imagery	7 (17.5)	**19 (47.5)**	14 (35.0)	40 (100.0)
	Recall	10 (22.2)	16 (35.6)	**19 (42.2)**	45 (100.0)

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 26
Pattern Classification Matrix of Contentment Manipulations with ANS Variables

		Predicted Emotion Condition			Total
		Film	Imagery	Recall	
Actual Manipulation	Film	**13 (28.9)**	14 (31.1)	18 (40.0)	45 (100.0)
	Imagery	8 (19.0)	**25 (59.5)**	9 (21.4)	42 (100.0)
	Recall	11 (24.4)	14 (31.1)	**20 (44.4)**	45 (100.0)

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 27
Pattern Classification Matrix of Sadness Manipulations with ANS Variables

		Predicted Emotion Condition			Total
		Film	Imagery	Recall	
Actual Manipulation	Film	**15 (33.3)**	13 (28.9)	17 (37.8)	45 (100.0)
	Imagery	13 (27.7)	**22 (46.8)**	12 (25.5)	47 (100.0)
	Recall	13 (28.9)	15 (33.3)	**17 (37.8)**	45 (100.0)

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 28
Pattern Classification Matrix of Amusement Manipulations with ANS Variables

		Predicted Emotion Condition			Total
		Film	Imagery	Recall	
Actual Manipulation	Film	**24** **(53.3)**	10 (22.2)	11 (24.4)	45 (100.0)
	Imagery	14 (31.1)	**21** **(46.7)**	10 (22.2)	45 (100.0)
	Recall	10 (23.8)	16 (38.1)	**16** **(38.1)**	42 (100.0)

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 29
Pattern Classification Matrix of Neutral Manipulations with ANS Variables

		Predicted Emotion Condition			Total
		Film	Imagery	Recall	
Actual Manipulation	Film	**16 (39.0)**	12 (29.3)	13 (31.7)	41 (100.0)
	Imagery	11 (26.2)	**18 (42.9)**	13 (31.0)	42 (100.0)
	Recall	12 (30.0)	12 (30.0)	**16 (40.0)**	40 (100.0)

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 30
Significance Tests for Classification Rates using ANS Variables

Fear	N	Observed	Expected	χ^2	p
Film	46	30	15.3	21.04	<.005
Imagery	40	19	13.3	3.61	>.05
Recall	45	19	15	1.6	>.05
Overall	131	68	43.7	20.34	<.005
Con	N	Observed	Expected	χ^2	P
Film	45	13	15	0.4	>.05
Imagery	43	25	14.3	11.9	<.005
Recall	45	20	15	2.5	>.05
Overall	132	58	44	6.7	<.01
Sad	N	Observed	Expected	χ^2	P
Film	45	15	15	0.0	>.05
Imagery	47	22	15.7	3.8	=.05
Recall	45	17	15	0.4	>.05
Overall	137	54	45.7	2.3	>.05
Amu	N	Observed	Expected	χ^2	P
Film	45	24	15	8.1	<.005
Imagery	45	21	15	3.6	>.05
Recall	42	16	14	0.4	>.05
Overall	132	61	44	9.9	<.005
Neu	N	Observed	Expected	χ^2	P
Film	41	16	13.7	0.6	>.05
Imagery	42	18	14	1.7	>.05
Recall	40	16	13.3	0.8	>.05
Overall	123	50	41	3.0	>.05

Key: Con=Contentment, Sad=Sadness, Amu=Amusement, Neu=Neutral

Table 31
Correlation Table for SR Variables within each Emotion

		Induction		
		Film	Imagery	Recall
Fear	Film	1.		
	Imagery	.507**	1.	
	Recall	.224	.560**	1.
Con	Film	1.		
	Imagery	.336**	1.	
	Recall	.243	.403**	1.
Sad	Film	1.		
	Imagery	.388**	1.	
	Recall	.463**	.583**	1.
Amu	Film	1.		
	Imagery	.193	1.	
	Recall	.580**	.294*	1.

APPENDICES

APPENDIX A

NEUTRAL IMAGERY SCRIPT

Read the following text and imagine yourself in this scenario.

"You are sitting in your living room reading on a Sunday afternoon. Sitting back, releaxed, you look out of the window. It is a sunny autumn day outside. Red and brown leaves drift slowly down from the trees and several cars and a truck go by in the street. Wind from the cars blows the leaves which are lying in the street. They scatter onto the pavement and the thick green lawn."

APPENDIX B

FEAR IMAGERY SCRIPT

Read the following text and imagine yourself in this scenario.

"You are awakened late at night by a noise downstairs. Someone is forcing open your front door. It is dark and you are aloe. You hear someone slowly crossing your living room and you become instantly alert. The footsteps approach your bedroom and you tremble as your fumble for the phone to call for help. A shadowy form looms toward you from your bedroom doorway. You try to scream but nothing comes out! Your heart is beating wildly as you drop the phone to the floor."

APPENDIX C

CONTENTMENT IMAGERY SCRIPT

Read the following text and imagine yourself in this scenario.

"You are alone in a canoe that is drifting lazily down a slow moving river. The sun is shining brightly and feels warm on your face and arms. Everything is peaceful and quiet. You hear only some distant birds chirping and leaves rustling gently in the wind. You feel calm, relaxed and very content as you start drifting off into a gentle sleep."

APPENDIX D

AMUSEMENT IMAGERY SCRIPT

Read the following text and imagine yourself in this scenario.

"You notice that a tall male student is often bullying another student whenever you leave one of your classes. One day you see this bully walking across the dining hall with a girl that he is flirting with when he suddenly trips on a rug and lands with his face in the food on his tray. As he stands, everyone realizes that he has split his pants and his underwear is showing. Embarrassed, his face turns red and he runs from the dining area as many people are laughing at him. You continue to watch as he awkwardly runs while attempting to hold his split pants together."

APPENDIX E

SADNESS IMAGERY SCRIPT

Read the following text and imagine yourself in this scenario.

"You are standing in the cemetery, trembling. You barely remember the funeral service earlier that morning. You feel numb all over. Inside your voice is whispering, "I am so alone now." You feel yourself start to quiver as you try to fight back the tears. You are struggling to gain control but you feel tired and heavy as you wonder if life is worth living anymore."

APPENDIX F

TWENTY-ITEM ALEXITHYMIA SCALE

Using the scale provided as a guide, indicate how much you agree or disagree with each of the following statements by checking the corresponding number. Give only one answer for each statement.

1. I am often confused about what emotion I am feeling.

1	2	3	4	5
Strongly Disagree	Moderately Disagree	Neither Disagree Nor Agree	Moderately Agree	Strongly Agree

2. It is difficult for me to find the right words for my feelings.

1	2	3	4	5
Strongly Disagree	Moderately Disagree	Neither Disagree Nor Agree	Moderately Agree	Strongly Agree

3. I have physical sensations that even doctors don't understand.

1	2	3	4	5
Strongly Disagree	Moderately Disagree	Neither Disagree Nor Agree	Moderately Agree	Strongly Agree

4. I am able to describe my feelings easily.

1	2	3	4	5
Strongly Disagree	Moderately Disagree	Neither Disagree Nor Agree	Moderately Agree	Strongly Agree

5. I prefer to analyze problems rather than just describe them.

1	2	3	4	5
Strongly Disagree	Moderately Disagree	Neither Disagree Nor Agree	Moderately Agree	Strongly Agree

6. When I am upset, I don't know if I am sad, frightened, or angry.

1	2	3	4	5
Strongly Disagree	Moderately Disagree	Neither Disagree Nor Agree	Moderately Agree	Strongly Agree

7. I am often puzzled by sensations in my body.

1	2	3	4	5
Strongly Disagree	Moderately Disagree	Neither Disagree Nor Agree	Moderately Agree	Strongly Agree

8. I prefer to just let things happen rather than to understand why they turned out that way.

1	2	3	4	5
Strongly Disagree	Moderately Disagree	Neither Disagree Nor Agree	Moderately Agree	Strongly Agree

9. I have feelings that I can't quite identify.

1	2	3	4	5
Strongly Disagree	Moderately Disagree	Neither Disagree Nor Agree	Moderately Agree	Strongly Agree

10. Being in touch with emotions is essential.

1	2	3	4	5
Strongly Disagree	Moderately Disagree	Neither Disagree Nor Agree	Moderately Agree	Strongly Agree

11. I find it hard to describe how I feel about people.

1	2	3	4	5
Strongly Disagree	Moderately Disagree	Neither Disagree Nor Agree	Moderately Agree	Strongly Agree

12. People tell me to describe my feelings more.

1	2	3	4	5
Strongly Disagree	Moderately Disagree	Neither Disagree Nor Agree	Moderately Agree	Strongly Agree

13. I don't know what's going on inside me.

1	2	3	4	5
Strongly Disagree	Moderately Disagree	Neither Disagree Nor Agree	Moderately Agree	Strongly Agree

14. I often don't know why I am angry.

1	2	3	4	5
Strongly Disagree	Moderately Disagree	Neither Disagree Nor Agree	Moderately Agree	Strongly Agree

15. I prefer talking to people about their daily activities rather than their feelings.

1	2	3	4	5
Strongly Disagree	Moderately Disagree	Neither Disagree Nor Agree	Moderately Agree	Strongly Agree

16. I prefer to watch "light' entertainment shows rather than psychological dramas.

1	2	3	4	5
Strongly Disagree	Moderately Disagree	Neither Disagree Nor Agree	Moderately Agree	Strongly Agree

APPENDIX G

Mind-Body Laboratory Recent History Questionnaire

A very brief medical history must be obtained as part of the experimental protocol. It is very important that you be completely honest. This information will be kept strictly confidential.

1. What is your age, height, weight, and gender?

Age: _____ years

Height: _____ feet, _____ inches

Weight: _____ pounds

Sex: ___M ___F

2. Since birth, have you ever been hospitalized or had any major medical problems?

___ Yes ___ No

If Yes, briefly explain:

3. Have you ever experienced a concussion or lost consciousness due to a blow to the head?

___ Yes ___ No

If Yes, briefly explain:

4. Have you ever had problems that required you to see a counselor, psychologist, or psychiatrist?

___ Yes ___ No

If Yes, briefly explain:

5. Do you use tobacco products of any kind?

___ Yes ___ No

If Yes, describe what kind how often/much:

6. Have you ever been diagnosed with a psychological disorder?

___ Yes ___ No

If Yes, briefly explain:

7. Do you currently have or have you ever had any of the following?

___ Yes ___ No Strong reaction to cold weather

___ Yes ___ No Circulatory problems

___ Yes ___ No Tissue disease

___ Yes ___ No Skin disorders (other than facial acne)

___ Yes ___ No Arthritis

___ Yes ___ No Asthma

___ Yes ___ No Lung problems

___ Yes ___ No Cardiovascular disorder/disease

___ Yes ___ No Diabetes

___ Yes ___ No Hypoglycemia

___ Yes ___ No Hypertension (high blood pressure)

___ Yes ___ No Hypotension (low blood pressure)

___ Yes ___ No Hepatitis

___ Yes ___ No Neurological problems

___ Yes ___ No Epilepsy or seizures

___ Yes ___ No Brain disorder

___ Yes ___ No Stroke

If you responded Yes to any of the above conditions, briefly explain:

8. Have you ever been diagnosed as having:

___ Yes ___ No Learning deficiency or disorder

___ Yes ___ No Reading deficiency or disorder

___ Yes ___ No Attention deficit disorder

___ Yes ___ No Attention deficit hyperactivity disorder;

9. Do you have:

___ Yes ___ No Claustrophobia (extreme fear of small closed spaces)

___ Yes ___ No Blood phobia (extreme fear of needles or blood)

___ Yes ___ No Phobia of any type (if Yes, briefly explain:)

___ Yes ___ No Generalized anxiety disorder

___ Yes ___ No Anxiety disorder of any type (if Yes, briefly explain:)

If you responded Yes, briefly explain here:

10. List any over-the-counter or prescription medications you are currently taking:

11. List the symptoms that these drugs are treating

12. List any other medical conditions that you have or have had in the past:

13. What is your average daily caffeine consumption (approximate number of cups/glasses of coffee, tea, or caffeinated soda)?

14. What is your average weekly alcohol consumption (approximate number of alcoholic beverages)?

15. How many hours of sleep do you average per night?

APPENDIX H

Mind-Body Laboratory Recent Health Behaviors Questionnaire

A very brief medical history must be obtained as part of the experimental protocol. It is very important that you be completely honest. This information will be kept strictly confidential.

1. When was the last time that you have had any alcohol before the study began?

2. When was the last time you have had a caffeinated beverage before the study began?

3. When was the last time that you are before the study began?

4. What phase of the menstrual cycle are you currently in (beginning, middle, end, or N/A)?

5. How many hours of sleep did you get last night?

6. Did you engage in vigorous exercise within the last 2 hours?

APPENDIX I

Film Affect Self-Report Questionnaire

<u>The following questions refer to how you *felt while watching the film*.</u>

0	1	2	3	4	5	6	7	8
not at all/ none				somewhat/ some				extremely/ a great deal

Using the scale above, please indicate the greatest amount of EACH emotion you experience while watching the film.

Amused ___
Fearful ___
Sad ___
Content ___
Neutral ___
Pleasant ___
Unpleasant ___
Negative ___
Positive ___

What was the intensity of the emotion you experienced? ___
Had you seen this film before? No/Yes
Did you close your eyes or look away during any scenes? No/Yes

APPENDIX J

Imagery Affect Self-Report Questionnaire

The following questions refer to how you *felt while imaging the scenario*.

0	1	2	3	4	5	6	7	8
not at all/ none				somewhat/ some				extremely/ a great deal

Using the scale above, please indicate the greatest amount of EACH emotion you experience while imaging the scenario.

Amused ___
Fearful ___
Sad ___
Content ___
Neutral ___
Pleasant ___
Unpleasant ___
Negative ___
Positive ___

What was the intensity of the emotion you experienced? ___
How vividly were you able to see the scenario? ___

APPENDIX K

Recall Affect Self-Report Questionnaire

The following questions refer to how you *felt while remembering the event.*

0	1	2	3	4	5	6	7	8
not at all/ none				somewhat/ some				extremely/ a great deal

Using the scale above, please indicate the greatest amount of EACH emotion you experience while remembering the event.

Amused ___
Fearful ___
Sad ___
Content ___
Neutral ___
Pleasant ___
Unpleasant ___
Negative ___
Positive ___

What was the intensity of the emotion you experienced? ___
How vividly were you able to see the memory? ___