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A CONTROLLED COMPARISON OF EMOTIONAL REACTIVITY AND PHYSIOLOGICAL RESPONSE IN CHRONIC OROFACIAL PAIN PATIENTS

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ABSTRACT OF DISSERTATION

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The Graduate School

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A CONTROLLED COMPARISON OF EMOTIONAL REACTIVITY AND PHYSIOLOGICAL RESPONSE IN CHRONIC OROFACIAL PAIN PATIENTS

ABSTACT OF DISSERTATION

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the College of Arts and Sciences at the University of Kentucky

By
John E Schmidt

Lexington, Kentucky

Director: Dr. Charles R Carlson, Professor of Psychology

Lexington, Kentucky

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A CONTROLLED COMPARISON OF EMOTIONAL REACTIVITY AND PHYSIOLOGICAL RESPONSE IN CHRONIC OROFACIAL PAIN PATIENTS

This study examined the emotional and physiological differences between masticatory muscle pain patients and age, height, and weight matched pain-free controls. Physiological activation and emotional reactivity were assessed in the 22 muscle pain patients and 23 pain-free controls during a baseline rest period, while discussing a personally relevant stressor, and during a post-stressor recovery period. Physiological activity was assessed through the use of the frequency domain heart rate variability indices. Activity in the high frequency heart rate variability range is an index of parasympathetic activity while activity in the low frequency heart rate variability range is an index of both sympathetic and parasympathetic activity (Akselrod, 1981). The muscle pain patients showed significantly more physiological activation during both the baseline rest and the post-stressor recovery periods. These physiological differences were quantified by higher low frequency heart rate variability and lower high frequency heart rate variability during these study periods. This pattern of higher activation was also present in the report of emotional reactivity in the muscle pain patients. The emotional and physiological differences between the groups across study periods were more pronounced in muscle pain patients who reported a traumatic life experience. These results provide evidence of physiological activation and emotional responding in masticatory muscle pain patients that differentiates them from matched pain-free controls. The use of HRV indices to measure physiological functioning quantifies the degree of sympathetic and parasympathetic activation. Study results suggest the use of these HRV indices will improve understanding of the role that excitatory and inhibitory mechanisms play in the onset and maintenance of chronic masticatory muscle pain conditions.

KEY WORDS: Orofacial Pain, Heart Rate Variability, Emotional Reactivity, Self-Regulation, Inhibitory Response

John E Schmidt

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To many of my generation, there is something absent in our lives as we struggle and grow in our personal character and professional development. Most don't talk about this missing piece and many don't even notice. What I am referring to here is the presence and effect of a role model or some might even say a 'hero' as an influential force that fosters a strong desire to grow in character and vision. In generations past, heroes were celebrated and younger folks would strive to adopt and emulate the accomplishments, characteristics, and qualities of their heroes. People like Charles Lindbergh, Helen Keller, FDR and Eleanor Roosevelt, Martin Luther King, Jr., Jane Adams, and Neil Armstrong stood as heroes and role models to their generations. Unfortunately, today's 'heroes' are singled out solely on success and sensationalism rather than the qualities that set them apart from the average person. In each chapter of my life so far, I can point to a person who stood as a beacon to me as I grew and strived to achieve my goals. These individuals are not 'famous' by the standard definition, but stand out as true mentors and role models for myself and many others.

When I was working towards my Eagle Scout award, my sponsor Ron Ralston helped keep me focused and continuously challenged. While I served in the Navy, I learned the benefits of perseverance, loyalty, and hard work from Captain G.W. Ertel. Just as important to my individual growth during this time was Commander Jim Zagranis. Jim taught me how to overcome adversity with confidence, to cherish and strengthen important friendships, and most notably, to have fun and enjoy life under the most strenuous of conditions.

During my time as a graduate student, I have worked with many accomplished and stimulating people. Among all the academics and student colleagues, there are two individuals without whom I would not have become a motivated and committed behavioral scientist and clinician. As a behavioral scientist, Michael Andrykowski challenged me to improve my research skills in all aspects from formulating ideas to implementation, to analytic strategies, to writing, to presentation, and to review and publication. He set an expectation of excellence and quality in all aspects of my work, as well as a desire to continuously improve these skills. Perhaps one of the most important

things I learned from working under his guidance is the ability to think about the 'big picture' not only in my work, but also in my life.

When I first began my graduate career, I was lucky enough to be one of Charley Carlson's graduate students. I knew he was a competent clinician, an accomplished academic, and all-around nice guy. I really had no notion of how much his guidance, mentorship, and vision would affect me over the years of my training. Charley embodies the 'scientist-practitioner' in every way with his natural enthusiasm and desire to learn. He would take every opportunity to question why patients were reacting as they did in a continuous effort to improve their lives through research and data-driven clinical treatment. He would try to instill these same drives in his students, a lesson that was repeated again and again while working with him. Charley also helped me see the importance of balancing my work and professional aspirations with the needs of my heart through taking time for my wife and my children.

These are my own personal heroes and I thank them from the bottom of my heart for seeing in me something that was worth taking the time and effort to mold, teach, and guide. I would not be where I am today without the guidance, support, and mentorship of these individuals.

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Chapter One

Introduction

Background

Orofacial pain occurs within the umbrella of Temporomandibular Disorders (TMD), and is one of the most common regional pain syndromes (Macfarlane et al., 2002). These conditions are primarily present in young and middle-aged adults and are less common among children or the elderly. There is also a large gender difference, with women twice as likely to report a TMD problem (LeResche, 1997). Orofacial pain may arise after a temporomandibular joint suffers injury and mechanical function is impaired. Poor functional habits such as grinding the teeth or habitual tensing of the jaw musculature may also initiate a TMD or exacerbate an already existing TMD. A recent epidemiological study found 5.3% of the US population to be experiencing some form of TMD pain (Lipton, Ship, & Larach-Robinson, 1993). Other prevalence studies have placed the incidence of TMD even higher, at about 12% (Von Korff, Dworkin, LeResche, & Kruger, 1988). As with most chronic problems, these conditions are associated with high health care costs and lost productivity (White, Williams, & Leben, 2001). Contributing to these high costs and loss of productivity is likely the high incidence of comorbid physiological conditions present in orofacial pain patients (e.g., interstitial cystitis, fibromyalgia, GERD) and suggests broad physiological dysfunction (Aaron, Burke, & Buchwald, 2000). Clearly, an orofacial pain condition can be a complex problem with potentially wide-ranging physiological effects.

Compared to pain-free controls, chronic orofacial pain patients have reported lower pain tolerance and thresholds (Maixner, Fillingim, Booker, & Sigurdsson, 1995), more emotional and cardiovascular reactivity (Curran, Carlson, & Okeson, 1996), more psychological distress, more fatigue, and more sleep dysfunction (Carlson et al., 1998). Several studies have also demonstrated the comorbidity and increased incidence of anxiety (Kight, Gatchel, Ellis, & Holt, 1999; McNeil et al., 2001) and depression (Banks & Kerns, 1996) in orofacial pain patients. These characteristics may reflect a more fragile and reactive behavioral response system. In fact, orofacial pain patients have

demonstrated heightened emotional reactivity to stressors. For example, Curran and colleagues found that patients with masticatory muscle pain responded to a standard math stressor (serial subtraction) with more anger when compared to controls (Curran et al., 1996). In a similar study, however, Carlson and colleagues found significant emotional and physiological responses in both an orofacial pain sample and matched controls to a standard math stressor (serial subtraction) (Carlson et al., 1998). The lack of significant differences in emotional responding between patients and controls after exposure to a standard stressor may reflect study design or measurement issues. It has been suggested that the use of a personally-relevant stressor is critical in differentiating TMD patients from controls on physiological domains (Flor, Birbaumer, Schugen, & Lutzenberger, 1992; Flor, Birbaumer, Schulte, & Roos, 1991; Ohrbach, Blascovich, Gale, McCall, & Dworkin, 1998).

Another feature of these patients is comorbidity to traumatic events. A recent study found 49.8% of over twelve hundred orofacial pain patients reported traumatic life events (de Leeuw, Bertoli, Schmidt, & Carlson, 2005b). The incidence of orofacial pain patients reporting clinically significant symptomatology of PTSD is also high, ranging from 15% to 23% (de Leeuw, Bertoli, Schmidt, & Carlson, 2005a; Sherman, 1998; Sherman, Carlson, Wilson, Okeson, & McCubbin, 2005). A diagnosis of PTSD is associated with persistent hyperarousal as well as increased physiological reactivity when exposed to a reminder of the traumatic event (DSM-IV). These factors likely contribute to a reduction in the range of behavioral regulation and an increase in emotional reactivity.

The systemic and chronic level of activation present in orofacial pain patients, that are even more pronounced in patients reporting a traumatic stressor, does not seem to easily abate or subside over time. The characteristics commonly found in chronic orofacial pain patients of increased emotional reactivity, increased incidence of psychopathology, and increased physiological reactivity imply a compromised autonomic regulation system and suggests the need for a quantitative measure of autonomic system regulation and response. A physiological measure representative of autonomic balance would provide a better understanding of the associations among emotional and

physiological response to environmental challenge by providing an index of autonomic homeostasis and flexibility. Heart rate variability is a physiological index that has demonstrated usefulness in providing a quantitative measure of sympathetic and parasympathetic activity, and is a good candidate to index autonomic balance.

Heart Rate Variability

Heart rate variability (HRV) is an index of fluctuations in the time interval between normal heartbeats. Fluctuations in inter-beat interval are expressed as beat-to-beat alterations in heart rate and are a representation of the heart's ability to respond to normal regulatory impulses that affect heart rhythm (Akselrod, 1995). This index is commonly presented as a function of power at different frequency ranges of heart functioning. The lower frequency range (LF) includes both sympathetic and parasympathetic influences (Chiu & Kao, 2001). Basic studies using atropine and similar drugs that block or dampen vagal stimulation to the heart have resulted in strongly reduced LF power (Akselrod et al., 1985; Akselrod, Gordon, & Ubel, 1981). The higher frequency range (HF) reflects vagal activity and is thus parasympathetically modulated (Akselrod et al., 1981). Increased HF power has been associated with higher parasympathetic activity in studies of paced breathing (Ring et al., 1999) and treatment for depression (Carney, Freedland, & Stein, 2000). Total vagal blockade essentially eliminates the power in the HF range, and reduces power in the LF range. With gradual blockade of vagal input, the ratio of LF to HF power increases, demonstrating a shift in the sympathovagal equilibrium towards sympathetic dominance (Malliani, Pagani, Lombardi, & Cerutti, 1991).

Basic research into demographic and physiological correlates of HRV has shown an association with age (Carter, Banister, & Plaber, 2003; Fagard, Pardaens, & Staessen, 1999), regular exercise and aerobic fitness (Carter et al., 2003), and genetic factors (Singh, Larson, O'Donnell, & Levy, 2001). Functionally, respiration pattern is a major component in the study of HRV. Respiratory Sinus Arrhythmia (RSA) refers to the cyclical fluctuations in heart rate that coincide with respiratory cycle. Heart rate increases during inspiration and decreases during exhalation. In HRV frequency indices,

RSA is reflected in the HF range and has been used as a non-invasive measure of parasympathetic function (Task Force, 1996).

Heart Rate Variability and Trauma

The ability of HRV to provide a quantitative index of autonomic functioning is most apparent in studies of trauma survivors suffering from posttraumatic stress disorder (PTSD). A diagnosis of PTSD may result in reduced HRV, reduced emotional inhibition, and a lack of behavioral flexibility in stressful situations. To test these hypotheses, Cohen and colleagues conducted two studies (1998, 2000) comparing PTSD patients with age and sex matched controls on HRV indices while resting, when discussing a personally relevant stressor, and post-stressor. The pattern of autonomic response in the PTSD participants showed no significant change across study periods, while the control group showed a decrease in HF and an increase in LF during the stressor period compared to the baseline and post periods (Cohen et al., 2000; Cohen et al., 1998). The response to recalling a distressing event by the control group appears to represent a normal and well-balanced autonomic reaction. In contrast, the response of the PTSD patients demonstrates a lack of heart rate variability in either a restful *or* distressing state. This rigidity of autonomic activity may reflect the constant state of hyperactivation characterized by increased sympathetic activity and decreased parasympathetic activity in PTSD sufferers. These physiological characteristics of the PTSD patients in these studies suggest chronic dis-inhibition of sympathetic activity.

Engaging in inhibitory control of sympathetic activity after a stressor likely represents a healthy, balanced psychophysiological response system, while dis-inhibition of sympathetic activity suggests psychophysiological inflexibility. Thayer has developed a model of neurovisceral integration (Thayer & Lane, 2000), which seeks to demonstrate how anxiety related arousal represents a disinhibition of positive feedback circuits normally under tonic inhibitory control. This model strives to account for the interactions of cognitive, affective, behavioral, and physiological states and dispositions across the spectrum of normal and pathological functioning. A reduction in overall system flexibility is thought to result from a disinhibition of sympathetic nervous system

activity. When vagal input to the heart is decreased, the individual is less able to track rapid changes in environmental demands due to the slow response of sympathetic input. Instead of the negative feedback loop associated with increased parasympathetic functioning and subsequent inhibition of sympathetic activation after arousal, a positive feedback loop becomes dominant in situations where there is sustained attention or vigilance to environmental stimuli (Porges, 1992; Thayer & Lane, 2000). Thayer proposes that autonomically mediated HRV provides an index of neurovisceral integration and system flexibility by providing quantitative values of sympathetic and parasympathetic activity present at the sino-atrial node of the heart.

The use of heart rate variability to investigate autonomic activity in orofacial pain patients might broaden the understanding of the dynamic relationships among emotional reactivity, negative life experiences, and the development of a chronic pain condition. Further, the information provided by a focused and controlled analyses of HRV with orofacial pain patients may provide a distinct quantitative index of autonomic regulation and demonstrate a consistent pattern of behavioral disinhibition in these patients.

Study Aims and Hypotheses

The present study has two general aims. First, this study investigated differences in heart rate variability indices between chronic orofacial pain patients and pain-free controls at rest, during a stressor condition, and during a post-stressor recovery period. The stressor condition consisted of having the participant discuss a personally relevant distressing experience. Second, this study investigated factors including psychological distress (e.g., anxiety, depression), social-environment (e.g., social support, social constraints), disposition (e.g., emotion regulation), and family of origin characteristics that may be associated with HRV indices during the baseline, stressor, and recovery periods in the orofacial pain sample as compared to a pain-free matched control sample.

Specific Hypotheses

1) While quietly sitting during baseline assessment, orofacial pain patients will have lower HF, higher LF, and higher LF/HF ratio HRV indices compared to pain-free controls (Porges, 1992; Thayer & Lane, 2000).

2) During the recovery period, orofacial pain patients will have lower HF, higher LF, and higher LF/HF ratio HRV indices compared to pain-free controls (Porges, 1992; Thayer & Lane, 2000).

3) Orofacial pain patients reporting a traumatic stressor will show very little change in HRV indices between baseline, stressor, and recovery (Cohen et al., 2000; Cohen et al., 1998).

4) Orofacial pain patients will report more emotional reactivity to the stressor condition as reported on the EAS compared to pain-free controls (Curran et al., 1996; Maixner et al., 1995).

5) Orofacial pain patients will report more psychological distress, sleep dysfunction, and fatigue than pain-free controls on self-report measures (Carlson et al., 1998; Kight et al., 2001).

6) Orofacial pain patients will report less social support, more social constraints, and a family-of-origin environment characterized by conflict and aggression, compared to pain-free controls (Repetti, Taylor, & Seeman, 2002).

7) Orofacial pain patients will report use of the emotion regulation strategy of suppression and less use of reappraisal compared to pain-free controls (Gross & John, 2003).

Chapter 2

Methods

Setting and Participants

This study was approved by the University of Kentucky Institutional Review Board and all participants provided written informed consent. Study participants were recruited from patients seeking care at the University of Kentucky Orofacial Pain Center. Controls were recruited by posting flyers describing the study throughout the University of Kentucky Medical Center. Controls were matched to patients on age, height, and weight. All participants were recruited and completed the study between February and August, 2005.

Study inclusion criteria for patients were as follows: (1) age 18 years or older; (2) female; (3) Research Diagnostic Criteria/Temporomandibular Disorders (RDC/TMD) Axis I TMD diagnosis (Dworkin and LeResche, 1992) made by a faculty member or resident trained in orofacial pain examination and management; (3) diagnosis of pain duration of at least two months; (4) current pain level of at least 3 on a 0-10 visual analog scale (0=no pain and 10= worst pain imaginable); (5) no past or current history of hypertension or heart disease; (6) not taking any cardiovascular control medication (e.g., beta-blockers); (7) no history of asthma or other chronic respiratory conditions; (8) no history of diabetes; (9) not pregnant at time of study participation; (10) prior to participation, resting blood pressure must meet the following criteria: systolic blood pressure < 140mmHg, diastolic blood pressure < 90mmHg (Chobanian et al., 2003). Controls met the same criteria with the exception of items 2, 3, and 4. In addition, controls had no current or past chronic pain condition (e.g., back pain, TMD, arthritis). All participants were compensated $40 for completion of this study.

The participants in this study were 22 female orofacial pain patients with a mean age of 41.0 years (sd=12.6), a mean weight of 151.5 pounds (sd=29.3), and a mean height of 64.5 inches (sd=1.8). Patients were matched to 23 pain-free controls with a mean age of 36.0 years (sd=11.7), a mean weight of 149.2 pounds (sd=24.1), and a mean height of 64.8 inches (sd=2.4).

Design

The study design compared patients with orofacial pain to matched pain-free controls on a standard set of psychometric measures and on physiological responses before, during, and after a laboratory challenge. Dentists experienced in the diagnosis and treatment of TM disorders recruited patients during the initial diagnostic appointment. Patients were then recruited by the principal investigator (PI) and scheduled for participation. Control participants were matched to patients on height, weight, and age prior to study participation. The laboratory challenge for all participants was administered by the PI.

Dependent Measures

Prior to the initial evaluation by the attending dentist, all patients completed an orofacial pain questionnaire that gathers demographic data, historical information regarding pain, a general medical history, and a battery of psychological questionnaires. The orofacial pain examination includes a detailed history of the patient's chief complaints(s), associated symptoms, TMJ noise, mandibular dysfunction, parafunctional habits, past trauma, previous treatments/consultations for their chief complaint(s), as well as psychosocial history. The battery of psychological questionnaires administered to patients included the following measures:

Symptom Check List –90 (SCL-90). The SCL-90-R (Derogatis, 1979) is a 90-item multi-dimensional self-report measure of psychological functioning scored on a five-point scale of distress (0-4). The specific dimensions on the SCL-90-R include somatization, obsessive-compulsive behavior, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism. A global severity index is also available from this measure. Test-retest reliabilities range from r=0.78 to 0.90 for non-patient samples, and internal consistencies range from 0.77 to 0.90 (Derogatis, 1979).

Pittsburgh Sleep Quality Index (PSQI). The PSQI (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) is a 12-item measure of sleep quality. The PSQI gathers information regarding the amount of hours the patient sleeps each night, the amount of

hours in bed each night, how often the patient is woken up and why, as well as how difficult it is for the patient to return to sleep upon awakening. The PSQI has exhibited test-retest stability (full scale $\underline{r} = 0.85$), good overall internal consistency ($\underline{\alpha} = 0.83$), and provides a valid and reliable assessment of overall sleep quality and disturbance. (Buysse et al., 1989; Carpenter & Andrykowski, 1998).

Posttraumatic stress disorder Check List – Civilian version (PCL-C). The PCL-C (Weathers, Litz, Herman, Huska, & Keane, 1993) is a self-report measure used to assess the incidence of significant life stressors and prevalence of PTSD symptomatology. The patient first identifies significant stressors they may have experienced from a list (e.g., military combat, violent attack, incarceration, natural or man-made disaster, severe auto accident, sudden injury/serious accident, observed someone hurt or killed). The patient selects the most significant stressor and the notes the date of occurrence. The patient then answers 17 symptom-related items by noting how much he or she has been bothered by each symptom in the last month. The items are scored on a five-point Likert scale from 1 (not at all) to 5 (extremely). The PCL-C provides a total score as well as three subscale scores (reexperiencing, avoidance/numbing, and arousal). The PCL-C has exhibited test-retest stability ($r = 0.96$), good overall internal consistency (alpha = 0.92), and provides a valid and reliable assessment of the presence of PTSD symptoms (Blanchard et al., 1996). The PCL-C has demonstrated efficacy in the screening of PTSD in orofacial pain patients (Sherman, 1998; Sherman et al., 2005).

Multi-dimensional Fatigue Symptom Inventory (MFSI). The MFSI (Stein, Martin, Hann, & Jacobsen, 1998) is a 30-item measure designed to identify 5 facets of fatigue: 1) global experience of fatigue; 2) somatic symptoms of fatigue; 3) cognitive symptoms of fatigue; 4) affective symptoms of fatigue; and 5) behavioral symptoms of fatigue. Patients are asked to rate each statement according to how true it has been over the past 7 days along a 5-point Likert scale from 0 (not at all) to 4 (Extremely). The MFSI has demonstrated efficacy in predicting the presence and magnitude of self-reported fatigue in orofacial pain patients (de Leeuw, Studts, & Carlson, 2005).

Emotion Regulation Questionnaire (ERQ). The ERQ (Gross & John, 2003) is a 10-item measure designed to assess individual differences in the habitual use of two

emotion regulation strategies: cognitive reappraisal and expressive suppression. Respondents are asked to indicate strength of agreement with each item on a seven-point Likert scale from 1 (strongly disagree) to 7 (strongly agree). The ERQ has shown good overall internal consistency (coefficient alphas: reappraisal = 0.79, suppression = 0.73) (Gross & John, 2003).

Emotion Assessment Scale (EAS). The EAS (Carlson et al., 1989) is a 24-item scale designed to measure eight fundamental dimensions of emotional responses (surprise, fear, disgust, anger, guilt, anxiety, sadness, and happiness). The EAS contains 24 visual analog scale items that range from 0 to 100 mm. The EAS has a split-half reliability of .94 (Carlson et al., 1989).

Family of Origin Scale (FOS). The FOS (Hovestadt, Anderson, Piercy, Cochran, & Fine, 1985) is a 40-item measure of the perceived tone of social-emotional relationships in the family-of-origin, focusing on warmth and acceptance. The participant is asked to indicate strength of agreement with each item on a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). The 15-item short form was used in this study (Ryan, Powel, Kawash, & Fine, 1995). The FOS has shown good overall internal consistency (coefficient alphas: total 40-item form=0.96, 15-item short form=0.95).

Social Constraints Scale (SCS). The SCS (Lepore & Ituarte, 1999) is a 15-item self-report measure of the extent to which the participant's social environment inhibits expression of distressing thoughts and feelings. This study used the "friends/family" version of the SCS. The participant notes incidence of different social experiences in the past month using a 4-point Likert scale. The scale ranges from "never" to "often." The test-retest reliability of the SCS is 0.71 at nine months, and coefficient alpha has ranged from 0.89 to 0.92 (Lepore & Ituarte, 1999).

Duke-UNC Functional Social Support Questionnaire (DUKE-SSQ). The DUKE-SSQ (Broadhead, Gehlbach, De Gruy, & Kaplan, 1988) is an eight-item, multidimensional, functional social support questionnaire designed for use with medical populations. The participant notes level of satisfaction with amount of social support in various areas using a 5-point Likert scale. The scale ranges from "much less than I

would like" to "as much as I would like." The DUKE-SSQ yields a total score, and coefficient alpha has ranged from 0.86 to 0.88 (Andrykowski, Cordova, Studts, & Miller, 1998; Schmidt & Andrykowski, 2004).

Control participants were administered the following questionnaires: Symptom Check List –90 (SCL-90), Pittsburgh Sleep Quality Index (PSQI), Posttraumatic stress disorder Check List – Civilian version (PCL-C), Multi-dimensional Fatigue Symptom Inventory (MFSI), Emotion regulation questionnaire (ERQ), Emotion Assessment Scale (EAS), Family of Origin Scale (FOS), Social Constraints Scale (SCS), and the DUKE-Social Support Questionnaire (DUKE-SSQ).

Current stage of menstrual cycle

Day of menstrual cycle was recorded for participants by asking for the last day of their previous period. The menstrual cycle is divided into four phases: menstruation (days 1-5), proliferative phase (days 6-13), ovulation (day 14), and luteal or secretory phase (days 15 to 28). Research has demonstrated that autonomic regulation of the heart fluctuates during the menstrual cycle with HRV being lower in the luteal phase that in the other phases (Landen et al., 2004; Sato, Miyake, Akatsu, & Kumashiro, 1995). The results of these studies suggest that sympathetic nervous system activity is dominant during the luteal phase. This difference is thought to be due to high concentrations of progesterone present during this phase of the menstrual cycle.

Physiological measures

The physiological measures were recorded using the MP150 Biopac data acquisition system (Biopac Systems, Inc.). The configuration for this study included the electrocardiogram and end-tidal carbon dioxide amplifier modules. Cardiovascular activity was recorded using three Ag/AgCl electrodes using shielded leads connected to an ECG100C electrocardiogram amplifier module. The sampling rate for this module was set to 1000 samples/second. The electrodes were placed in the Lead I configuration, with the positive and negative electrodes connected to the inside of the forearms (Guyton, 1991). Module settings were as follows: gain = 1000; high pass filter = .05Hz; notch

interference filter (35Hz) = on.

To calculate the heart rate variability frequency domain indices, the ECG signal was first filtered and transformed into R-R intervals using the Biopac Aquire system software. These data were then saved as a text file for frequency domain analyses. Frequency domain analyses were completed using HRV Analysis Software version 1.1 SP1 by Biomedical Signal Analysis Group, Department of Applied Physics, University of Kuoplo, Finland. This software package is a stand-alone HRV analysis program that provides a variety of HRV indices including non-parametric Fast Fourier Transform (FFT) spectrum values of HRV, geometric HRV measures, and parametric Auto Regressive spectrum values of HRV. For this study, the non-parametric FFT HRV values in normalized units will be reported. These include the Low Frequency (LF) index, the High Frequency (HF) index, and the LF/HF ratio.

End Tidal Carbon Dioxide and breathing rate were recorded by placing a nasal canula under the participant's nose. The canule tubing was connected a CO2100C amplifier module. This module records quickly varying carbon dioxide concentration levels, and provides a continuous measure of ETCO2 throughout the study. Sampling rate for this module is 100ml/min. The mean peak ETCO2 value was recorded as a percentage. Breathing rate in breaths per minute was also recorded via the data collected with this module. The only adjustable setting for this module is gain, which was set to 5%CO2/volt for the present study. Due to equipment problems, ETCO2 data were not available for all participants therefore these data will not be reported. Breathing rate was successfully recorded for all study participants.

Procedure

Prior to the laboratory evaluation, participants completed an informed consent and were interviewed to ensure they met all screening criteria. Height and weight were recorded and the participant then completed study psychometric measures in a quiet room free from distractions. Once the study measures were completed, the PI introduced the participant to the physiological laboratory and equipment. The participant was seated in a comfortable chair and the physiological recording leads were attached. After the leads

were attached and tested, the participant rested quietly for a five-minute adaptation period. Following this, a ten-minute baseline recording was completed (baseline period). During the baseline, the participant was instructed to sit quietly and was alone in the laboratory. The first EAS was administered after the baseline recording. This was followed by the laboratory challenge (recall period).

The laboratory challenge consisted of having the participant describe one past significant stressful negative life event for ten-minutes. Participants were encouraged not to 'relive' negative life experiences, only to describe them. Prior to beginning the laboratory challenge, the PCL-C was reviewed and if a traumatic event was reported, the participant was asked to describe the event marked as most distressing. If no traumatic event was reported on the PCL-C, the participant was asked to describe the most significant stressful life event experienced. All narratives were videotaped. The videotapes from this study will be analyzed and coded for a future paper. Prior to describing the significant life event, a two-minute narrative trial was completed to acclimate the participant to the stimulus condition. The participant was instructed to describe the day's activities while facing the video camera. During the two-minute acclimation and the ten-minute narrative, the participant was alone in the laboratory.

This stimulus procedure has been used to investigate HRV differences among normal controls and with individuals diagnosed with PTSD and panic anxiety (Cohen et al., 2000; Cohen et al., 1998). This type of procedure has also been successfully used in research concerning emotional expression with normals (Campbell, 2001), cancer patients (Graves et al., 2005), and with TMD patients (Ohrbach et al., 1998).

The instructions for the emotion stimulus protocol were as follows:

> Two-minute acclimation: I'd like to help you get more comfortable with talking out loud while facing the video camera. During the next two minutes I would like you to face the camera and talk about your activities for the day. Talk about what you've already done today and what you plan on doing during the rest of the day. The important thing is that you describe your activities in as much detail as possible. Remember to talk directly into the camera, being careful not to slouch down in the chair or look down at the floor. If you find you've run out of things to say, its okay to repeat some of the things you might have said earlier. The important thing is just that you try to keep talking during the whole two minutes. I'll leave the room now, and then let you know when the two-minutes are up.

> Ten-minute narrative: During the next 10 minutes, I want you to talk about the most traumatic and upsetting experience of your life. When talking, try not to relive the event. Instead, describe the event and your thoughts and feelings about the event. Remember to talk directly into the camera, without slouching or looking down at the floor, and to talk about your thoughts and feelings about this traumatic and upsetting experience in your life. If you find you've run out of things to say, its okay to repeat some of the things that you might have said earlier. The most important thing is that you continue talking as much as possible about your thoughts and feelings about this traumatic and upsetting experience. You will be alone in this private room to talk about the experience, with no one listening to you. I will knock on the door and then enter to let you know when the ten-minutes are up.

The laboratory challenge was followed by a ten-minute post-stressor recording (recovery period). Again, the participant was alone in the room during the recording. This was followed by completion of another EAS. Participants were then debriefed and excused from the study.

Chapter 3

Results

Analytic Strategy

Overall 2 (pain patients vs. matched pain-free controls) X 3 (baseline, stressor, and recovery) repeated measures MANOVAS were performed on the physiological and emotional status data. Specific hypotheses for physiological and emotional status variables were tested with focused contrasts. Hypothesized differences between the two groups on general psychological and social-environment variables were compared with univariate ANOVAs. All statistical analyses were completed with the Statistical Package for the Social Sciences, Release 11.5.0.0 (SPSS Inc., 1989-2004). The criterion for statistical significance was set at $p < .05$. To control for Type 1 error associated with multiple comparisons, Bonferroni corrections were used as appropriate. Effect sizes for hypothesized analyses are reported using Cohen's d. Correlations among the main study variables for each group are presented in Tables 3.1 and 3.2.

Pain Assessment

Pain evaluations were completed prior to beginning the laboratory challenge to ensure the patients diagnosed with Masticatory Muscle Pain (MMP) were indeed experiencing ongoing muscle pain at the time of the study. The MMP group reported a mean present pain intensity over the previous week of 53.50 (sd = 25.81) on the pain VAS ('0' to '100' mm) where '0' is 'no pain at all' and '100' is 'the worst pain imaginable.' The Pain Free Control (PFC) group reported no chronic pain condition or present pain complaint at the time of study participation.

Current stage of menstrual cycle

Prior to the completing the physiological analyses, the two groups were compared on phase of menstrual cycle during time of study participation. This comparison was done to ensure there was an equal distribution of participants in the luteal phase between the groups at the time of study completion. A Chi-square comparison was completed and

showed no significant difference in the number of participants in the luteal phase, MMP = 6 vs. PFC = 3; chi-square (1,44) = 1.42, $p < .30$.

Incidence and Severity of Traumatic Stressors

The two groups were compared on number of participants that reported a traumatic stressor and met criteria for clinically significant PTSD symptomatology according to the cut-off score established by Blanchard et al. (1996). A Chi-Square comparison between the two groups was completed and showed no significant difference in the number of participants reporting a significant stressor on the PCL-C, MMP = 14 vs. PFC = 11; chi-square (1,44) = 1.13, $p < .30$. These two sub-groups were compared on the PCL-sum score to determine if there was a significant difference in reported PTSD symptom intensity. Results showed no significant difference between the two sub-groups on PCL-sum score, MMP = 35.14 vs. PFC = 31.18; $F(1,24) = .79$, $p < .40$. The number of participants that met the cut-off score for clinically significant PTSD symptomatology was n = 5 (23%) for the MMP group and n = 1 (4%) for the PFC group.

Physiological Variables

The overall MANOVA for HRV indices indicated no significant main effect for group differences between the MMP group and PFC group, Wilks' Lambda (3,41) = .86, $p < .10$. Results showed a significant main effect for time, Wilks' Lambda (6,38) = .38, $p < .001$. Pairwise comparisons among the HRV indices across the three study time periods showed significant differences between the baseline and recall periods (LF baseline = 55.45, recall = 74.23, $p < .001$; HF baseline = 44.55, recall = 25.34, $p < .001$; Ratio baseline = 1.55, recall = 4.06, $p < .001$) and the recall and recovery periods (LF recall = 74.23, recovery = 59.07, $p < .001$; HF recall = 25.34, recovery = 41.55, $p < .001$; Ratio recall = 4.06, recovery = 1.96, $p < .001$). These data confirm the effectiveness of the stress recall procedure used in this study. There was no main effect for the interaction of time x group, Wilks' Lambda (6,38) = .87, $p < .10$.

The overall MANOVA was followed by focused contrasts to evaluate the a priori hypothesis that the MMP group would have lower HF, higher LF, and higher LF/HF ratio

HRV indices at baseline compared to the PFC group. Focused contrasts showed marginally significant differences in the LF and HF baseline HRV values with the MMP group higher on LF HRV, MMP = 60.11 vs. PFC = 51.18, $F(1,44) = 3.86$, $p < .06$, Cohen's d = .59, and lower on HF HRV, MMP = 39.89 vs. PFC = 48.82, $F(1,44) = 3.86$, $p < .06$, Cohen's d = .59, when compared to the PFC group. As expected the LF/HF baseline value was significantly higher in the MMP group, MMP = 1.97 vs. PFC = 1.16, $F(1,44) = 9.17$, $p < .01$, Cohen's d = .90, when compared to the PFC group.

To evaluate the a priori hypothesis that the MMP group will have higher LF, lower HF, and higher LF/HF ratio HRV indices at recovery compared to the PFC group, univariate comparisons between the experimental groups were completed on these HRV indices. Results showed the MMP group to be significantly higher on LF compared to the PFC group, MMP = 63.87 vs. PFC = 54.96, $F(1,44) = 4.30$, $p < .05$, Cohen's d = .62, significantly lower on HF compared to the PFC group, MMP = 36.13 vs. PFC = 46.49, $F(1,44) = 6.11$, $p < .056$, Cohen's d = .74, and significantly higher on the LF/HF ratio compared to the PFC group, MMP = 2.72 vs. PFC = 1.26, $F(1,44) = 6.47$, $p < .05$, Cohen's d = .75. Characteristics of the HRV indices are presented in Table 3.3. Figures 3.1, 3.2, and 3.3 provide graphical displays of the LF, HF, and LF/HF ratio HRV indices group differences across study periods.

To determine if the differences were due to initial baseline differences between the groups, Analyses of Covariance (ANCOVA) using the initial baseline values as the covariate were completed for the recall and recovery period HRV indices. No differences were found between the two groups on recall or recovery period HRV indices when baseline values were used as covariates. These results of the ANCOVA analyses are presented in Table 3.4.

A 1 (stressor) X 3 (baseline, stressor, recovery) repeated measures analyses of variance was used to evaluate the hypothesis that participants in the MMP group reporting a traumatic stressor will show very little change in HRV indices between the three recording periods. Of the 22 MMP participants in this study, 14 (64%) reported a traumatic stressor. The overall MANOVA for the HRV indices indicated no significant main effect for time, Wilks' Lambda $(2,12) = .52$, $p < .20$. Repeated measures univariate

analyses were significant for LF HRV [$F(2,12) = 6.40$, $p < .05$, HF HRV, $F(2,12) = 6.40$, $p < .01$, and LF/HF ratio, $F(2,12) = 7.26$, $p < .01$ across the three study periods. Within-subject focused contrasts showed a significant difference between the baseline and recall periods for all HRV indices, however, there were no significant differences between the recall and recovery periods on the HRV indices. The HRV means and standard deviations for the MMP patients that reported a traumatic stressor are shown presented in Table 3.5.

Breathing rates in breaths-per-minute were also recorded and calculated for each period. Univariate comparisons between groups for the baseline, MMP = 18.8 vs. PFC = 16.4, $F(1,44) = 2.57$, $p < .200$, and recovery periods, MMP = 18.2 vs. PFC = 15.6, $F(1,44) = 3.33$, $p < .10$, showed no significant difference in breathing rates between the two experimental groups.

Emotional Reactivity

Emotional status was assessed immediately following the baseline period and again, after the recovery period. All study participants completed the EAS at these time-points. The overall 2 (group) X 2 (baseline vs. recovery) MANOVA on the emotional reactivity variables indicated a significant difference between the MMP and PFC groups, Wilks' Lambda $(16,27) = .245$, $p<001$. To evaluate the hypothesis that the MMP group would report more emotional reactivity to the stressor period compared to the PFC group, univariate comparisons were completed on the emotional status variables. The MMP group reported more 'anxiety' prior to the stressor, MMP = 25.0 vs. PFC = 11.0, $F(1,43) = 4.35$, $p < .05$, Cohen's $d = .62$, and more 'anger' after the recovery period, MMP = 11.18 vs. PFC = 2.74, $F(1,43) = 5.87$, $p < .05$, Cohen's $d = .72$, compared to the PFC group. In contrast, the PFC group reported more 'happiness' prior to the stressor, MMP = 25.6 vs. PFC = 42.8, $F(1,43) = 4.09$, $p < .05$, Cohen's $d = .60$, than did the MMP group.

Psychological, physical, and social Variables

The between groups MANOVA on the psychological, fatigue, and sleep variables indicated a significant difference between the MMP group and PFC group, Wilks'

Lambda (15,29) = .152, p < 001. To evaluate the hypothesis that the MMP group would report more psychological distress compared to the PFC group, a univariate comparison was completed on the Global Severity Index (GSI) of the SCL-90-R. The MMP group scored significantly higher on the GSI, F(1,44) = 16.69, p < .001, Cohen's d = 1.22, compared to the PFC group. This analysis was followed by post-hoc comparisons on the individual SCL-90-R subscales using Bonferroni corrections to control for Type 1 error. The MMP group reported greater somatization, F(1,44) = 44.71, p < .001, Cohen's d = 2.0, obsessive-compulsive behavior, F(1,44) = 7.74, p < .01, Cohen's d = .81, depression, F(1,44) = 10.03, p < .01, Cohen's d = .95, and anxiety, F(1,44) = 7.54, p < .01, Cohen's d = .82 on the SCL-90-R subscales as compared to the PFC group. To evaluate the hypothesis that the MMP group would report more fatigue compared to the PFC group, univariate comparisons were made on the subscales of the MFSI. The MMP group reported significantly more general fatigue, F(1,44) = 13.56, p < .001, Cohen's d = 1.22, physical fatigue, F(1,44) = 32.99, p < .001, Cohen's d = 1.74, and mental fatigue, F(1,44) = 12.87, p < .001, Cohen's d = 1.01, than the PFC group. The MMP group also reported significantly less vigor F(1,44) = 11.72, p < .001, Cohen's d = 1.02, compared to the PFC group. As hypothesized, the MMP group reported more sleep dysfunction compared to the PFC group, F(1,44) = 56.88, p < .001, Cohen's d = 2.0. These data are presented in Table 3.6.

To evaluate the hypothesis that the MMP group would report more social constraints, less social support, and a family-of-origin environment characterized by conflict and aggression when compared to the PFC group, univariate comparisons were completed on these variables. A significant difference was found on perceived social constraints, SCS: F(1,44) = 7.40, p < .01, Cohen's d = .78, with the MMP group reporting a more constraining social environment than did the PFC group. In contrast, no difference was noted between the two groups on perceived social support, DUKE-SSQ: F(1,44) = .08, p < .80. The MMP group also reported a more dysfunctional family-of-origin, FOS: F(1,44) = 4.46, p < .05, Cohen's d = .65, compared to the PFC group. These results are presented in Table 3.7.

To test the hypotheses that the MMP group would report more use of the emotion regulation strategy of reappraisal and less use of suppression compared to the PFC group, univariate comparisons were completed on these two variables. The two groups were not significantly different on the measured emotion regulation strategies of reappraisal, ERQ-Reappraisal: $F(1,44) = .93$, $p < .40$, or suppression, ERQ-Suppression: $F(1,44) = .04$, $p < .900$. These data are presented in Table 3.7 as well.

A post-hoc comparison on social environment measures was then completed among the participants in the MMP group who reported a traumatic stressor. Results showed that the MMP group participants reporting clinically significant PTSD symptomatology reported significantly higher perceived social constraints, MMP(PTSD-positive) = 43.0 vs. MMP(PTSD-negative) = 29.6; $F(1,13) = 6.33$, $p < .05$, Cohen's $d = 1.5$, and lower perceived social support, MMP (PTSD-positive) = 23.2 vs. MMP (PTSD-negative) = 33.1; $F(1,13) = 8.78$, $p < .05$, Cohen's $d = 1.8$, compared to the MMP group participants who reported a traumatic stressor, but did not meet the cut-off for clinically significant PTSD symptomatology. There were no differences on the Family of Origin measure between these two sub-groups of patients, MMP (PTSD-positive) = 41.7 vs. MMP (PTSD-negative) = 38.0; $F(1,13) = .25$, $p < .700$.

Measure															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. LF/HF-B	1.0														
2. LF/HF-R	.555*	1.0													
3. VAS	-.351	-.294	1.0												
4. Duration	.219	.191	.311	1.0											
5. PSQI	.178	.372	.264	-.167	1.0										
6. SCS	-.538*	-.223	.710**	.335	-.188	1.0									
7. DUKE	.736*	.329	-.624*	-.031	-.110	-.717*	1.0								
8. ERQ-R	-.227	-.226	-.198	-.011	-.176	.306	-.219	1.0							
9. ERQ-S	-.057	-.252	.617	.209	-.016	.340	-.258	-.022	1.0						
10. FOS	.371	.208	-.777**	-.165	.153	-.604*	.496	-.266	-.318	1.0					
11. GSI	-.285	.010	.447	.082	.432	.486	-.495	-.068	.213	-.221	1.0				
MFSI															
12. General	-.437	-.192	.550	.095	.439	.373	-.499	-.275	.163	-.404	.505	1.0			
13. Emotion	-.230	.050	.647	.121	.541*	.500	-.454	-.102	.334	-.251	.850*	.600*	1.0		
14. Physical	-.354	-.101	.622	.347	.419	.591*	-.682*	.039	.298	-.346	.820*	.565*	.775*	1.0	
15. Mental	-.122	.082	.359	.156	.472	.368	-.358	.162	.206	-.096	.827*	.337	.637*	.585*	1.0
16. Vigor	.041	-.123	-.290	-.385	-.460	-.208	.178	.261	-.203	.073	-.326	-.615*	-.584*	-.423	-.161

* correlation is significant at the .01 level.

Note. LF/HF=Low Frequency to High Frequency HRV Ratio (B=Baseline, R=Recovery). VAS=Visual Analog Scale of present pain. Duration=Duration of pain. PSQI=Pittsburgh Sleep Quality Index. SCS=Social Constraints Scale. DUKE-SSQ: Duke Social Support Questionnaire. ERQ-R=Emotion Regulation Questionnaire-Reappraisal. ERQ-S=Emotion Regulation Questionnaire-Suppression. FOS=Family of Origin Scale. GSI=General Severity Index of the SCL-90R. MFSI=Multidimensional Fatigue Symptom Inventory.

Table 3.1

Intercorrelations Between Major Independent Variables with Dependent Variables for the Muscle Pain Patients. (N = 22)

Measure													
	1	2	3	4	5	6	7	8	9	10	11	12	13
1. LF/HF-B	1.0												
2. LF/HF-R	.244	1.0											
3. PSQI	-.112	-.118	1.0										
4. SCS	.458	.035	.232	1.0									
5. DUKE	-.449	-.081	.035	-.689*	1.0								
6. ERQ-R	-.443	-.065	-.097	-.313	.427	1.0							
7. ERQ-S	-.019	.144	.006	.349	-.351	-.117	1.0						
8. FOS	-.245	.278	.013	-.476	.565*	.259	.130	1.0					
9. GSI	.205	.160	.343	.539*	-.556*	.357	.495*	-.300	1.0				
MFSI													
10. General	.006	.202	.454	.174	-.174	-.226	.460*	.070	.682*	1.0			
11. Emotion	.136	.155	.352	.376	-.353	-.156	-.055	-.349	.545*	.412	1.0		
12. Physical	-.105	-.005	-.126	.213	-.157	-.190	.385	-.053	.490	.397	.112	1.0	
13. Mental	.176	.465	.257	.198	-.415	-.279	.554*	-.088	.658*	.789*	.310	.191	1.0
14. Vigor	-.156	.039	.228	-.176	.554*	.297	-.234	.140	-.381	.018	-.095	-.175	-.068

* correlation is significant at the .01 level.

Note. LF/HF=Low Frequency to High Frequency HRV Ratio (B=Baseline, R=Recovery). VAS=Visual Analog Scale of present pain. Duration=Duration of pain. PSQI=Pittsburgh Sleep Quality Index. SCS=Social Constraints Scale. DUKE-SSQ: Duke Social Support Questionnaire. ERQ-R=Emotion Regulation Questionnaire-Reappraisal. ERQ-S=Emotion Regulation Questionnaire-Suppression. FOS=Family of Origin Scale. GSI=General Severity Index of the SCL-90R. MFSI=Multidimensional Fatigue Symptom Inventory.

Table 3.2

Intercorrelations Between Major Independent Variables with Dependent Variables for the Pain Free Controls. (N = 23)

Table 3.3

Characteristics of Heart Rate Variability Indices

	Pain Group (n=22) M (sd)	Control Group (n=23) M (sd)	F(1,44)	p	Cohen's d
Baseline					
LF (nu)	60.11 (17.92)	51.18 (11.89)	3.86	.056	.59
HF (nu)	39.89 (17.92)	48.82 (11.89)	3.86	.056	.59
LF/HF	1.97 (1.16)	1.16 (.52)	9.17	.004	.90
Recall					
LF (nu)	74.65 (14.80)	73.83 (12.36)	.04	.843	.06
HF (nu)	24.44 (12.27)	26.17 (12.36)	.22	.646	.14
LF/HF	4.40 (3.37)	3.76 (2.36)	.53	.470	.16
Recovery					
LF (nu)	63.87 (16.61)	54.69 (12.66)	4.30	.044	.62
HF (nu)	36.13 (16.61)	46.49 (10.82)	6.11	.018	.74
LF/HF	2.72 (2.71)	1.26 (.49)	6.47	.015	.75

Note. LF (nu) = Low Frequency (normalized units), HF (nu) = High Frequency (normalized units), LF/HF = Low Frequency to High Frequency ratio. Cohen's d notes effect sizes for significant contrasts.

Table 3.4

ANCOVA Results for Heart Rate Variability Indices

	Pain Group (n=22) M (sd)	Control Group (n=23) M (sd)	F(1,44)	P
Recall				
LF (nu)	74.65 (14.80)	73.83 (12.36)	.07	.793
HF (nu)	24.44 (12.27)	26.17 (12.36)	.00	.985
LF/HF	4.40 (3.37)	3.76 (2.36)	.00	.987
Recovery				
LF (nu)	63.87 (16.61)	54.69 (12.66)	1.02	.318
HF (nu)	36.13 (16.61)	46.49 (10.82)	2.26	.140
LF/HF	2.72 (2.71)	1.26 (.49)	1.07	.308

Note. Baseline values for HRV indices were used as covariates for these data. LF (nu) = Low Frequency (normalized units), HF (nu) = High Frequency (normalized units), LF/HF = Low Frequency to High Frequency ratio.

Table 3.5

Characteristics of Heart Rate Variability Indices in MMP Patients Reporting a Trauma

	Baseline	Recall	Recovery
MMP reporting a trauma (n=14)			
LF (nu)	59.15[a] (18.27)	77.18[b] (13.43)	64.37[b] (17.25)
HF (nu)	40.85[a] (18.28)	22.81[b] (13.43)	35.63[b] (17.25)
LF/HF	1.91[a] (1.19)	5.17[b] (4.01)	3.07[b] (3.33)

Note. Means and standard deviations are shown. LF (nu) = Low Frequency (normalized units), HF (nu) = High Frequency (normalized units), LF/HF = Low Frequency to High Frequency ratio.

[ab] When superscripts are the same between the periods on a measure, focused contrasts indicate no significant difference in period means. When superscripts are different, focused contrasts indicate significant difference between period means at $p < .05$.

Table 3.6

SCL-90-R Symptom Dimension, Fatigue, and Sleep Quality Means and Standard Deviations

	Pain Group (n=22) M (sd)	Control Group (n=23) M (sd)	F(1,44)	p	Cohen's d
General Severity Index (GSI)	64.55 (6.89)	54.26 (9.69)	16.69	.001	1.22
Somatization	67.95 (7.56)	50.48 (9.78)	44.71	.001	2.00
Obsessive-compulsive	63.23 (10.56)	54.39 (11.24)	7.74	.009	.81
Interpersonal Sensitivity	58.73 (9.07)	56.78 (11.55)	.39	.534	.19
Depression	63.36 (5.67)	56.04 (9.32)	10.03	.003	.95
Anxiety	59.14 (11.13)	50.48 (10.02)	7.54	.009	.82
Hostility	55.91 (10.46)	50.91 (7.12)	3.54	.067	.56
Phobic anxiety	56.09 (11.75)	50.87 (8.77)	2.87	.097	.80
Paranoid ideation	57.41 (11.48)	50.43 (11.79)	4.03	.051	.60
Psychoticism	59.09 (11.45)	55.74 (11.56)	.95	.334	.29
MFSI					
General Fatigue	16.77 (8.96)	6.68 (7.52)	13.56	.001	1.22
Emotional Fatigue	9.91 (5.99)	6.96 (4.90)	3.27	.077	.54
Physical Fatigue	11.95 (3.22)	6.73 (2.76)	32.99	.001	1.74
Mental Fatigue	8.59 (5.37)	3.65 (3.76)	12.87	.001	1.01
Vigor	8.91 (4.45)	12.91 (3.34)	11.72	.001	1.02
PSQI	11.36 (3.54)	4.70 (2.29)	56.88	.001	2.00

Note. SCL-90-R = Symptom CheckList 90 – Revised, MFSI = Multidimensional Fatigue Symptom Inventory, PSQI = Pittsburgh Sleep Quality Index.
Cohen's d notes effect sizes for significant contrasts.

Table 3.7

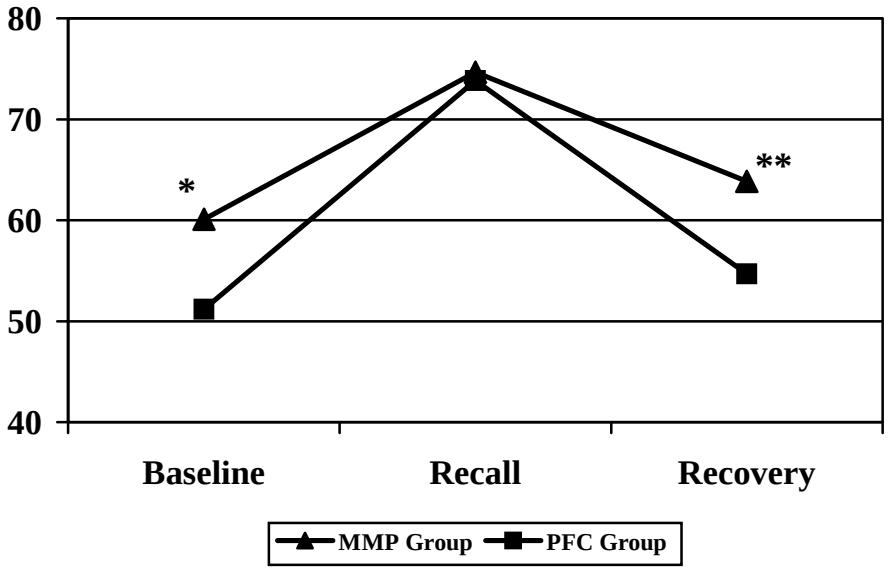
Characteristics of Self-Report Psycho-Social Domain Measures

Measure	Pain Group (n=22) M (sd)	Control Group (n=23) M (sd)	F(1,44)	p	Cohen's d
SCS	34.33 (11.95)	26.00 (9.26)	7.40	.009	.78
DUKE-SSQ	30.62 (7.05)	31.27 (8.19)	.08	.779	.09
Family of Origin	42.48 (12.58)	50.09 (11.32)	4.46	.041	.65
ERQ-Reappraisal	31.33 (5.20)	29.65 (5.84)	.93	.341	.30
ERQ-Suppression	12.86 (3.77)	12.35 (4.67)	.04	.851	.12

Note. PSQI = Pittsburgh Sleep Quality Index, SCS = Social Constraints Scale, DUKE-SSQ – DUKE Social Support Questionnaire, ERQ = Emotion Regulation Questionnaire, MFSI = Multidimensional Fatigue Symptom Inventory. Cohen's d notes effect sizes for significant contrasts.

Figure 3.1

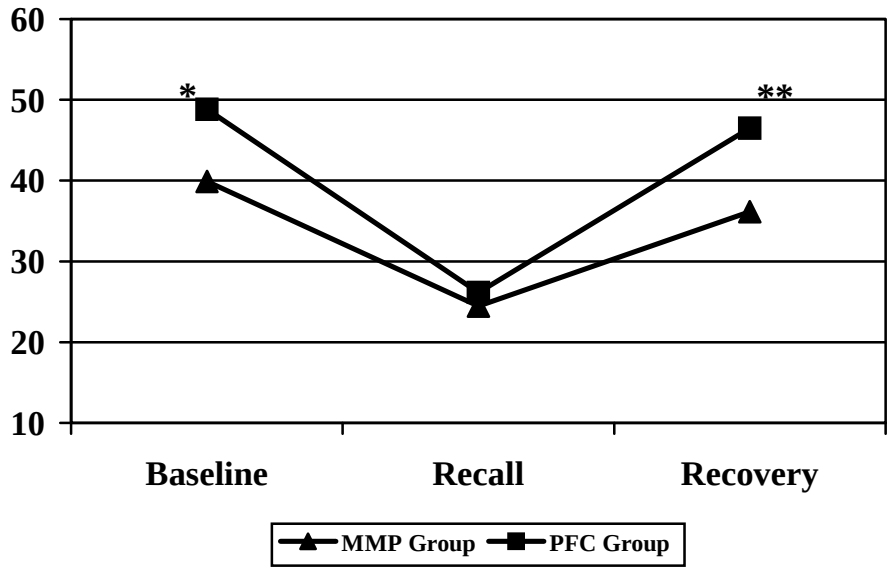
Low Frequency (nu) HRV



Note: *p<.06 between group comparison marginally significant at the baseline period.
**p<.05 between group comparison significant at the recovery period.

Figure 3.2

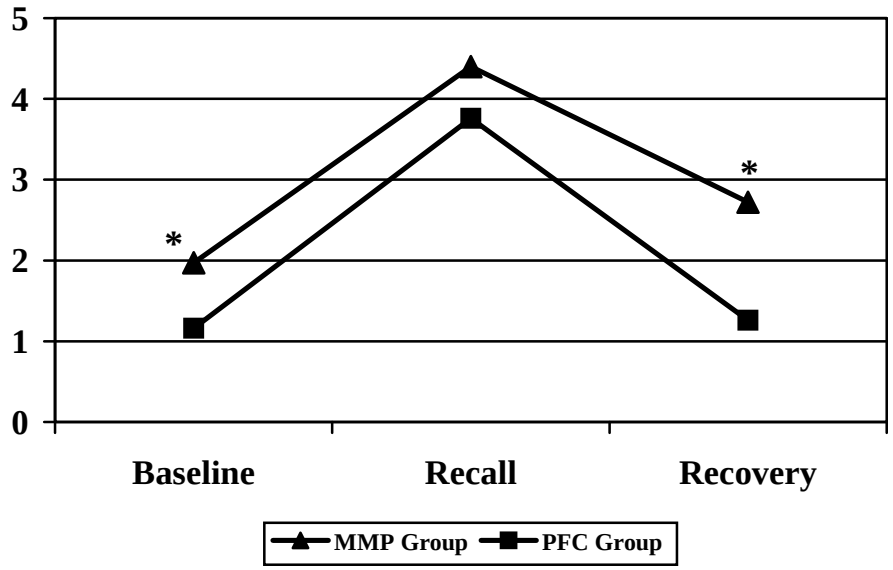
High Frequency (nu) HRV



Note: *p<.06 between group comparison marginally significant at the baseline period.
**p<.05 between group comparison significant at the recovery period.

Figure 3.3

Low Frequency to High Frequency Ratio (LF/HF)



Note: *p<.05 between group comparisons significant at the baseline and recovery periods.

Chapter 4

Discussion

This study compared a group of chronic masticatory muscle pain patients with a group of age, height, and weight matched pain-free controls on emotional and physiological reactivity to a personally relevant stressor. The main aim of this study was to determine the efficacy of using heart rate variability indices as quantitative measures of autonomic regulation that would differentiate chronic masticatory muscle pain patients from matched pain-free controls. One of the noteworthy findings from this study was that muscle pain patients showed significantly higher LF, LF/HF ratio, and lower HF HRV indices during recovery from a personally relevant stressor compared to the pain-free controls. During the stressor period the HRV index values were nearly the same for both study groups.

The physiological differences shown by the HRV indices between muscle pain patients and pain-free controls during the recovery period helps us understand previous findings of heightened physiological activation with these patients. Masticatory muscle pain patients have shown more cardiovascular and emotional reactivity to a standard stressor when compared to controls (Carlson et al., 1998; Curran et al., 1996). Muscle pain patients have also consistently shown lower pain threshold and tolerance when compared to pain-free controls (Carlson et al., 1998; Maixner et al., 1995; Maixner, Fillingim, Sigurdsson, Kincaid, & Silva, 1998). While pain-sensitivity differences are likely due to a complex integration of central nervous system changes, these differences also could be linked to chronic physiological activation that does not respond to inhibitory controls. The HRV differences between muscle pain patients and pain-free controls in the present study suggest potential use of HRV indices as a means to study the relative contributions of sympathetic and parasympathetic activity. Furthermore, the nearly significant increased sympathetic activity and decreased parasympathetic activity noted in the muscle pain patients at rest in this study as compared to the pain-free controls raises the possibility that these patients may be experiencing compromised inhibitory control of sympathetic activity.

Heart rate variability as an index of autonomically-mediated inhibitory control is central to Thayer's model of neurovisceral integration (Thayer & Lane, 2000). Within the framework of this model, Thayer proposed that the measurement of HRV may quantify self-regulatory ability. Specifically, higher vagal tone as indexed by higher HF HRV is associated with enhanced self-regulatory ability through greater behavioral flexibility and adaptability. Poor HRV, as indexed by higher LF and lower HF HRV, is associated with poor self-regulation and a lack of behavioral flexibility (Porges, 1992; Thayer & Lane, 2000). Thayer's model posits that a reduction in overall system flexibility results from disinhibition of sympathetic nervous system activity. The data presented here provide evidence of such sympathetic disinhibition in chronic muscle pain patients. Higher LF and lower HF index values in the muscle pain patients during the baseline and recovery periods compared to pain-free controls suggest diminished inhibitory control both at rest and after a stressor. This pattern of physiological activation indexed by HRV measures has been associated with not only other chronic pain conditions, but other negative life experiences as well (Thayer & Lane, 2002).

It is not surprising, therefore, that patients reporting a traumatic stressor could not inhibit sympathetic activation during the recovery period. As we hypothesized, the HRV values during the recovery period were similar to HRV values during the stressor period for these patients. The high LF and low HF HRV index values in this group of muscle pain patients during recovery suggest an inability to inhibit sympathetic activity. Previous studies exploring hyperarousal in PTSD patients also have demonstrated a basal state of autonomic activation characterized by pronounced sympathetic activity, followed by no significant inhibitory activity of sympathetic tone after recounting traumatic events or after discussion of the traumatic experience linked to the onset of PTSD (Cohen et al., 2000; Cohen et al., 1998). The lack of variability in autonomic activity in PTSD patients in these studies suggests a prolonged activation of the sympathetic nervous system. Although the muscle pain patients reporting a traumatic experience in the present study did respond to discussing the event with an increase in LF and a decrease in HF HRV indices, these patients also had sustained physiological arousal between the stressor and recovery periods. The differences between results found by Cohen and the present study may be due mainly to patient characteristics. The patient volunteers in Cohen's studies

were all diagnostically classified with PTSD and were being treated on an outpatient basis for this disorder. In contrast, only 23% of the patients reporting a traumatic event in this study met the cut-off for clinically significant PTSD symptomatology. Thus it is not surprising that physiological activation in the muscle pain patients was not as pronounced as is found in those with a diagnosis of PTSD.

The HRV characteristics of the muscle pain patients across study periods suggest the problem is not in reaction to a stressor per se, but more likely a problem of prolonged sympathetic activation stemming from inhibitory failure, or a failure of recovery following exposure to stressors. Since the muscle pain patients also reported more anxiety after the baseline period and more anger after the recovery period compared to the pain-free controls, it may be that emotional reactivity is contributing to the elevated level of physiological functioning found in the muscle pain patients as compared to the pain-free controls. The presence of more emotional reactivity in the muscle pain patients suggests that emotion regulation may be a factor. These results are in contrast to Carlson et al (1998), who did not report any differences on emotional reactivity between masticatory muscle pain patients and matched controls at baseline or after a standard stressor. On the other hand, use of a personally relevant stressor, in this case discussing a distressing or traumatic life experience, may account for this difference. While the change in HRV indices between the baseline and recall periods for both the muscle pain patients and the pain-free controls indicate the emotional stressor did in fact significantly influence autonomic system functioning through emotional arousal, the patients reported more emotional reactivity both prior to and after the stressor. In Thayer's model of neurovisceral integration (Thayer & Lane, 2000), the inability to inhibit sympathetic activity has been associated with a defensive attentional style characteristic of anxiety, hyperarousal, and poor emotion regulation capabilities. These characteristics may also be present to some degree in chronic muscle pain patients and be contributing to the prolonged physiological activation.

Consistent with previous literature focused on psychological distress in muscle pain patients, the SCL-90 results also suggest a problem with persistent emotional turmoil and poor emotional processing. The psychological distress in these patients may be the result of an emotion regulation deficiency, pre-morbid psychopathology, a long-

term problem due to an antagonistic and unloving family-of-origin environment, or a combination thereof. Regardless of the source, problems in the social environment, as shown by the presence of social constraints in the muscle pain patients, suggests insufficient opportunities for cognitive processing of distress-related information. This is consistent with social-cognitive processing theory (Lepore, 2001; Lepore & Helgeson, 1998) which posits that trauma-related distress may remain elevated if the individual fails to engage in suitable discussion of thoughts and feelings regarding the traumatic experience. Such failure may occur due to the lack of ability to express trauma-related thoughts and feelings (e.g., alexithymia). A failure to discuss trauma-related thoughts and feelings may also be due to a social environment that is constraining, where the individual's attempts at discussion are met with unexpected or negative responses from others. Discussion and processing of trauma-related thoughts and feelings in a non-constraining social environment, on the other hand, provides opportunities for the individual to confront and reevaluate thoughts and feelings so that this information can be integrated into preexisting mental schemas.

There is conflicting evidence in the literature about the etiology and mechanisms involved in maintenance of muscle pain conditions. For example, some evidence suggests alterations in central processing structures maintain these conditions (Maixner et al., 1995; Maixner, Fillingim, Kincaid, Sigurdsson, & Harris, 1997; Maixner et al., 1998). This central nervous system change may be due to alterations in baroreceptor effects, which in turn are influenced by arterial blood pressure changes (Maixner et al., 1998). There is also evidence to support the pain-adaptation model (Graven-Nielsen, Svensson, & Arendt-Nielsen, 1997), which proposes chronic pain arises from increases in muscle activity in antagonist musculature structures. This increase in antagonist muscle structures is likely a functional adaptation of muscle coordination to limit muscle activity at the site of pain (Lund, 1991). In general, however, the evidence that over-activation of muscle structures as a driving mechanism for chronic muscle pain is not consistent (Ohrbach & Dworkin, 1998). The present study suggests that a failure of inhibitory control of sympathetic activation may be influencing central processing, as well as physiological changes in peripheral structures.

The data presented here suggest the use of HRV frequency analyses can be helpful in identifying muscle pain patients with chronic autonomic arousal. The HRV indices are consistent and stable biomarkers for sympathetic activation and inhibitory failure. More importantly, HRV frequency indices demonstrate the ability to differentiate among muscle pain patients with traumatic experiences and those without such experiences. There is also potential application of these quantitative markers for evaluating the effects of the treatment of chronic masticatory muscle pain patients. Techniques that conceivably strengthen sympathetic inhibitory control through increasing vagal tone should lead to an improvement in HRV indices, increased parasympathetic tone, improved inhibition of sympathetic activation, and possible changes in psychophysiological response to environmental challenge. Carlson and colleagues have developed a Physical Self-Regulation Training protocol for chronic orofacial pain patients that includes components tailored to reduce physiological activation through the use of diaphragmatic breathing training, gentle stretching exercises, and proprioceptive awareness training (Carlson, Bertrand, Ehrlich, Maxwell, & Burton, 2001). While the effect of these interventions on HRV indices have yet to be evaluated, the physiological activation differences between the muscle pain patients and pain-free controls in the present study suggest such self-regulatory skills training improves inhibitory control of sympathetic activity. Indeed, recent work by Lehrer and colleagues has shown that biofeedback training using HRV indices resulted in increased vagal tone and parasympathetic arousal as well as an increase in baroreflex gain (Lehrer et al., 2003).

Limitations

While the results of this study are potentially very important, several limitations must be noted. Although the experimental design lays the essential foundation for determining between-group differences, nearly significant baseline group differences on the HRV indices make it difficult to establish definitively the problem of recovery after the stressor. Recovery from events that provoke sympathetic activity in pain patients thus remains an open question that requires further study. Additionally, the sample size in this study is small and only includes women. There is also evidence of gender differences in

HRV measures (Carter et al., 2003). These limitations suggest the need for replication of this study, and broader evaluation of HRV characteristics in orofacial pain patients.

The Emotion Regulation Questionnaire did not demonstrate differences between the groups on the emotion regulation strategies of suppression or reappraisal. This result may be due to no differences between the groups on these emotion regulation strategies. However, it may also be due to a measurement issue with this population or with the self-report instrument itself. The psychological data in this study and in previous studies suggest that emotion regulation is an important issue for MMP patients. Future studies should consider more focused measures of emotion regulation to investigate associations between that construct and other characteristics of patients with orofacial pain conditions.

Summary

In summary, the present study provides evidence of physiological activation and emotional responding to a personally-relevant stressor in masticatory muscle pain patients that differentiates them from matched pain-free controls. The use of HRV indices to measure physiological functioning quantifies the degree of sympathetic and parasympathetic activity. The results suggest the use of these HRV indices will improve understanding of the role that excitatory and inhibitory mechanisms play in the onset and maintenance of chronic masticatory muscle pain conditions.

Appendix

Pittsburgh Sleep Quality Index (PSQI)

Name_____ ID#_____ Date_____ Age_____

Instructions:
The following questions relate to your usual sleep habits during the past month ONLY. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions.

1. **During the past month, when have you usually gone to bed at night**?

USUAL BED TIME_____

2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night?

NUMBER OF MINUTES_____

3. During the past month, when have you usually gotten up in the morning?

USUAL GETTING UP TIME_____

4. During the past month, how many hours of *actual sleep* did you get at night? (This may be different than the number of hours you spend in bed.)

HOURS OF SLEEP PER NIGHT_____

For each of the remaining questions, check the one best response. Please answer ***all*** questions.

5. During the past month, how often have you had trouble sleeping because you……..

(a) cannot get to sleep within 30 minutes

Not during the Less than Once or Three or more
past month_____ once a week_____ twice a week_____ times a week_____

(b) Wake up in the middle of the night or early morning

Not during the Less than Once or Three or more
past month_____ once a week_____ twice a week_____ times a week_____

(c) Have to get up to use the bathroom.

Not during the Less than Once or Three or more
past month_____ once a week_____ twice a week_____ times a week_____

(d) Cannot breathe comfortably.

Not during the Less than Once or Three or more
past month_____ once a week_____ twice a week_____ times a week_____

(e) Cough or snore loudly.

Not during the Less than Once or Three or more
past month_____ once a week_____ twice a week_____ times a week_____

(f) Feel too cold.

Not during the Less than Once or Three or more
past month_____ once a week_____ twice a week_____ times a week_____

(g) Feel too hot.

Not during the Less than Once or Three or more
Past month_____ once a week_____ twice a week_____ times a week_____

(h) Had bad dreams.

Not during the Less than Once or Three or more
Past month_____ once a week_____ twice a week_____ times a week_____

(i) Have pain.

Not during the Less than Once or Three or more
Past month_____ once a week_____ twice a week_____ times a week_____

(j) Other reason(s), please describe_____

How often during the past month have you had trouble sleeping because of this?

Not during the Less than Once or Three or more
Past month_____ once a week_____ twice a week_____ times a week_____

6. During the past month, how would you rate your sleep quality overall?

Very good _____
Fairly good _____
Fairly bad _____
Very bad _____

7. During the past month, how often have you taken medicine (Prescribed or "over the counter") to help you sleep?

Not during the Less than Once or Three or more
Past month_____ once a week_____ twice a week_____ times a week_____

8. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?

Not during the Less than Once or Three or more
Past month_____ once a week_____ twice a week_____ times a week_____

9. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?

No problem at all _____
Only a very slight problem _____
Somewhat of a problem _____
A very big problem _____

10. Do you have a bed partner or share a room?

No bed partner or do not share a room _____
Partner/ flatmate in other room _____
Partner in same room, but not same bed _____
Partner in same bed _____

11. If you have a bed partner or share a room, ask him/her how often in the past month you have had……

(a) Loud snoring.

Not during the Less than Once or Three or more
Past month_____ once a week_____ twice a week_____ times a week_____

(b) Long pauses between breaths while asleep.

Not during the Less than Once or Three or more
Past month_____ once a week_____ twice a week_____ times a week_____

(c) Legs twitching or jerking while you sleep.

Not during the Less than Once or Three or more
Past month_____ once a week_____ twice a week_____ times a week_____

(d) Episodes of disorientation or confusion during sleep.

Not during the Less than Once or Three or more
Past month_____ once a week_____ twice a week_____ times a week_____

(e) **Other restlessness while you sleep: please describe_____**
_____

Not during the Less than Once or Three or more
Past month_____ once a week_____ twice a week_____ times a week_____

Posttraumatic stress disorder Check List – Civilian version (PCL-C)

Sometimes things happen to people that are stressful or disturbing – events that involve experiencing or witnessing actual or threatened death or serious injury to oneself or others. These events may cause the person to feel intense, fear, helplessness, or horror. These include earthquakes, very serious accidents or fires, physical assault or rape, being mugged or robbed, being physically or sexually abused, seeing other people killed or dead, being in a war or heavy combat, being diagnosed with a life-threatening illness or some other type of disaster.

Have any of these or other kinds of things happened to you?

Yes
No

Please check each relevant item on the list below.

- ☐ Military combat
- ☐ Violent attack (robbery, mugging, sexual/physical assault)
- ☐ Being kidnapped
- ☐ Taken hostage
- ☐ Terrorist attack
- ☐ Torture
- ☐ Incarceration (POW, Concentration camp)
- ☐ Natural or man-made disaster
- ☐ Severe auto accident
- ☐ Being diagnosed with a life-threatening illness
- ☐ Sudden injury/serious accident
- ☐ Observed someone hurt or killed
- ☐ Learned about family member or close friend hurt or killed
- ☐ Learned your child has a life-threatening illness
- ☐ Other (Please describe)

Please write the item from the above list that has been YOUR MOST SIGNIFICANT STRESSOR here:

Please enter the month and year the stressor occurred:

Please complete the following questions with reference to YOUR MOST SIGNIFICANT STRESSOR.

Below is a list of problems and complaints that people sometimes have in response to stressful experiences. Please read each one carefully, then circle one of the numbers to indicate how much you have been bothered by that problem in the past month.

1. Repeated, disturbing memories, thoughts or images of a stressful experience?

1	2	3	4	5
Not at all	A little bit	Moderately	Quite a bit	Extremely

2. Repeated, disturbing dreams of a stressful experience?

1	2	3	4	5
Not at all	A little bit	Moderately	Quite a bit	Extremely

3. Suddenly acting or feeling as if a stressful experience were happening again (as if you were reliving it)?

1	2	3	4	5
Not at all	A little bit	Moderately	Quite a bit	Extremely

4. Feeling very upset when something reminded you of a stressful experience?

1	2	3	4	5
Not at all	A little bit	Moderately	Quite a bit	Extremely

5. Having physical reactions (e.g., heart pounding, trouble breathing, sweating) when something reminded you of a stressful experience?

1	2	3	4	5
Not at all	A little bit	Moderately	Quite a bit	Extremely

6. Avoiding thinking about or talking about of a stressful experience or avoiding having feelings related to it?

1	2	3	4	5
Not at all	A little bit	Moderately	Quite a bit	Extremely

7. Avoiding activities or situations because they reminded you of a stressful experience?

1	2	3	4	5
Not at all	A little bit	Moderately	Quite a bit	Extremely

8. Trouble remembering important parts of a stressful experience?

1	2	3	4	5
Not at all	A little bit	Moderately	Quite a bit	Extremely

9. Loss of interest in activities you used to enjoy?

1	2	3	4	5
Not at all	A little bit	Moderately	Quite a bit	Extremely

10. Feeling distant or cut off from other people?

1	2	3	4	5
Not at all	A little bit	Moderately	Quite a bit	Extremely

11. Feeling emotionally numb or being unable to have loving feelings for those close to you?

1	2	3	4	5
Not at all	A little bit	Moderately	Quite a bit	Extremely

12. Feeling as if your future somehow will be cut short?

1	2	3	4	5
Not at all	A little bit	Moderately	Quite a bit	Extremely

13. Trouble falling or staying asleep?

1	2	3	4	5
Not at all	A little bit	Moderately	Quite a bit	Extremely

14. Feeling irritable or having angry outbursts?

1	2	3	4	5
Not at all	A little bit	Moderately	Quite a bit	Extremely

15. Having difficulty concentrating?

1	2	3	4	5
Not at all	A little bit	Moderately	Quite a bit	Extremely

16. Being “superalert” or watchful or on guard?

1	2	3	4	5
Not at all	A little bit	Moderately	Quite a bit	Extremely

17. Feeling jumpy or easily startled?

1	2	3	4	5
Not at all	A little bit	Moderately	Quite a bit	Extremely

In response to the YOUR MOST SIGNIFICANT STRESSOR have you…

Reacted with feelings of intense fear, helplessness, or horror? YES or NO

Felt that the event was a potential threat to your life and safety or the lives and safety of others? YES or NO

Multi-dimensional Fatigue Symptom Inventory (MFSI).

Below is a list of statements that describe how people sometimes feel. Please read each item carefully, then circle the one number next to each item which best describes how true each statement has been for you in the past 7 days.

		Not at all	A little	Moderately	Quite a bit	Extremely
1.	I have trouble remembering things	0	1	2	3	4
2.	My muscles ache	0	1	2	3	4
3.	I feel upset	0	1	2	3	4
4.	My legs feel weak	0	1	2	3	4
5.	I feel cheerful	0	1	2	3	4
6.	My head feels heavy	0	1	2	3	4
7.	I feel lively	0	1	2	3	4
8.	I feel nervous	0	1	2	3	4
9.	I feel relaxed	0	1	2	3	4
10.	I feel pooped	0	1	2	3	4
11.	I am confused	0	1	2	3	4
12.	I am worn out	0	1	2	3	4
13.	I feel sad	0	1	2	3	4
14.	I feel fatigued	0	1	2	3	4
15.	I have trouble paying attention	0	1	2	3	4
16.	My arms feel weak	0	1	2	3	4
17.	I feel sluggish	0	1	2	3	4

18.	I feel run down	0	1	2	3	4
19.	I ache all over	0	1	2	3	4
20.	I am unable to concentrate	0	1	2	3	4
21.	I feel depressed	0	1	2	3	4
22.	I feel refreshed	0	1	2	3	4
23.	I feel tense	0	1	2	3	4
24.	I feel energetic	0	1	2	3	4
25.	I make more mistakes than usual	0	1	2	3	4
26.	My body feels heavy all over	0	1	2	3	4
27.	I am forgetful	0	1	2	3	4
28.	I feel tired	0	1	2	3	4
29.	I feel calm	0	1	2	3	4
30.	I am distressed	0	1	2	3	4

Emotion Regulation Questionnaire (ERQ)

We would like to ask you some questions about your emotional life, in particular, how you control (that is, regulate and manage) your emotions. We are interested in two aspects of your emotional life. One is your emotional experience, or what you feel like inside. The other is your emotional expression, or how you show your emotions in the way you talk, gesture, or behave. Although some of the following questions may seem similar to one another, they differ in important ways. For each item, please answer using the following scale:

1----------2----------3----------4----------5----------6----------7
strongly disagree **neutral** **strongly agree**

1. ____ When I want to feel more *positive* emotion (such as joy or amusement), I *change what I'm thinking about*.

2. ____ I keep my emotions to myself.

3. ____ When I want to feel less *negative* emotion (such as sadness or anger), I *change what I'm thinking about*.

4. ____ When I am feeling *positive* emotions, I am careful not to express them.

5. ____ When I'm faced with a stressful situation, I make myself *think about it* in a way that helps me stay calm.

6. ____ I control my emotions by *not expressing them*.

7. ____ When I want to feel more *positive* emotion, I *change the way I'm thinking* about the situation.

8. ____ I control my emotions by *changing the way I think* about the situation I'm in.

9. ____ When I am feeling *negative* emotions, I make sure not to express them.

10. ____ When I want to feel less *negative* emotion, I *change the way I'm thinking* about the situation.

Emotion Assessment Scale (EAS)

For each word listed, place a slash (/) somewhere on the appropriate line to indicate how you are feeling at this moment.

		Least Possible	Most Possible
1.	Surprised		
2.	Afraid		
3.	Disgusted		
4.	Angry		
5.	Guilty		
6.	Anxious		
7.	Sad		
8.	Delighted		
9.	Scared		
10.	Astonished		
11.	Repulsed		
12.	Mad		
13.	Ashamed		
14.	Worried		
15.	Disturbed		
16.	Joyful		
17.	Frightened		
18.	Amazed		
19.	Sickened		
20.	Annoyed		
21.	Humiliated		
22.	Nervous		
23.	Hopeless		
24.	Happy		

Family of Origin Scale – short form (FOS)

Instructions:
Using the scale below as a guide, write a number besides each statement to indicate how much you agree with it.

Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

_____ In my family, we encouraged each other to develop new friendships.

_____ Conflicts in my family never got resolved.

_____ I found it difficult to understand what other family members said and how they felt.

_____ In my family, I expressed just about any feeling I had.

_____ My family was receptive to the different ways various family members viewed life.

_____ I often had to guess at what other family members thought or how they felt.

_____ My family members rarely expressed responsibility for their actions.

_____ Sometimes in my family I did not have to say anything, but felt understood.

_____ I found it easy to understand what other family members said and how they felt.

_____ I found it difficult to express my own opinions in my family.

_____ In my family, no one cared about the feelings of other family members.

_____ In my family, certain feelings were not allowed to be expressed.

_____ My family members usually were sensitive to one another's feelings.

_____ In my family, people took responsibility for what they did.

_____ I remember my family as being warm and supportive.

SCS

Below is a list of social experiences. For each question, please circle a number of how often you have had that experience in the past month.

	How often in the past month did your friends or family…	Never	Rarely	Sometimes	Often
1.	change the subject when you tried to discuss your problems?	1	2	3	4
2.	not seem to understand your situation?	1	2	3	4
3.	avoid you?	1	2	3	4
4.	minimize your problems?	1	2	3	4
5.	seem to be hiding their feelings?	1	2	3	4
6.	act uncomfortable when you talked about your problems?	1	2	3	4
7.	trivialize your problems?	1	2	3	4
8.	complain about their own problems when you wanted to share yours?	1	2	3	4
9.	act cheerful around you to hide their true feelings or concerns?	1	2	3	4
10.	tell you not to worry so much about your health?	1	2	3	4
11.	tell you to try not to think about your problems?	1	2	3	4
12.	give you the idea that they didn't want to hear about your problems?	1	2	3	4
13.	make you feel as though you had to keep your feelings about your problems to yourself, because they made them feel uncomfortable?	1	2	3	4
14.	make you feel as though you had to keep your feelings about your problems to yourself, because they made them feel upset?	1	2	3	4
15.	let you down by not showing you as much love and concern as you would have liked?	1	2	3	4

DUKE-SSQ

Below is a list of things that other people do for us or give us that may be helpful or supportive. Please read each statement carefully and indicate an answer that is closest to your situation. Respond to each question by picking a number on the scale from "1" to "5" to tell me how you feel about the amount of support you receive. Answering "1" would mean that you get that type of support "much less than you would like" and answering "5" would mean that you get that type of support "as much as you would like." Answering with numbers 2, 3, and 4 would indicate that you feel somewhere in-between. For example, if asked if you get enough vacation time, answering "4" means that you get "almost" as much vacation time as you would like, but not quite as much as you would like. Answer each item as best you can. There are no right or wrong answers.

		Much less than I would like				As much as I would like
1.	I have people who care about what happens to me.	1	2	3	4	5
2.	I get love and affection.	1	2	3	4	5
3.	I get chances to talk to someone about problems at work or with my homework.	1	2	3	4	5
4.	I get chances to talk to someone I trust about my personal and family problems.	1	2	3	4	5
5.	I get chances to talk about money matters.	1	2	3	4	5
6.	I get invitations to go out and do things with other people.	1	2	3	4	5
7.	I get useful advice about important things in life.	1	2	3	4	5
8.	I get help when I'm sick in bed.	1	2	3	4	5

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Weathers, F. W., Litz, B. T., Herman, D. S., Huska, J. A., & Keane, T. M. (1993, October). *The PTSD Checklist (PCL): Reliability, validity, and diagnostic utility.* Paper presented at the International Society for Traumatic Stress Studies, San Antonio, TX.

White, A. B., Williams, L. A., & Leben, J. R. (2001). Health care utilization and cost among health maintenance organization members with temporomandibular disorders. *Journal of Orofacial Pain, 15*(2), 158-169.

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BIOGRAPHICAL INFORMATION

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CONTACT INFORMATION

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EDUCATION

8/99 – 8/06 University of Kentucky

Ph.D. in Clinical Psychology, August 2006

Title of Dissertation:
A Controlled Comparison of Emotional Reactivity and Physiological Response in Orofacial Pain Patients

M.S. in Clinical Psychology, March 2002

Title of Master's Thesis:
The Role of Social and Dispositional Variables Associated With Emotional Processing in Adjustment to Breast Cancer

8/96 - 5/99 West Chester University
Graduate studies in Clinical Psychology

7/91 - 5/95 Widener University
Bachelor of Science in Electrical Engineering, May 1995
Graduated *Magna Cum Laude*

RESEARCH EXPERIENCE

2006	Guest Reviewer, Quality of Life Research.
2004, 2005	Guest Reviewer, Health Psychology.
2004	Guest Reviewer, British Journal of Health Psychology.
6/03 - 8/05	NIMH Predoctoral Trainee UK Dept. of Behavioral Science: Lexington, KY.
4/02 -4/04	Research Consultant Bethesda Naval Hospital Orofacial Pain Center.
6/00 - 6/03	DOD Research Trainee UK Dept. of Behavioral Science: Lexington, KY.
6/00 - 8/05	Research Assistant, UK Orofacial Pain Center: Lexington, KY.
8/99 - 8/05	Research Assistant, UK Dept. of Psychology: Lexington, KY.
8/98 - 5/99	Research Assistant, West Chester University Dept. of Psychology.

CLINICAL EXPERIENCE

8/06 – present	Postdoctoral Fellow in Medical Psychology and Pain Rehabilitation. Mayo Graduate School of Medicine, Mayo Clinic. Rochester, MN
8/05 – 8/06	Psychology Intern, Federal Medical Center, Lexington, KY. Pre-doctoral APA Accredited Internship. Major rotation: Behavioral Medicine.
9/00 - 8/05	Student Therapist, *JGH Psychological Services Center*
6/00 - 8/05	Psychology Intern, *UK Orofacial Pain Center*

TEACHING EXPERIENCE

1/00 – 5/00	Teaching Assistant, University of Kentucky. Laboratory Instructor for Applications of Statistics in Psychology. Supervisor: Sung Hee Kim, Ph.D.
8/99 - 12/99	Teaching Assistant, University of Kentucky. Laboratory Instructor for Introduction to Psychology Course. Supervisor: Jonathan Golding, Ph.D.

PROFESSIONAL WORK EXPERIENCE

5/98 - 6/99	Program Specialist, *Elwyn Incorporated* Adult Residential Mental Health Services
4/96 - 2/98	Electrical Engineer, *Somat Corporation*
6/95 - 4/96	Electrical Engineer, *Armstrong World Industries*
6/94 - 3/95	Cooperative Associate, *SmithKline Beecham Pharmaceuticals* Anti-Infectives Manufacturing
8/92 - 6/93	Cooperative Associate, *Pennsylvania Power and Light Company* Susquehanna Nuclear Electric Station
6/85 - 7/91	Communications Technician and Supervisor, *United States Navy* USS LaSalle (AGF-3), USS Boulder (LST-1190)

SCHOLASTIC HONORS

2004	Meritorious Student Paper Award *Society of Behavioral Medicine Annual Meeting*.
2003-2005	NIMH Predoctoral Traineeship in Medical Behavioral Science.
2002	Meritorious Student Poster Award *Society of Behavioral Medicine Annual Meeting*.
2000-2003	DOD Predoctoral Traineeship in Psychosocial Breast Cancer Research.
1995	Elected to Phi Kappa Phi; The National Honor Society.
1995	Graduated Magna Cum Laude, Widener University.
1995	Shirley M. Kornfield Undergraduate Award – Widener University.
1994-1995	President - Tau Beta Pi; The National Engineering Honor Society.
1991-1995	National Dean's List (all semesters, Widener University).

NON-SCHOLASTIC HONORS

1998	Honorable Discharge - United States Navy.
1991	Navy Achievement Medal.
1982	Eagle Scout.

PROFESSIONAL AFFILIATIONS

1998 - present	American Psychological Association.
2000 - present	APA Division 12 - Clinical Psychology.
2000 - present	APA Division 38 - Health Psychology.
2003 – present	APA Division 5 – Evaluation, Measurement, and Statistics.
2000 - present	Society of Behavioral Medicine.

EXTERNAL FUNDING

Self-regulation in Orofacial Pain and Fibromyalgia
Funding Agency: National Institute Of Dental & Craniofacial Research
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Principal Investigator: **John E. Schmidt**
Sponsors: Charles R. Carlson, Ph.D. and Leslie J. Crofford, M.D.
This funding was declined in lieu of postdoctoral fellowship in Medical Psychology at Mayo Clinic

REFEREED JOURNAL PUBLICATIONS

Andrykowski, M.A., Beacham, A.O., **Schmidt, J.E**., Harper, F.W.K. (2006). Application of the Theory of Planned Behavior to Understanding Physical and Psychosocial Health Behaviors after Cancer Diagnosis and Treatment. *Psycho-Oncology, 15,* 759-771.

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De Leeuw, R., Bertoli, E., **Schmidt, J.E**., & Carlson, C.R. (2005). Prevalence Of Traumatic Stressors In Patients With Temporomandibular Disorders. *Journal of Oral and Maxillofacial Surgery, 63,* 42-50.

Ransom, S., Jacobsen, P.B., **Schmidt, J.E**., & Andrykowski, M.A. (2005). Relationship of Problem-Focused Coping Strategies to Changes in Quality of Life Following Treatment for Early Stage Breast-Cancer. *Journal of Pain and Symptom Management, 30,* 243-253.

Schmidt, J.E. & Andrykowski, M.A. (2004). The Role of Social and Dispositional Variables Associated with Emotional Processing in Adjustment to Breast Cancer: An Internet-Based Study. *Health Psychology, 23(3),* 259-266.

Vazquez-Delgado, E., **Schmidt, J.E**., Carlson, C.R., de Leeuw, R., & Okeson, J.P. (2004). Psychological and Sleep Quality Differences Between Chronic Daily Headache and Temporomandibular Disorder Patients. *Cephalalgia,24,* 446-454.

Lindroth, J. E., **Schmidt, J. E**., & Carlson, C. R. (2002). A Comparison Between Masticatory Muscle Pain Patients and Intracapsular Pain Patients on Behavioral and Psychosocial Domains. *Journal of Orofacial Pain, 16*, 277-283.

MANUSCRIPTS IN PRESS

Harper, F.W.K., **Schmidt, J.E.,** Beacham, A.O., Salsman, J., Averill, A., Boerner, L., Graves, K.D., Andrykowski, M.A. (In Press). The Role of Social Cognitive Processing Theory and Optimism in Positive Psychosocial and Physical Behavior Change after Cancer Diagnosis and Treatment *(Psycho-oncology).*

MANUSCRIPTS UNDER REVIEW

Harper, F.W.K., **Schmidt, J.E.**, Graves, K.D., Andrykowski, M.A. (2005). How does the Internet Compare? A study of Internet, mail, and telephone methods of question administration (*Psychological Assessment*).

Lim, P.F., Okeson, J.P., de Leeuw, R., Carlson, C.R., **Schmidt, J.E.**, & Albuquerque, R. (2005). Surface Electromyography Characterization of the Local Twitch Response Elected by Trigger Point Injection and Snapping Palpation in Myofascial Pain Patients *(Journal of Orofacial Pain).*

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Kelly, K., Graves, K.D., Harper, F.W.K., **Schmidt, J.E.,** Dickinson, S.L., Andrykowski, M.A. (2005). Assessing Perceptions of Cancer Risk: Does numeracy or mode of assessment matter? *(Preventive Medicine).*

Schmidt, J.E., Graves, K.D., & Andrykowski, M.A. (2004). The Terrorist Attacks of September 11th, 2001: Social Cognitive Processing Theory and Psychological Response. *(Personality and Social Psychology Bulletin).*

INVITED ARTICLES

Schmidt, J.E. (2003, Summer). Web-based Research in Health Psychology. *Outlook*, Society of Behavioral Medicine Newsletter.

BOOK CHAPTERS

Bernstein, D. A., Carlson, C. R., **Schmidt, J.E.** (in press). Progressive relaxation: Abbreviated methods. In P. M. Lehrer & R. Woolfolk (Eds.), Principles and practices of stress management (3rd ed). New York: Guilford

PUBLISHED ABSTRACTS

Harper, F.W.K., Graves, K.D., **Schmidt, J.E.**, Andrykowski, M.A. (2005). Internet: Boon or Bane? A Comparison of Internet, Mail, and Phone Methods of Data Collection. [Abstract] *Annals of Behavioral Medicine, 29* (Suppl.), S211.

Andrykowski, M.A., **Schmidt, J.E.**, Beacham, A. (2005). Use of a Theory of Planned Behavior to Understand Physical and Psychosocial Health Behavior Change After Cancer Diagnosis. [Abstract] *Psycho-Oncology, 14* (Suppl.), S10-S11.

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Graves, K.D., Harper, F.K., **Schmidt, J.E.**, Andrykowski, M.A. (2004). Move Over Social Support: Influence of Social Constraints on Quality of Life in Women Screened for Ovarian Cancer. [Abstract] *Annals of Behavioral Medicine, 27* (Suppl.), S046.

Schmidt, J.E., Graves, K.D., Beacham, A., Salsman, J., Averill, A., Boerner, L., & Andrykowski, M.A. (2004). Linguistic Analysis and Cancer-Related Distress: Characteristic Differences in Written Disclosure. [Abstract] *Annals of Behavioral Medicine, 27* (Suppl.), S010.

Kelly, K., Harper, F., Graves, K., **Schmidt, J.E.**, Andrykowski, M. (2004). Perceived risk of colon cancer: Impact of numeracy and questionnaire administration method. [Abstract] *Annals of Behavioral Medicine, 27* (Suppl.), S008.

Andrykowski, M.A., **Schmidt, J.E.**, Beacham, A., Salsman, J., Averill, A., Graves, K., & Harper, F. (2004). Psychosocial and Physical Health Behavior Change After Cancer Diagnosis and Treatment. [Abstract] P*sycho-Oncology, 13* (Suppl.), S21.

Harper, F.W.K., Graves, K.D., **Schmidt, J.E.**, Beacham, A.O., Salsman, J., Averill, A., Boerner, L., Andrykowski, M.A. (2004). The Role of Social Support and Positive Mood in Cancer-Related Distress in Breast and Lung Cancer Patients. [Abstract] P*sycho-Oncology, 13* (Suppl.), S61.

Graves, K.D., Harper, F.W.K., **Schmidt, J.E.**, Beacham, A., Salsman, J., Averill, A., Boerner, L., & Andrykowski, M.A. (2004). Linguistic Analysis of Cancer Patients' Expressive Writing: Association with Psychosocial Variables and Differences among Disease Stages. [Abstract] P*sycho-Oncology, 13* (Suppl.), S37.

Schmidt, J.E., & Andrykowski, M.A. (2003). The Role of Social and Dispositional Factors Associated with Emotional Processing in Adjustment to Breast Cancer: An Internet-Based Study. [Abstract] *Annals of Behavioral Medicine, 25* (Suppl.), S060.

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Schmidt, J.E., Beacham, A., Bollmer, J.M., Malik, U., Andrykowski, M.A., & Jacobsen, P. (2002). Evaluation of the Diagnostic Interview for Cancer-Related Fatigue (DICRF) in women with breast cancer. [Abstract] *Annals of Behavioral Medicine, 24* (Suppl.), S172.

Schmidt, J.E., Baer, R., De Leeuw, R., & Carlson, C.R. (2002). Use of the NEO-Five Factor Inventory with orofacial pain patients. [Abstract] *Annals of Behavioral Medicine, 24* (Suppl.), S005.

Bollmer, J.M., Beacham, A., **Schmidt, J.E.**, Malik, U., Andrykowski, M.A., & Jacobsen, P. (2002). Longitudinal study of fatigue after adjuvant treatment for breast cancer. [Abstract] *Annals of Behavioral Medicine, 24* (Suppl.), S005.

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Bollmer, J.M., **Schmidt, J.E.**, Blonder, L.X., & Andrykowski, M.A. (2001). Emotional expression in women with breast cancer: A comparative study. [Abstract] *Annals of Behavioral Medicine, 23* (Suppl.), S078.

REFEREED PAPER PRESENTATIONS

Harper, F.W.K., Graves, K.D., **Schmidt, J.E.**, Andrykowski, M.A. (2005, April). *Internet: Boon or Bane? A Comparison of Internet, Mail, and Phone Methods of Data Collection.* Paper presented at the 26th annual meeting of the Society of Behavioral Medicine, Boston, MA.

Andrykowski, M.A., **Schmidt, J.E.**, Beacham, A. (2005, January). *Use of a Theory of Planned Behavior to Understand Physical and Psychosocial Health Behavior Change After Cancer Diagnosis.* Paper presented at the 2nd annual meeting of the American Psychosocial Oncology Society, Phoenix, AZ.

Schmidt, J.E., Jacobsen, P.B., & Andrykowski, M.A. (2004, March). *Fatigue Course During Radiotherapy for Breast Cancer: What Influences Fatigue Recovery?* Paper presented at the 25th annual meeting of the Society of Behavioral Medicine, Baltimore, MD. **Selected as a Meritorious Student Paper.**

Harper, F.W.K., **Schmidt, J.E.**, Beacham, A.O., Salsman, J., Averill, A., Boerner, L., Graves, K.D., Andrykowski, M.A. (2004, March). *Positive Psychosocial and Physical Health Behavior Change after Cancer Diagnosis and Treatment.* Paper presented at the 25th annual meeting of the Society of Behavioral Medicine, Baltimore, MD.

Graves, K.D., Harper, F.K., **Schmidt, J.E.**, Andrykowski, M.A. (2004, March). *Move Over Social Support: Influence of Social Constraints on Quality of Life in Women Screened for Ovarian Cancer*. Paper presented at the 25th annual meeting of the Society of Behavioral Medicine, Baltimore, MD.

Andrykowski, M.A., **Schmidt, J.E.**, Beacham, A., Salsman, J., Averill, A., Graves, K., & Harper, F. (2004, January). *Psychosocial and Physical Health Behavior Change After Cancer Diagnosis and Treatment.* Paper presented at the 1st annual meeting of the American Psychosocial Oncology Society, Orlando, FL.

Schmidt, J.E., Graves, K.D., & Andrykowski, M.A. (2003, March). *Social-Cognitive Processing Theory and Psychological Response to September 11th, 2001: An Internet-*

Based Study. Paper presented at the 24th annual meeting of the Society of Behavioral Medicine, Salt Lake City, UT.

REFEREED POSTER PRESENTATIONS

Schmidt, J.E., Graves, K.D., & Andrykowski, M.A. (2005, June). *Anticipating Dropout in Web-Based Research Designs.* Poster presented at the Critical Issues in eHealth Research Conference, Bethesda, MD.

Schmidt, J.E., Graves, K.D., & Andrykowski, M.A. (2005, April). *Emotional Intelligence: A Novel Construct In Predicting Post-Traumatic Growth.* Poster presented at the 26th annual meeting of the Society of Behavioral Medicine, Boston, MA.

Salsman, J.M., **Schmidt, J. E.**, & Andrykowski, M.A. (2005, April). *Religious And Spiritual Behavior Change Among Cancer Survivors.* Poster presented at the 26th annual meeting of the Society of Behavioral Medicine, Boston, MA.

Harper, F.W.K., Graves, K.D., **Schmidt, J.E.**, Andrykowski, M.A. (2005, January). *Colorectal Cancer Patient's Perceptions About Treatment: Are They Related to Psychological Adjustment and Positive Health Behaviors?* Poster presented at the 2nd annual meeting of the American Psychosocial Oncology Society, Phoenix, AZ.

Graves, K.D., Harper, F.W.K., **Schmidt, J.E.**, & Andrykowski, M.A. (2005, January). *Well-Regulated Equals Well-Being: Predictors of Depression and Anxiety in Colorectal Cancer Patients*. Poster presented at the 2nd annual meeting of the American Psychosocial Oncology Society, Phoenix, AZ.

Huss, D.B., **Schmidt, J.E.,** Balasubramaniam, R., Okeson, J., & Carlson, C. (2004, November). *Predictors of Fatigue in Orafacial Pain Patients*. Poster presented at the 38th annual meeting of the Association For Advancement of Behavior Therapy, New Orleans, LA.

Schmidt, J.E., Graves, K.D., Beacham, A., Salsman, J., Averill, A., Boerner, L., & Andrykowski, M.A. (2004, March). *Linguistic Analysis and Cancer-Related Distress: Characteristic Differences in Written Disclosure.* Poster presented at the 25th annual meeting of the Society of Behavioral Medicine, Baltimore, MD.

Kelly, K., Harper, F., Graves, K., **Schmidt, J.**, Andrykowski, M. (2004, March). *Perceived risk of colon cancer: Impact of numeracy and questionnaire administration method*. Poster presented at the 25th annual meeting of the Society of Behavioral Medicine, Baltimore, MD.

Balasubramaniam, R., de Leeuw, R., **Schmidt, J.E.**, Carlson, C.R. (2004, March). *Depression And Somatization Are Predictors Of Fatigue In TMD Patients.* Poster presented at the Annual Scientific Meeting on Orofacial Pain & Temporomandibular Disorders, San Francisco, CA

Harper, F.W.K., Graves, K.D., **Schmidt, J.E.**, Beacham, A.O., Salsman, J., Averill, A., Boerner, L., Andrykowski, M.A. (2004, January). *The Role of Social Support and Positive Mood in Cancer-Related Distress in Breast and Lung Cancer Patients.* Poster presented at the 1st annual meeting of the American Psychosocial Oncology Society, Orlando, FL.

Graves, K.D., Harper, F.W.K., **Schmidt, J.E.**, Beacham, A., Salsman, J., Averill, A., Boerner, L., & Andrykowski, M.A. (2004, January). *Linguistic Analysis of Cancer Patients' Expressive Writing: Association with Psychosocial Variables and Differences among Disease Stages.* Poster presented at the 1st annual meeting of the American Psychosocial Oncology Society, Orlando, FL.

Schmidt, J.E., & Andrykowski, M.A. (2003, March). *The Role of Social and Dispositional Factors Associated with Emotional Processing in Adjustment to Breast Cancer: An Internet-Based Study*. Poster presented at the 24th annual meeting of the Society of Behavioral Medicine, Salt Lake City, UT.

Vazquez-Delgado, E., **Schmidt, J.E**., Carlson, C.R., de Leeuw, R., & Okeson, J.P. (2003, March). Psychological and Sleep Quality Differences Between Chronic Daily Headache and Temporomandibular Disorder Patients. Poster presented at the IX Congress of the International Headache Society, Rome, Italy.

Beacham, A., Heaton, L., **Schmidt, J.**, Carlson, C., Okeson, J., & Phillips, B. (2002, November). *Sleep Dysfunction in Orofacial Pain Patients: Implications for Cognitive-Behavioral Group Treatment.* Poster presented at the 36th annual meeting of the Association for Advancement of Behavior Therapy, Reno, NV.

Schmidt, J.E., Beacham, A., Bollmer, J.M., Malik, U., Andrykowski, M.A., & Jacobsen, P. (2002, April). *Evaluation of the Diagnostic Interview for Cancer-Related Fatigue (DICRF) in Women with Breast Cancer.* Poster presented at the 23rd annual meeting of the Society of Behavioral Medicine, Washington, D.C.

Schmidt, J.E., Baer, R., De Leeuw, R., & Carlson, C.R. (2002, April). *Use of the NEO-Five Factor Inventory with Orofacial Pain Patients.* Poster presented at the 23rd annual meeting of the Society of Behavioral Medicine, Washington, D.C. **Selected as a Meritorious Student Poster.**

Bollmer, J.M., Beacham, A., **Schmidt, J.E.**, Malik, U., Andrykowski, M.A., & Jacobsen, P. (2002, April). *Longitudinal Study of Fatigue after Adjuvant Treatment for Breast Cancer.* Poster presented at the 23rd annual meeting of the Society of Behavioral Medicine, Washington, D.C.

Schmidt, J. E., Bollmer, J. M., Blonder, L. X., & Andrykowski, M. A. (2001, March). *Development of a Behavioral Approach to Assessing Emotional Expression.* Poster presented at the 22nd annual meeting of the Society of Behavioral Medicine, Seattle.

Bollmer, J. M., **Schmidt, J. E.**, Blonder, L. X., & Andrykowski, M. A. (2001, March). *Emotional Expression in Women With Breast Cancer: A Comparative Study.* Poster presented at the 22nd annual meeting of the Society of Behavioral Medicine, Seattle.

Lindroth, J. E., **Schmidt, J. E.**, & Carlson, C. R. (2001, March). *A Comparison Between Masticatory Muscle Pain Patients and Intracapsular Pain Patients on Behavioral and Psychosocial Domains.* Poster presented at the Annual Scientific Meeting on Orofacial Pain & Temporomandibular Disorders, Washington, D.C.