SUBGROUP ANALYSES OF THE LONG-TERM EFFECTS OF AN EARLY INTERVENTION TREATMENT PROGRAM FOR ACUTE TMJMD PATIENTS

by

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Abstract

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Most researchers suspect that anywhere from 5% to 12% of Americans suffer from Temporomandibular Joint and Muscle Disorders (TMJMDs), which impair jaw functioning and can promote various complications, particularly for people with myogenous TMJMD. Fortunately, past research has established that an early intervention is effective for TMJMD patients in that it not only relieves symptoms but also provides long-term benefits. It was suspected that an investigation of treatment effects on diagnostic subgroups of TMJMD patients would clarify such findings. However, to my knowledge, long-term treatment effects had not been evaluated in an acute TMJMD population by subgroups of diagnoses. Therefore, I hypothesized that the effects of a biobehavioral intervention, which is meant to address health issues from a biopsychosocial perspective, would benefit myogenous TMJMD patients the most when compared to other patients in terms of psychological distress, pain, and functionality. Ultimately, it was found that pain was reduced and functionality was increased for myogenous TMJMD patients who received a biobehavioral intervention; however, these patients did not report the most improvement in terms of psychological distress.

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Chapter 1

Introduction

Do the effects of an early intervention treatment program on individuals with acute Temporomandibular Joint and Muscle Disorder (TMJMD) vary based on diagnosis, and, if so, how? Early interventions for TMJMD, especially interventions with biobehavioral components, have been recommended to prevent the development of a chronic form of the disorder (Dworkin et al., 1994; Gatchel, Stowell, Wildenstein, Riggs, & Ellis, 2006), and past research has established that an early intervention is, in fact, effective for TMJMD patients. Such an intervention has been shown to relieve current TMJMD-related symptoms and provide long-term benefits (Gardea, Gatchel, & Mishra, 2001, Gatchel et al., 2006; Ingram et al., 2011; Stowell, Gatchel, & Wildenstein, 2007); thus, it is suspected that an investigation of treatment effects on diagnostic subgroups of patients will clarify such findings. However, to my knowledge, long-term treatment effects by diagnoses have not been evaluated in an acute TMJMD population. Therefore, the major goal of the current investigation was to determine if the effects of a biobehavioral intervention, which is meant to address health issues from a biopsychosocial perspective, would differ based on the type and number of diagnoses; I expected that patients with myogenous TMJMD (i.e., a muscle disorder) would benefit the most from such an intervention in terms of psychological distress, pain, and functionality.

Temporomandibular Joint and Muscle Disorder

The temporomandibular joints are located lateral to the face and connect the temporal bone to the mandible (NIDCR, 2013). A pliable disc is situated between the temporal bone and the condyles, which are the circular ends of the mandible, and permits smooth movements of the jaw (NIDCR, 2013). This disc also acts as a shock absorber (NIDCR, 2013) and facilitates talking, eating, and yawning (Dworkin et al., 2002a;

NIDCR, 2013). Both the temporomandibular joint and the associated muscular structures enable horizontal and vertical movements through sliding and bending motions, but, when a dysfunction or abnormality arises in any of these areas, a condition called TMJMD, a common musculoskeletal condition affecting the orofacial region, can develop (Dworkin et al., 2002a; Galdon et al., 2006; Jerjes et al., 2008; NIDCR, 2013; Rodrigues et al., 2010).

Symptoms

TMJMD impairs jaw functioning and can promote complications such as stiffening in the jaw, orofacial pain, a restricted range of motion in the mandibular joints, and abnormal or audible jaw movements (e.g., clicking and popping; Carlsson, 1999; Crider, Glaros, & Gervitz, 2005; Dworkin et al., 2002a; Gatchel, Potter, Hinds, & Ingram, 2011; NIDCR, 2013; Scrivani et al., 2008; White, Williams, & Leben, 2001; Wright et al., 2004). TMJMD patients also often experience symptoms that resemble other conditions (Demarin & Kes, 2010; Penker et al., 2000; Suvinen, Reade, Kemppainen, Kononen, & Dworkin, 2005). For instance, patients may experience a condition called tinnitus, which involves a persistent buzzing or ringing in the ear, or they may experience deficits in sound perception (Penker et al., 2000). Some researchers have found that people afflicted with TMJMD also have problems in proprioception and, therefore, may experience vertigo or dizziness (Penker et al., 2000; Scrivani et al., 2008; White et al., 2004). Visual disturbances, such as blurry vision (Penker et al., 2000), may also occur, as may psychosocial problems such as depression (Gatchel et al., 2011; Plesh, Adams, & Gansky, 2011; Wright et al., 2004).

Overall, though, pain is documented as the most common symptom of TMJMD, and it typically dictates treatment-seeking behavior (Ahn et al., 2011; Auerbach et al., 2001; Dworkin et al., 2002a; Gatchel et al., 2011; Gonçalves, Bigal, Jales, Camparis, &

Speciali 2010; List & Dworkin, 1999; NIDCR, 2013; Ohrbach, 2010b; Suvinen et al., 2005; Wright & North, 2009). Therefore, pain reduction is the primary goal of many treatments, and it tends to be the most prominent outcome in comparison to the alleviation of other symptoms (Wright & North, 2009). TMJMD pain has been linked to poor circulation and uncontrolled activation in the muscles surrounding the joint, which then tends to lead to inflammation (Kitsoulis et al., 2011; Svensson et al., 1996). This activation can spread into other regions of the body and cause headaches as well as pain in the neck, shoulders, or ears (Jerjes et al., 2008; NIDCR, 2013; Suvinen et al., 2005; Wright & North, 2009).

Diagnosis

Considering the myriad symptoms, various diagnostic tools have been developed. Unfortunately, there has been no unanimously accepted method of diagnosing TMJMD in clinical settings. Nevertheless, the Research Diagnostic Criteria for Temporomandibular Disorder (RDC/TMD; Dworkin & LeResche, 1992) have garnered much acceptance and international use in objectively diagnosing and assessing TMJMD for research purposes (Garofalo, Gatchel, Wesley, & Ellis, 1998; List & Axelsson, 2010; Schiffman et al., 2010b). One of the strengths of the RDC/TMD lie in the comprehensive quality of its two axes, which capture physical symptoms (Axis I) and psychosocial symptoms (Axis II), respectively. The physical symptoms are used to assign diagnoses: muscle disorders, disc displacements, and degenerative joint diseases. With regard to the other axis, the psychosocial symptoms of the RDC/TMD include pain-related disability, depressive symptoms, mandibular limitations, and somatization tendencies. Though useful, care must be taken in interpreting the diagnostic information gathered from the RDC/TMD. The RDC/TMD are not meant to be used as an exhaustive, singular diagnostic tool for every type of TMJMD, orofacial pain, or psychiatric condition (Dworkin,

2010); instead, its intended use is to provide the first step of a replicable, standardized method of identifying and classifying subgroups of TMJMD using the biopsychosocial perspective (Schiffman et al., 2014). Consequently, now that this first step has been established, a newer version of the RDC/TMD have been created with the title Diagnostic Criteria for Temporomandibular Disorder (DC/TMD), and they promise to expand upon the success of its predecessor.

DC/TMD

Following the release of the RDC/TMD, great strides were made in pain research, and, as a result, new assessments and constructs were created (Schiffman et al., 2014). These advances led to a quest for improving how the RDC/TMD assess TMJMD (Schiffman et al., 2014). In 2001, a group of researchers engaged in a seven-year validation project, which consisted of a series of six studies (Anderson et al., 2010; Look et al., 2010; Ohrbach et al., 2010a; Schiffman et al., 2010a; Schiffman et al., 2010b; Truelove et al., 2010). After the culmination of these studies, the RDC/TMD were revised, and the name was changed to the DC/TMD (Schiffman et al., 2014). New diagnostic criteria were released on February 3rd, 2014 and are intended to: (1) assess TMJMD to a greater extent than did the RDC/TMD; (2) clarify the interpretation of the diagnostic information; and (3) be used in both research settings and clinical settings (Schiffman et al., 2014).

Prevalence Rate

Unfortunately, many people suffer from TMJMD-related symptoms. According to the National Institute of Dental and Craniofacial Research (NIDCR), about 10 million people in the USA (i.e., 4% of the population) are suspected to have TMJMD (NIDCR, 2013a; 2014); however, most researchers predict that anywhere from 5% to 12% of Americans suffer from TMJMD (NIDCR, 2014). It is important to note that the reported

prevalence of TMJMD is largely dependent on the method by which the condition is assessed. As mentioned earlier, there is no consensus of the criteria that would warrant a diagnosis of TMJMD in clinical settings (Ohrbach, 2010b); therefore, it can be reasonably assumed that the larger prevalence rates associated with TMJMD in past research are more reflective of self-reported symptoms of TMJMD than an objective count of diagnostic incidences (Carlsson, 1999; Goncalves et al., 2010; NIDCR 2014). Furthermore, it has been reported that only a small percentage (i.e., up to 13%) of TMJMD sufferers actually have a severe, debilitating case of the disorder (Andreu et al., 2006; Carlsson, 1999; Dworkin et al., 2002a; John et al., 2003; Manfredini et al., 2010b).

Physical and psychosocial

In terms of diagnoses, researchers found that myogenous TMJMD, particularly myofascial pain, was the most prevalent diagnosis (Ballegaard et al., 2008; List & Dworkin, 1996; Manfredini et al., 2011; Manfredini et al., 2012; Mora, Weber, Neff, & Rief, 2013; Scrivani et al, 2008; Machado, Nery, Leles, Nery, & Okeso, 2009). Cases of arthrogenous TMJMD, of which most were diagnosed with arthralgia, were not as common as myogenous cases. Arthrogenous TMJMD, however, was more prevalent than disc displacements, of which most patients had a reduction (i.e., correction; List & Dworkin, 1996; Manfredini et al., 2012). With regard to psychosocial measures, most patients report low levels of pain-related disability, depressive symptoms, and somatization (List & Dworkin, 1996; Manfredini et al., 2011).

Demographic characteristics

Research has found demographic differences among people who acquire TMJMD. For instance, racial differences in TMJMD diagnoses have been found to be moderated by age such that, at younger ages, Whites had the highest rate of the disorder when compared to other ethnicities of the same age, and Blacks had the highest rate of

the disorder when the participants were older (Isong, Gansky, & Plesh, 2008; Plesh et al., 2011). In spite of these findings, however, racial disparities have not been found consistently across research studies (Doyle, Chiu, Haggard, Gatchel, & Wiggins, 2012; Reiter, Eli, Gavish, & Winocur, 2006; Riley, Gilbert, & Heft, 2002). Therefore, some investigators have suspected that racial differences among TMJMD sufferers may actually be more indicative of treatment-seeking behavior and socioeconomic status (Riley et al., 2002).

Typically, females of reproductive ages are diagnosed with TMJMD more often than are males (Ballegaard et al., 2008; Doyle et al., 2012; Gatchel et al., 2006b; Isong et al., 2008; NIDCR, 2013; Wieckiewicz et al., 2014). Over 80% of the patients receiving treatment for TMJMD are women, a finding which supports the claim that a gender disparity exists (Carlsson, 1999; Demarin & Kes, 2010; Gatchel et al., 2006b; Isong et al., 2008; Phillips, Gatchel, Wesley, & Ellis, 2001). This gender difference is suspected to be attributable to a number of different factors. For instance, elevated hormone levels in females may create a hypersensitivity to stress and pain (Phillips et al., 2001). Also, females have been shown to have low pain thresholds, which implies that females may actually be less tolerant of pain and, therefore, may report their symptoms differently than do males (Phillips et al., 2001; Scrivani et al., 2008). Furthermore, females may be more likely to participate in research studies, and this may over-represent females in the TMJMD population (Ballegaard et al., 2008).

Estimated Costs

TMJMD sufferers are reported as having a significantly greater usage of health care services when compared to patients not seeking care regarding TMJMD (White et al., 2001). It is estimated that TMJMD patients spend over $4 billion per year to treat their symptoms (Gatchel et al., 2006a; NIDCR, 2014). This estimate is supported by a

study which found that TMJMD patients receiving usual care spent about $430 during a 12-month period compared to patients who received an early treatment intervention and spent about $130 (Stowell et al., 2007). However, other researchers found that, per patient, about $966 can be spent on health care services per year (White et al., 2001).

These high costs are related to the multifaceted symptom presentation of the disorder. As indicated earlier in this paper, TMJMD tends to manifest itself in various ways (e.g., depressive symptoms, pain, restlessness, somatization, etc.) that can vary substantially across the patients who are affected by it. Given the myriad symptoms that emerge from TMJMD, it is typical for TMJMD sufferers to seek treatment from numerous health care professionals (e.g., physical therapists, physicians, dentists, psychiatrists, etc.), which inevitably imposes a major financial burden on people who seek treatment (Dworkin et al., 1994; Wright et al., 2004).

Etiology

Given the prevalence and high cost of TMJMD, many investigations have been conducted to uncover the cause of the disorder. However, in most cases, there is no single cause of TMJMD; instead, it appears to emerge from a variety of causes, often in combination, such as from a traumatic event, stress, clenching of the teeth, or some other medical condition (e.g., bruxism; Dworkin et al., 2002a; Gustin et al., 2011; Jerjes et al., 2008; NIDCR, 2013; Rodrigues et al., 2010: Wright & North, 2009).

Biopsychosocial perspective

Most view the cause of TMJMD from a biopsychosocial perspective (Gatchel, Peng, Peters, Fuchs, & Turk, 2007; Ohrbach, 2010a; Suvinen et al., 2005). As the name suggests, the biopsychosocial approach to TMJMD assumes that the disorder arises from a combination of biological (e.g., an injury), psychological (e.g., pain appraisals), and social (e.g., conflict) factors (Gatchel et al., 2007; Gustin et al., 2011; Ohrbach,

2010a; Suvinen et al., 2005). This perspective is vital to the treatment of TMJMD because focusing solely on the physical attributes of TMJMD dismisses the powerful influence of both psychological and social factors, both of which are suspected to differentiate between people who improve and people who worsen (Gustin et al., 2011; Ohrbach, 2010a; Suvinen et al., 2005).

Vicious cycle theory & pain adaptation model

Despite the elusive nature of TMJMD's etiology, researchers have identified mechanisms that they suspect can explain the perpetuating nature of the disorder: the Vicious Cycle Theory and the Pain Adaptation Model (Peck, Murray, & Gerzina, 2008). The Vicious Cycle Theory proposes that the symptoms of TMJMD are the result of a type of domino effect, which starts from a triggering event and then perpetuates itself (Dworkin et al., 1994; Peck et al., 2008). Conversely, the Pain Adaptation Model posits that, upon symptom presentation (e.g., pain when eating), the jaw joints and muscles adjust to functioning in a manner that is intended to prevent further dysfunction; however, this adjustment often leads to a worsening of symptoms (Peck et al., 2008). The Vicious Cycle Theory and the Pain Adaptation Model have been both supported and challenged by research, but it is suspected that a more integrative version of the Pain Adaptation Model, which includes the multifaceted view of the pain experience, is needed to explain the mechanisms behind TMJMD (Peck et al., 2008).

Central sensitization

Another possible mechanism for the cause of TMJMD is central sensitization. Upon either repeated injury or an injury with prolonged symptom presentation, neurons in the dorsal horn of the spinal cord gradually become more excitable; this is known as "wind-up" (Kandel, Schwartz, Thomas, Siegelbaum, & Hudspeth, 2013; Woolf, 2011). This alteration in excitability causes the Central Nervous System to preserve the

experience of noxious input in a manner comparable to a memory, which then results in central sensitization (Kandel et al., 2013; Woolf, 2011). In essence, central sensitization reduces the pain threshold, and this can lead to either allodynia, which is pain that is induced by a non-painful stimulus, or hyperalgesia, which is the exaggerated experience of pain (Greenspan et al., 2013; Kandel et al., 2013; Woolf, 2011).

Though researchers have their suspicions, the relationship between the dorsal horn neurons of the spinal cord and TMJMD is not fully understood (Woolf, 2011). For instance, a contrarian view would argue that the trigeminal nerve, which is the fifth cranial nerve, is involved in the etiology of TMJMD as opposed to dorsal horn neurons. On the contrary, however, when orofacial pain arises as a result of abnormalities in the trigeminal nerve, the individual would be diagnosed with trigeminal neuralgia, which is a neuropathic pain condition (NIH, 2013b). This condition is markedly different from TMJMD, which is a musculoskeletal disorder involving the jaw joints and masticatory muscles. However, it is suspected that the point at which the trigeminal nerve converges onto the dorsal horn of the cervical spinal nerve (i.e., Vc/C_2) is related to TMJMD pain (Takeshita, Hirata, & Bereiter, 2001). Furthermore, comparatively to controls, research has produced findings suggesting that myogenous TMJMD sufferers show evidence of dysregulation in the trigeminal system (Younger, Shen, Goddard, & Mackey, 2010).

The OPPERA study

Recently, a team of researchers engaged in a project called the Orofacial Pain: Prospective Evaluation and Risk Assessment (OPPERA) study, which investigated probable risk factors that lead to first-onset TMJMD (Bair et al., 2013; Fillingim et al., 2013; Greenspan et al., 2013; Ohrbach et al., 2013; Sanders et al., 2013b; Smith et al., 2013). Over the course of five years, this prospective study evaluated 2,737 TMJMD-free individuals on various TMJMD-related measures in order to pinpoint the differences

between people who went on to develop TMJMD and people who remained free of the disorder. Ultimately, 9.5% (i.e., 260 individuals) of the study participants were found to have first-onset TMJMD (Bair et al., 2013; Fillingim et al., 2013; Greenspan et al., 2013; Smith et al., 2013), which reflects the prevalence rate of the disorder in the USA (NIDCR, 2014).

The OPPERA study team found that a number of psychosocial symptoms served as "risk factors" for first-onset TMJMD: somatic symptoms (e.g., somatization), depressive symptoms, obsessive-compulsive symptoms, interpersonal sensitivity, hostility, phobia, paranoia, psychoticism, Post-Traumatic Stress Disorder symptoms, neuroticism, stress, the number of negative events occurring during the previous year, the impact of negative events, state and trait anxiety, oral parafunctional behaviors, and both positive and negative affect (Bair et al., 2013; Fillingim et al., 2013; Ohrbach et al., 2013). The results also revealed that pain, including experimenter-induced pain caused by pressure (i.e., in the temporalis and masseter muscles and in the temporomandibular joint), was a risk factor for first onset TMJMD such that both patients with a low pain threshold and patients who reported high levels of pain (i.e., greater pain sensitivity) tended to develop TMJMD, respectively (Bair et al., 2013; Greenspan et al., 2013). Furthermore, the incidence of TMJMD was also related to medication usage (i.e., three or more medications) and poor ratings of general health (Sanders et al., 2013b).

In terms of physical symptoms, it was found that a higher resting heart rate was related to TMJMD incidences; this finding appears to be indicative of a highly reactive sympathetic nervous system (Bair et al., 2013; Greenspan et al., 2013). Also, reports of comorbid conditions (fibromyalgia, irritable bowel syndrome, low back pain, etc.) were highly predictive of first-onset TMJMD (Bair et al., 2013; Sanders et al., 2013b). Direct genetic risk factors were not found for acute TMJMD, and it is suspected that this

outcome was related to the small number of individuals who developed the disorder for the first time (Smith et al., 2013). Nevertheless, it was found that there were genetic links to phenotypes that are predictors for TMJMD. For instance, the MPDZ gene is related to pain caused by heat; this gene is responsible for encoding material needed to create G proteins that are coupled with receptors, which are necessary for nociception and analgesia (Smith et al., 2013).

Treatment

Having identified and evaluated the probable causes of TMJMD, researchers and health professionals are now able to pinpoint these areas in order to relieve the complications of the disorder. There are many treatment options available to TMJMD sufferers; however, it is recommended that TMJMD patients opt for treatments that do not permanently alter the jaw (NIDCR, 2013a). The methods typically used to treat TMJMD can be divided into two categories: invasive treatments and non-invasive treatments. Invasive treatments can include Botox injections, surgery, and implantation. Botox injections are not an approved method for treating TMJMD, but they have been approved for use in other, related disorders (e.g., migraines; NIDCR, 2013a). In fact, Botox has been shown to alleviate TMJMD symptoms and is, therefore, considered to be a viable treatment option (NIDCR, 2013a; Schwartz & Freund, 2002; Song, Schwartz, & Blitzer, 2007). Surgery provides a direct physiological modification of mandibular functioning and has been shown to be successful in some cases, but it can be dangerous in that it often involves a permanent change in one's bite or the resurfacing of one's teeth (Ingawale & Goswami, 2009; Jerjes et al., 2008; List & Axelsson, 2010; NIDCR, 2013; Reston & Turkelson, 2003). Implants consist of artificial material that is used to replace a faulty jaw joint, but such material has the possibility of being defective or malfunctioning after an

extended amount of time in the body (Ingawale & Goswami, 2009; Guarda-Nardini, Manfredini, & Ferronato, 2008; NIDCR, 2013).

Non-invasive treatments are preferable to invasive treatments because they pose less of a threat in terms of potential adverse side effects. Non-invasive treatments can include therapy, self-care methods, medication, and splints. Different types of therapy can be used to treat TMJMD such as cognitive behavioral therapy (CBT) and physical therapy. CBT is instrumental in helping patients identify and, subsequently, modify negative thoughts that can adversely influence health (Gatchel et al., 2006a; Jerjes et al., 2008; List & Axelsson, 2010; Turner et al., 2006) whereas physical therapy, which is sometimes referred to as manual therapy, involves guided exercise and manipulation of the jaw for the purpose of improving mobility (Furto, Cleland, Whitman, & Olson, 2006; Michelotti et al., 2004; NIDCR, 2013; Romero-Reyes & Uyanik, 2014; Wright & North, 2009). Self-care methods involve strategies that the affected individual can implement on his or her own such as: (1) making a conscious effort not to consume foods that may exacerbate the condition; (2) avoiding any exaggerated or repetitive motions of the jaw; and (3) engaging in stress reduction (Dworkin et al., 2002b; Jerjes et al., 2008; NIDCR, 2013; Romero-Reyes & Uyanik, 2014). Medications, such as non-steroidal anti-inflammatory drugs (NSAIDs) and muscle relaxants, may also relieve the discomfort and pain associated with TMJMD (Jerjes et al., 2008; NIDCR, 2013; Romero-Reyes & Uyanik, 2014; Scrivani, Keith, & Kaban, 2008). Another non-invasive treatment option is the use of splints, also known as bite guards, to stabilize the jaw; however, splints are not intended for long-term use and do not necessarily relieve pain, which is the most prevalent symptom of TMJMD (Jerjes et al., 2008; NIDCR, 2013; Wright & North, 2009; Yuasa et al., 2013).

Parent Study History

The present study was an offshoot of a larger Parent Study, which sought to address the afflictions of acute TMJMD patients from a biopsychosocial perspective. The Parent Study began in 2008 and ended as of 2014, and, thus far, preliminary results from the Parent Study have been promising. However, now that the data collection is complete, more in-depth studies, such as the present study, can be conducted to clarify these results. Before detailing the present study, though, it would be beneficial to provide an overview on the research leading to and involved in the Parent Study.

Chronic TMJMD Versus Non-Chronic TMJMD

Historically, TMJMD has been known as a chronic pain condition, and, being that over a third of all costs associated with such a condition is attributed to orofacial pain, members of our research group engaged in an investigation to determine how chronic TMJMD individuals differed from non-chronic TMJMD individuals (Garofalo et al., 1998). We found that chronic TMJMD patients were more likely to be female, have a myogenous or arthrogenous diagnosis, experience greater pain, suffer from TMJMD-related disabilities, report more severe depressive symptoms and somatization tendencies, and meet qualifications for mood and personality disorders (Garofalo et al., 1998; Epker, Gatchel, & Ellis, 1999). Furthermore, similar to the OPPERA study findings, we discovered that both pain intensity and a diagnosis of myofascial pain served as predictors for chronic TMJMD (Epker et al., 1999), and these predictors were entered into an algorithm, which correctly classified ninety-one percent of chronic TMJMD patients (Epker et al., 1999). Subsequently, in a separate study, we sought to strengthen the algorithm by accounting for other factors that may contribute to chronicity, and we found that people who were identified as high risk for developing chronic TMJMD reported higher levels depressive symptoms, had poorer coping skills, and tended to meet the

criteria for anxiety disorders, somatoform disorders, and Cluster C of Axis II of the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) more so than people who were identified as low risk for developing chronic TMJMD (Wright et al., 2004).

Treating Chronic TMJMD

Armed with this knowledge, members of our research group then sought to assess the effects of four different treatments conditions (cognitive-behavioral skills training (CBST), biofeedback (BFB), CBST and BFB, and no treatment) on chronic TMJMD patients, which were administered over twelve sessions. All participants reported less pain over time (Bernstein & Gatchel, 2000), but patients who received treatment reported less pain than people not receiving treatment both immediately after treatment (Mishra, Gatchel, & Gardea, 2000) and one-year following treatment (Gardea et al., 2001). Furthermore, mood improved over time for all participants immediately following treatment (Mishra et al., 2000), and, after one year, patients who received treatment reported reduced disability compared to people not receiving treatment (Gardea et al., 2001).

Treating Acute TMJMD

Naturally, the next step was to ascertain whether similar findings could be replicated in an acute TMJMD population, and it was found that, when administering a shortened version of both CBST and BFB combined (i.e., six sessions) to acute TMJMD individuals, patients receiving treatment reported reductions in pain, chronic risk status (i.e., as determined by the aforementioned algorithm; Epker et al., 1999), maladaptive coping, and DSM-IV Axis I diagnoses one-year following treatment compared to people not receiving treatment (Gatchel et al., 2006b). Furthermore, all patients who received treatment reported reduced pain and depressive symptoms after one year (Gatchel et al.,

2006a). These patients were also assessed in a long-term follow-up study (i.e., up to six years following entrance into the study), and, over time, they reported reduced pain, improved coping styles, and reduced depressive symptoms; furthermore, the treatment group revealed fewer DSM-IV-TR somatoform diagnoses compared to the control group after one-year (Robinson, 2007).

Following this study, our research group sought to compare the combination treatment (i.e., CBT and BFB) to both a comparison group (i.e., low risk for developing chronic TMJMD) as well as to an attention-education treatment. The treatments were administered to patients identified as at a high risk for developing chronic TMJMD (Epker et al., 1999), and prior to treatment, it was found that patients with multiple TMJMD diagnoses and were high risk had significantly greater chewing pain, self-reported pain, pain-related disability, depressive symptoms, somatization, and poorer physical wellbeing than patients without multiple diagnoses and who were low risk, respectively (Dougall et al., 2012; Lorduy, 2012; Lorduy, Dougall, Haggard, Sanders, & Gatchel, 2013).

Also prior to treatment, it was found that emotional distress (e.g., depressive symptoms) partially mediated Central Sensitization Syndrome (CSS) symptoms in patients with more than one diagnosis, but, over time, CSS symptoms decreased for the treatment groups (Lorduy, 2012; Lorduy et al., 2013). Also, emotional distress, pain, pain-related disability, and symptoms of both myogenous TMJMD and disc displacements were reduced immediately following the intervention for patients who received treatment (Ingram et al., 2011; Lorduy, 2012). Physical wellbeing was found to be a better indicator of a clinically meaningful difference in masticatory performance for both treatment groups than mental wellbeing, self-reported pain, and pain-related disability immediately following treatment (Ingram et al., 2011). This finding can be interpreted to mean that an improvement in physical wellbeing is positively related to

improvement in masticatory performance (Ingram et al., 2011). Furthermore, it was found that facial pain predicted chewing pain, and chewing pain decreased over time for all participants one-year after treatment, with the comparison group outperforming the treatment groups in masticatory performance (Sanders, 2013). In one of the more recent studies, there was evidence to suggest that treatment type influenced the decrease in the frequency of myogenous TMJMD diagnoses over time (Sanders, Dougall, Lorduy, Haggard, & Gatchel, 2013). Unfortunately, this effect led to null findings when probed, but, now that all data have been collected and we are able to look at treatment effects over a longer term, it is expected that these findings can be clarified.

Current Study

The purpose of the current study was to conduct subgroup analyses to assess the effects of an early intervention treatment program for acute TMJMD patients according to the diagnosis given prior to the intervention. Specifically, I predicted that the effects of a biobehavioral intervention would be most pronounced for myogenous TMJMD patients in terms of relieving psychological distress, relieving pain, and improving functionality. Interestingly, pain that is evoked from the jaw joints does not appear to be as debilitating as myogenous pain (Reissman et al., 2007), and this may be because myogenous TMJMDs, in particular, are inherently painful and affect a larger portion of the craniomandibular region as compared to other TMJMD diagnoses (i.e., disc displacements and joint diseases; Yap, Tan, Chua, & Tan, 2002). This discomfort can spread into other aspects of a TMJMD sufferer's life, and, therefore, it was believed that myogenous diagnoses would result in a heightened experience of various TMJMD-related symptoms.

Importance of the Current Study

The current study is important because, to my knowledge, subgroup analyses have not been conducted in an acute TMJMD population according to diagnoses. Subgroup analyses answer the question, "do the treatment effects vary among the levels of a baseline factor…[such as a] a specific patient characteristic?" (Wang, Lagakos, Ware, Hunter, & Drazen, 2007), and, since muscle disorders are common among TMJMD sufferers (Ballegaard et al., 2008; List & Dworkin, 1996; Manfredini et al., 2011; Manfredini et al., 2012; Mora, Weber, Neff, & Rief, 2013; Scrivani et al, 2008; Machado, Nery, Leles, Nery, & Okeso, 2009), it would be advantageous to determine if the subset of patients with this diagnosis are actually able to benefit from a treatment such as a biobehavioral intervention when compared to other patients with the same diagnosis. With this knowledge, treatment protocols for these patients can become more efficacious in relieving symptoms and, quite possibly, reducing the prevalence of the disorder.

Furthermore, investigations of acute TMJMD populations are imperative given the pervasiveness (NIDCR, 2013a; 2014), high costs (Gatchel et al., 2006a; NIDCR, 2014; Stowell et al., 2007; White et al., 2001), and debilitating nature of the disorder upon becoming chronic (Andreu et al., 2006; Carlsson, 1999; Dworkin et al., 2002a; John et al., 2003; Manfredini et al., 2010b). Such factors can be magnified when considering the number of co-occurring TMJMD diagnoses. Unfortunately, some studies have excluded people with multiple TMJMD diagnoses (Galdon et al., 2006; Michelotti et al., 2004) despite the fact that they are relatively common (Dougall et al., 2012; Machado et al., 2009; Manfredini et al., 2011; Manfredini et al., 2012; Lorduy, 2012; Lorduy et al., 2013; Wieckiewicz et al., 2014). This study, however, included analyses on patients with multiple diagnoses and, thus, is more generalizable and can add to the TMJMD literature.

Psychological Distress

Past research has shown that psychological distress (e.g., depressive symptoms, stress, somatization, etc.) shares a strong relationship with myogenous TMJMD diagnoses (Bernstein & Gatchel, 2000; Galdon et al., 2006; Manfredini et al., 2009; Wieckiewicz et al., 2014). For instance, somatization has been linked to an increase in the amount of pain sites in the masticatory muscles of TMJMD sufferers (Dworkin et al., 1994), and individuals with myogenous TMJMD tended to report more emotional distress when compared to other diagnostic groups (Wieckiewicz et al., 2014). Particularly, myogenous TMJMD sufferers have reported more depressive symptoms (Manfredini, Bandettini di Poggio, Cantini, Dell'osso, & Bosco, 2004) and increased anxiety compared to other diagnostic groups (McCreary, Clark, Merril, Flack, & Oakley, 1991). Additionally, it has been found that the muscle pain experienced by individuals with myogenous TMJMD can incite stress (van Selms, Lobbezoo, Visscher, & Naeije, 2008). One study assessed the relationship between the RDC/TMD Axis I diagnoses and the mental and personality disorders outlined in the Structured Clinical Interview for the Diagnostic and Statistical Manual of Mental Disorders (SCID); interestingly, only the myogenous diagnoses shared significant relationships with both current and past SCID disorders (Kight, Gatchel, & Wesley, 1999).

Though the mechanism behind myogenous TMJMD is unclear, it is possible that the connection between psychological distress and myogenous TMJMD is due to a hypersensitivity to symptoms, catastrophizing, and a dysfunctional style of behavior and coping (Galdon et al., 2006; Manfredini et al., 2011). Furthermore, one study found that TMJMD patients who experience depressive symptoms reportedly have an increased susceptibility to negative cognitions (Gatchel, Stowell, & Buschang, 2006), which can result in a worsening of symptoms. Therefore, researchers have suggested that a

myogenous TMJMD diagnosis necessitates treatment options that provide the tools needed to identify and cope with the associated distresses (McCreary et al., 1991).

Pain

According to the RDC/TMD, in order to be diagnosed with myogenous TMJMD, one must endorse pain upon palpation of at least three locations of the extraoral muscles and/or the intraoral muscles (Ohrbach, 2011). Therefore, the experience of pain is inherent in a diagnosis of myogenous TMJMD, and research has found that myogenous TMJMD sufferers have a heightened sensitivity to pain compared to controls (Svensson, List, & Hector, 2001). Likewise, people with myogenous TMJMD tend to suffer more so from pain in the facial and cervical regions of the body when compared to other diagnostic groups (Wieckiewicz et al., 2014).

As previously mentioned, TMJMD pain appears to instigate pain in other regions of the body (Jerjes et al., 2008; NIDCR, 2013; Suvinen et al., 2005; Wright & North, 2009), which has implications of possible interference with non-masticatory aspects of the TMJMD sufferer's life. For instance, people with myogenous TMJMD, either alone or in combination with another type of TMJMD diagnosis, tend to report higher levels of pain-related disability compared to people either without a diagnosis or with a different diagnosis (Manfredini et al., 2011; Reissmann et al., 2008).

Functionality

It is well-established that TMJMD sufferers experience difficulty in breaking down foods adequately for digestion (Ahn et al., 2011; Berretin-Felix, Genero, Trindade, & Trindade Junior, 2005; Felicio et al., 2007; Gatchel et al., 2006a; Hansdottir & Bakke, 2004; Pereira, Steenks, DeWijer, Speksnijder, & VanDerBilt, 2009). Furthermore, all TMJMD diagnostic groups (i.e., RDC/TMD Axis I) have been linked to poor health outcomes, particularly in terms of oral health-related quality of life, (OHRQoL;

Reissmann, John, Schierz, & Wassell, 2007), which can be defined as one's perception of his or her wellbeing physically, socially, and psychologically as it relates to oral health (Bennadi & Reddy, 2013; Locker & Allen, 2007). In fact, it was found that people with a RDC/TMD Axis I diagnosis had a more negative OHRQoL than the general population (John, Reissmann, Schierz, & Wassell, 2007).

People who suffer from a myogenous form of TMJMD, however, tend to suffer extraordinarily from the disorder. For example, it has been found that people with myogenous TMJMD had a poorer OHRQoL when compared to individuals with a different diagnosis (John, Reissmann, Schierz, & Wassell, 2007), particularly if they had more than one myogenous diagnosis as opposed to only one diagnosis (Reissman et al., 2007). Also, consider the muscles to be examined to determine a diagnosis of myogenous TMJMD; these involve the extraoral muscles (temporalis, masseter, and mandibular regions) and/or the intraoral muscles (temporalis tendon and lateral pterygoid). The temporalis muscles are responsible for facilitating mastication (Crider, Glaros, & Gervitz, 2005), the masseter muscles help in the stabilization and articulation of the jaw joint (DuPont & Brown, 2009), and the lateral pterygoid muscles aid in protruding and closing the mandible (Crider et al., 2005). Given these functions of the masticatory muscles, it is logical how any abnormalities in these areas can promote dysfunction.

Furthermore, oral parafunctional habits (e.g., clenching, grinding, etc.) are highly related to myogenous TMJMD diagnoses (Galdon et al., 2006; van Selms, Lobbezoo, Visscher, & Naeije, 2008; Wieckiewicz et al., 2014), and this relationship possibly exists due to a skewed perception that myogenous TMJMD patients may have regarding their ability to function normally (Galdon et al., 2006). These findings along with the discovery that TMJMD tends to precipitate seemingly non-TMJMD-related symptoms (e.g., tinnitus, vertigo, etc.) suggest that overall physical functioning, in addition to masticatory

functioning, may be inhibited for people who have myogenous TMJMD (Penker et al., 2000; Scrivani et al., 2008; White et al., 2004).

Biopsychosocial Treatment

Considering the evidence, the finding that myogenous TMJMD patients are more likely to seek treatment (Dworkin et al., 2002a) is logical; fortunately, though, research has shown that a myogenous TMJMD diagnosis is predictive of a favorable treatment response (Bernstein & Gatchel, 2000). When a treatment protocol is being selected for patients with TMJMD, it is imperative that a multifaceted approach be taken. It would not be sufficient to address only the physical consequences of TMJMD, which do not always coincide with the level of pain and dysfunction reported by the patient (Dworkin et al., 1994; Gatchel et al., 2007; Reissmann et al., 2008; Schiffman et al., 2014). In fact, it is the psychosocial aspect of the disorder that most heavily influences the diagnosis, pathology, and intervention options (Crider et al., 2005; Garofalo et al., 1998; Gustin et al., 2011; Ohrbach, 2010a; Suvinen et al., 2005). Therefore, treating TMJMD from a biopsychosocial perspective is critical. According to this perspective, health complications, especially those that involve pain, are typically experienced in conjunction with one's physical awareness, emotions, beliefs, and social environment (Borrel-Carrio, Sucbman, & Epstein, 2004; Bernstein & Gatchel, 2000; Dworkin et al., 2002a; Gatchel et al., 2007), and, as demonstrated in the preceding paragraphs, research has shown that such an interplay among factors is evident in people who suffer from myogenous TMJMD (Bernstein & Gatchel, 2000; Galdon et al., 2006; Manfredini et al., 2009; Manfredini et al., 2011; Reissman et al., 2007; Wieckiewicz et al., 2014).

A biobehavioral intervention uses a biopsychosocial perspective to treat health issues (Bernstein & Gatchel, 2000; Ohrbach, 2010a) and usually includes CBT and/or BFB (Dworkin et al., 2002a). In fact, past research has shown that CBT and BFB are the

most effective when used in combination with each other and have the ability to enhance pain management capabilities, especially when treating individuals with TMJMD; this is explained by BFB's ability to address the physiological aspect of the disorder on a short-term basis and by CBT's ability to address the psychosocial aspect of the disorder on a long-term basis (Bernstein & Gatchel, 2000; Gardea et al., 2001; Pulliam & Gatchel, 2003; Gatchel et al, 2006b; List & Axelsson, 2010).

CBT is instrumental in helping patients become aware of thoughts, behaviors, activities, or emotions that may exacerbate the debilitations they experience (Crider et al., 2005; Dworkin et al., 2002a; Dworkin et al., 1994). Once these thoughts have been identified, a trained clinician can aid the patient in correcting and modifying them in such a way that can actually improve their health. This can be done by educating patients about different relaxation techniques and coping strategies (Dworkin et al., 2002a; Dworkin et al., 1994), which would be especially helpful for people with myogenous TMJMD because they tend to be dysfunctional copers (Epker & Gatchel, 2000).

BFB, separately as well as in combination with CBT, has been shown to be effective in treating TMJMD, particularly if it is myogenous in nature (Crider et al., 2005). BFB involves a collection of techniques that increase the awareness of a patient's own physiological responses (i.e., autonomic nervous system responses and muscular activity) as related to volitional behaviors (Crider et al., 2005; Pulliam & Gatchel, 2003). Electronic devices, such as a laptop, can quantify these responses using sounds, numbers, or graphs, and, in this way, patients are made aware of the relationship between how their bodies respond to adverse stimuli and how they perceive their condition (Crider et al., 2005; Pulliam & Gatchel, 2003). For example, a negative evaluation of a patient's condition can cause an increase in muscle tension, and BFB is able to visually display this relationship to the patient.

As mentioned above, many of the studies conducted by members of our research group have reported varying levels of short-term and long-term symptom relief for TMJMD patients who received a biobehavioral intervention which included both CBT and BFB (Bernstein & Gatchel, 2000; Ingram et al., 2011; Gardea et al., 2001; Gatchel et al., 2006; Mishra et al., 2000; Lorduy, 2012). Research supporting the use of biobehavioral interventions in TMJMD patients has also been found by other research groups. For instance, studies have shown that TMJMD patients who received a biobehavioral intervention had significantly lower pain (Crider et al., 2005; Dworkin et al., 2002a) as well as significantly lower depressive symptoms (Turk, Zaki, & Rudy, 1993) when compared to people who did not receive such an intervention. However, the fuller extent of these treatment effects has been scarcely investigated, which affords an opportunity for the present study to fill this gap in the literature.

Hypotheses

Considering the preceding evidence, my hypotheses were as follows:

- H_1 = A biobehavioral intervention would be most beneficial for participants who are diagnosed with myogenous TMJMD when compared to other myogenous TMJMD patients in terms of reducing psychological distress over time. Furthermore, of the patients receiving the biobehavioral intervention, patients with a single diagnosis of myogenous TMJMD would have better outcomes than those with multiple diagnoses including a muscle disorder.
    - Specifically, it was expected that these participants would report a greater reduction in stress, depressive symptoms, and non-painful somatization along with a greater improvement in mental

wellbeing immediately following the intervention, one year after the intervention, and two years after the intervention.

- H_2 = A biobehavioral intervention would be most beneficial for participants who are diagnosed with myogenous TMJMD when compared to other myogenous TMJMD patients in terms of reducing pain over time. Furthermore, of the patients receiving the biobehavioral intervention, patients with a single diagnosis of myogenous TMJMD would have better outcomes than patients with multiple diagnoses including a muscle disorder.
    - Specifically, it was expected that these participants would report a greater reduction in facial pain, chewing pain, painful somatization, and pain-related disability immediately following the intervention, one year after the intervention, and two years after the intervention.
- H_3 = A biobehavioral intervention would be most beneficial for participants who are diagnosed with myogenous TMJMD when compared to other myogenous TMJMD patients in terms of improving functionality over time. Furthermore, of the patients receiving the biobehavioral intervention, patients with a singular diagnosis of myogenous TMJMD would have better outcomes than patients with multiple diagnoses including a muscle disorder.
    - Specifically, it was expected that these participants would report a greater improvement in both physical wellbeing and masticatory performance immediately following the intervention,

one year after the intervention, and two years after the intervention.

Exploratory investigation

In the main analyses for this study, my overarching expectation was that people with myogenous TMJMD would benefit the most from a biobehavioral treatment. However, I realized that there was a potential confound of regression towards the mean by virtue of the fact that patients diagnosed with myogenous TMJMD tend to have a more severe symptom presentation when compared to TMJMD patients with other diagnoses. Therefore, in an effort to combat this potential confound, I elected to analyze measures that I suspected could objectively confirm the results from the main analyses. These measures were health care utilization and medication use. It was my expectation that myogenous TMJMD patients who received the biobehavioral intervention would report a reduction in health care utilization and medication use.

Chapter 2

Methods

Participants

To be eligible for the current study, the participants were required to meet the inclusion/exclusion criteria, which were as follows: (1) be 18 years old or older; (2) have experienced jaw pain no more than six months prior to entering the study; (3) have no history of chronic jaw or face pain; and (4) have no co-morbid, pain-exacerbating condition (e.g., fibromyalgia). Participants were individuals in the Dallas-Fort Worth Metroplex seeking treatment for their TMJMD symptoms and were recruited between 2008 and 2013 in the following ways: referrals from community dental clinics; flyers which described the study; word-of-mouth; internet advertisements; and advertisements disseminated to a mailing list of prospective participants. Prior to their participation, the participants were given a packet of information detailing the Parent Study and were required to initial each page of the packet in addition to providing their signature on the Consent Form, thereby indicating that they had read and understood the information they had read. This Consent Form was approved by the University of Texas at Arlington's (UTA's) Institutional Review Board (IRB).

Each participant was treated ethically according to IRB regulations and was informed his or her participation in the study was completely voluntary. Personally identifiable information was kept confidential through the use of identification numbers, and the data were stored electronically on secured networks and physically in locked cabinets. Participant information is to be kept for at least three years following the termination of the Parent Study, and access to the information generated from the Parent Study is limited to the Secretary of the Department of Health and Human Services, the UTA IRB, the Federal Drug Administration (FDA), and affiliated research personnel.

Materials and Measures

To test my hypotheses, diagnoses were determined by the RDC/TMD, and various measures were used to evaluate psychological distress, pain, and functionality. Specifically, psychological distress was measured using the Perceived Stress Scale (PSS), the Beck Depression Inventory-II (BDI-II), the mental component score (MCS) of the Short Form-36 (SF-36), and the non-painful somatization scale of the RDC/TMD. Pain was measured using the Characteristic Pain Inventory (CPI) of the RDC/TMD, self-reported chewing pain, the painful somatization scale of the RDC/TMD, and the Graded Chronic Pain Scale (GCPS) of the RDC/TMD. Lastly, functionality was measured using the physical component score (PCS) of the SF-36 and two measures of masticatory performance (i.e., median particle size and broadness of the distribution).

RDC/TMD Axis I Diagnoses

Because the DC/TMD were released five years following the commencement of the Parent Study, the measures of the RDC/TMD (Dworkin & LeResche, 1992), which served as the standard diagnostic criteria at the time, were used for this study in order to diagnose and assess the TMJMD characteristics of our sample. According to some researchers, TMJMD is actually considered to be a set of disorders as opposed to being only one condition (Ohrbach, 2010b). This perspective is supported by the various sub-diagnoses which one can be given (Wright & North, 2009), and the RDC/TMD are able to capture these nuances through the comprehensive quality of the two axes: Axis I and Axis II (Ohrbach, 2011). Axis I measures the physical characteristics of TMJMD with regard to three groups: muscle disorders (Group I), disc displacements (DDs; Group II), and degenerative joint diseases (DJDs; Group III; Ohrbach, 2011). The muscle disorders include the presence of myofascial pain (Group Ia) as well as any limitations in opening the mouth that are associated with that pain (Group Ib; Ohrbach, 2011). DDs are side-

specific and involve the abnormal position of the disc in the jaw, which can be: (1) reduced upon the full opening of the mouth while making a noise (Group IIa); (2) associated with limited opening (Group IIb); or (3) without an association with limited opening (Group IIc; Ohrbach, 2011). The DJDs are also side-specific, and individuals can be diagnosed with arthralgia (Group IIIa), osteoarthritis of the jaw joint (Group IIIb), or osteoarthrosis of the jaw joint (Group IIIc; Ohrbach, 2011). The reader should note that Axis I of the RDC/TMD has demonstrated acceptable validity (Schiffman et al., 2014).

RDC/TMD Axis II Measures

Axis II of the RDC/TMD (Dworkin & LeResche, 1992) assesses the psychosocial symptoms of TMJMD, and four of its measures were used for the current study: CPI, GCPS, painful somatization, and non-painful somatization (Ohrbach, 2010a; 2011). These measures have been cross-validated in previous research (Dworkin et al., 2002b; Ohrbach, 2010a; 2011) and have demonstrated acceptable validity and reliability (Schiffman et al., 2014).

CPI

To get a measure of facial pain, the CPI was used. The CPI consists of three items, which ask participants to rate the severity of the pain they have been experiencing, from zero ("no pain") to ten ("pain as bad as could be"), in reference to three items: (1) current pain; (2) worst pain during the previous six months; and (3) average pain during the previous six months. The responses to these three items were averaged and then multiplied by ten to get a pain rating from zero to one-hundred with higher numbers corresponding to more pain. In our sample, the CPI showed high reliability, $\alpha = .88$.

GCPS

The GCPS is a validated scale that uses a combination of two different measures: the CPI and pain-related disability items (Dworkin et al., 2002b; Ohrbach,

2011; Von Korff, Ormel, Keefe, & Dworkin, 1992). In addition to the three CPI items used for the GCPS, there are four pain-related disability items of which three assess the degree to which pain has interfered with daily activities from zero ("no interference") to ten ("unable to carry on any activities"). The fourth pain-related disability item asks participants to indicate the number of days they have not been able to perform their usual activities. The responses to all seven items were funneled into five grades of disability from zero ("no disability") to four ("high disability-severely limiting"). In our sample, this scale exhibited moderate reliability, $\alpha = .56$.

Somatization

Both of the somatization measures are derivatives of the Symptom Checklist-90. The painful somatization scale consists of twelve items that gauge painful somatization tendencies (e.g., headaches, nausea, muscle soreness, etc.) that are measured on a five-point scale from zero ("not at all") to four ("extremely"), and the responses to the items were averaged to provide an overall score only if at least eight of the items were answered. If less than eight of the items were answered, a score was not given. In our sample, the painful somatization scale showed high reliability, $\alpha = .85$.

The non-painful somatization scale consists of seven items that gauge non-painful somatization tendencies (e.g., numbness, dizziness, feeling weak, etc.) that are assessed on the same five-point scale as the painful somatization measure, and the responses to the items were averaged to provide an overall score only if at least five of the items were answered. If less than five items were answered, a score was not given. Higher scores on each somatization scale indicated an endorsement of somatization tendencies, and, in our sample, the non-painful somatization scale showed high reliability, $\alpha = .79$.

Perceived Stress Scale

The PSS (Cohen, Kamarck, & Mermelstein, 1983) measures how one interprets the stressfulness of events that have occurred in the month prior to completing the scale, which consists of ten items. Participants indicated the frequency with which they experienced stressful emotions on a five-point scale that ranges from zero ("never") to four ("very often"). The fourth, fifth, seventh, and eighth items are positively worded and thus were reversed scored. Afterwards, responses to all ten items were summed, producing a score that could range from zero to forty. A higher score was indicative of a relatively higher level of stress, and, in our sample, the PSS demonstrated high reliability, $\alpha = .91$.

Beck Depression Inventory-II

The BDI-II (Beck, Steer, Ball, & Ranieri, 1996) was developed with the intention of reflecting the criteria for depression as stated in the DSM-III-R and DSM-IV; however, it is not meant to diagnose individuals with depression since it is meant to be used as a screening tool. Particularly, the BDI-II measures depressive symptoms in accordance with twenty-one items to which respondents can choose one of four response options, that range from zero to three. The responses to each item are totaled to glean a possible maximum score of sixty-three. Higher scores indicate more severe levels of depressive symptoms, and, in our sample, the BDI-II rendered high reliability, $\alpha = .92$.

Short Form 36

The SF-36 (Ware, 2004) is a health survey of thirty-six items that evaluates individuals' quality of life as a result of their current health. The survey is composed of eight scales, which measure different facets of health as related to both physical (PCS) and mental (MCS) wellness. The PCS gauges physical wellbeing, and its overall score is determined by four of the eight scales: Physical Functioning, Physical Role (i.e.,

interference due to physical health), Bodily Pain, and General Health. The remaining scales assess mental wellbeing and make up the MCS: Mental Health, Emotional Role (i.e., interference due to emotional health), Social Function, and Vitality. Scores ranged from zero to one-hundred with higher scores indicating a greater improvement in wellbeing. In our sample, this measure had acceptable reliability, $\alpha = .94$.

Chewing Pain

To get a measure of functional pain, participants were asked to chew five tablets of an artificial test food material (i.e., CutterSil®). After chewing the fifth tablet, participants were asked to indicate which side of their mouth felt most comfortable during chewing and to rate their level of chewing pain from zero ("no pain") to ten ("pain as bad as could be") for both sides. Because the TMJMD literature does not suggest one side of the mouth being more prone to pain than the other side, the pain rating was taken from the least comfortable side of the mouth. In the event that a participant indicated that both sides were equally comfortable, an average of the two pain ratings was used.

Masticatory Performance

As explained above, participants were given five tablets of CutterSil® to chew in order to ascertain each participant's level of masticatory performance. CutterSil® is a standardized, artificial test food material that consists of condensed silicone with negligible flavor, scent, or absorptive properties; these characteristics make CutterSil® a superb material for evaluating functionality in terms of mastication (Albert, Buschang, & Throckmortion, 2003). CutterSil® is produced at the Baylor College of Dentistry (BCD) and is manufactured into small tablets that are five millimeters in thickness and twenty millimeters in diameter (Albert et al., 2003), and a durometer is used to ensure that each tablet is consistent in terms of hardness (English, Buschang, & Throckmorton, 2002).

Participants were asked to chew the CutterSil® as they would natural food for twenty chews per tablet. Afterwards, the participants expectorated the material into a container, which was then transferred to BCD where it was analyzed. The sample was placed in an oven where it was allowed to dry at 808°C for one hour. Once the material dried, the sample was filtered through seven mesh sieves of different sizes (0.25 mm, 0.425 mm, 0.85 mm, 2.0 mm, 2.8 mm, 4.0 mm, and 5.6 mm) and then weighed to the nearest 0.01 gram (English et al., 2002).

To quantify functionality via masticatory performance, the Rosin-Rammler equation was used: $Q_w = 100\ [1\text{-}2^{-(x/x_{50})^b}]$. The "$Q_w$" represents the percent weight of the sample that has a diameter that is less than "X", which is the sieve size. The "X_{50}" represents the median particle size (MPS) and is the amount at which fifty percent of the sample's weight could pass through the sieve. The MPS is measured in millimeters and gives an indication of masticatory performance in that a small MPS is indicative of adequate breakdown of the test food material, which can give some indication of better nutritive absorption later on in the digestive process (Gatchel et al., 2006a). The "b" represents the broadness of the distribution (BD) of the sample. The BD has no real unit of measurement but serves as an indication of the variance of the sample. A small BD, which is associated with a wider distribution, indicates superior masticatory performance (English et al., 2002).

Health Care Utilization & Medication Use

As a part of exploratory analyses that were intended to provide objective support for the evidence gleaned from the main analyses of the present study, two other measures were analyzed: health care utilization and medication use. The health care utilization form allowed participants to indicate the frequency with which they sought medical attention. Specifically participants were asked to indicate the number of times

they visited health care professionals both for reasons related to jaw pain or discomfort and for reasons that were unrelated to their jaw condition. At the baseline evaluation, participants were asked to answer these questions in reference to three months prior to the date they first began experiencing jaw pain or discomfort. Afterwards, during the same evaluation, participants were asked to answer the same questions but, this time, in reference to the time period between the first experience of jaw pain or discomfort and the date that they were completing the baseline evaluation. At the following time points, these same questions were answered in reference to the time in-between the prior assessment and the current assessment.

The medication use form simply asked participants to indicate any medications of which they were under the influence that pertained to any of the following eight categories: nonsteroidal anti-inflammatory drugs (NSAIDs), muscle relaxants, anxiolytics, sedatives, anti-psychotics, antidepressants, opioids, and other. A count of the medications taken overall and per category was used for analyses (e.g., under the category of NSAIDs, a participant who indicated taking Ibuprofen and Advil was assigned a value of 2 regardless of dosage or amount of pills taken).

Study Design

The current study used data gathered from participants who were involved in the Parent Study, which was a longitudinal intervention study conducted by mental health professionals of the Acute TMJMD Treatment Program at UTA. After the participants consented and were deemed eligible for the study, the baseline evaluation (T1) was completed, which included the aforementioned assessments. Once the baseline evaluation was administered, each participant's chronic risk status, which was dictated by the algorithm created by Epker and colleagues (1999), was calculated. If participants were determined to be at a low risk for developing chronic TMJMD, they were assigned

to the Low-Risk/Non-Intervention (LR/NI) group. If participants were determined to be at a high risk for developing chronic TMJMD, they were randomized into one of two intervention groups: the High-Risk/Biobehavioral group (HR/BB) or the High-Risk/Self-Care group (HR/SC).

During the intervention phase, the HR/BB group received a biobehavioral intervention, which included CBT and BFB, and the HR/SC group received a self-care intervention, which included educational materials on the management of TMJMD (Figure 2-1). The intervention phase included six sessions that lasted for about three weeks, depending on the respective participant's schedule, and, afterwards, a series of post-intervention follow-up evaluations were administered to all participants. These post-intervention evaluations occurred immediately after the intervention (T2), one year after the intervention (T3), and two years after the intervention (T4).

Biobehavioral Intervention

The protocol for the biobehavioral intervention was created by Drs. Anna Wright Stowell and Robert J. Gatchel and was based on a treatment workbook authored by Brown and Lewinsohn (1984). In the intervention, study clinicians, who were trained by a Licensed Professional Counselor, taught the patients in the HR/BB group the following techniques: relaxation training, distraction methods, pleasant activity scheduling, cognitive skills training, and coping. The relaxation training consisted of two different types: tense-relaxation training and passive relaxation training. In the tense-relaxation training, the patients practiced actively tightening certain muscle groups while simultaneously loosening others. In the passive relaxation training, the patients learned how to create a rhythm between breathing and relaxing the entire body. Study clinicians also taught HR/BB patients how to use distraction (e.g., counting backwards) and

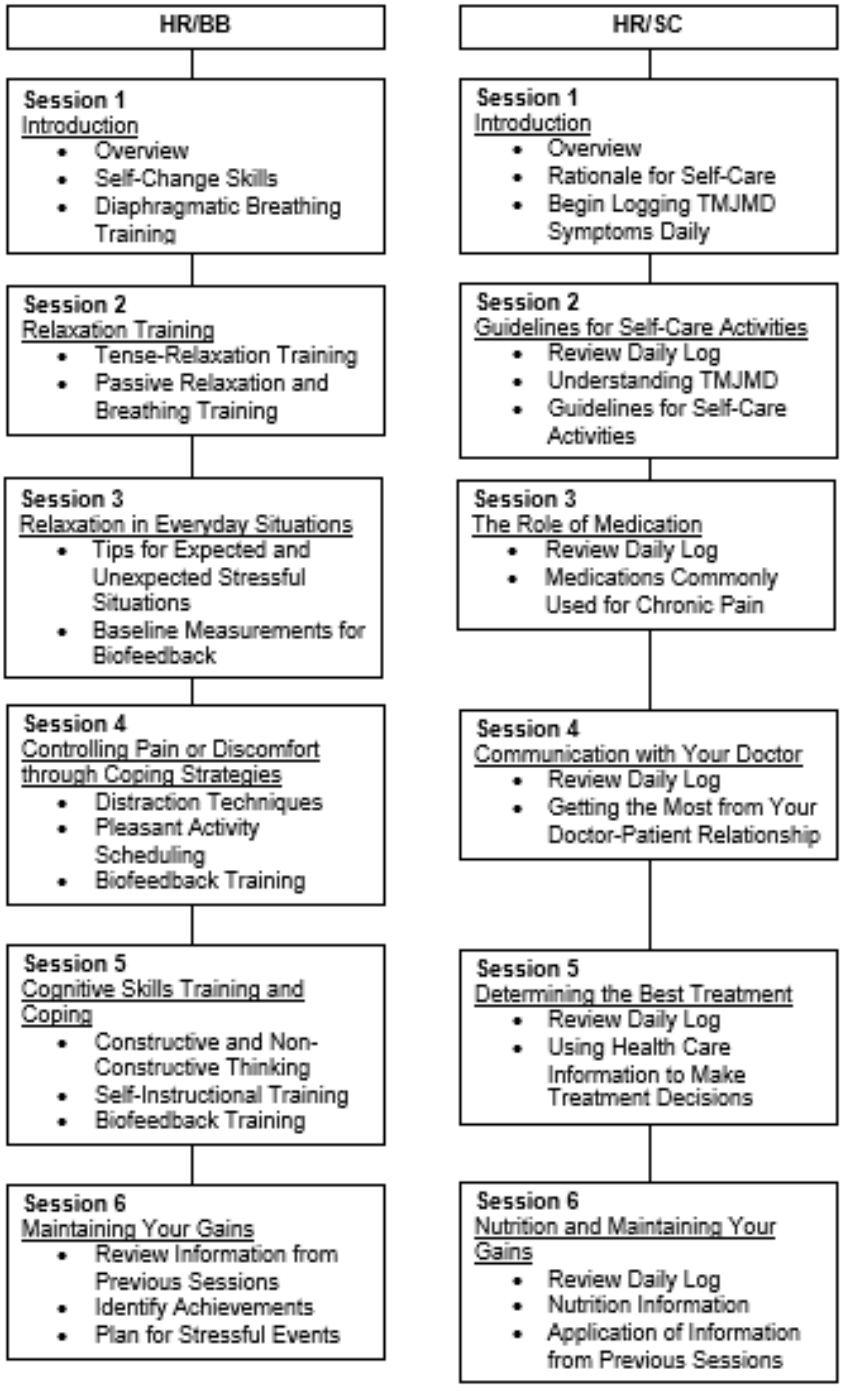

Figure 2-1 Flowchart of Interventions

pleasant activities (i.e., allotting time for such activities) as a way to cope with the pain they were experiencing. In the cognitive skills training and coping portion of the intervention, study clinicians gave the patients information about the relationship among thought processes, behaviors, and emotions. Clinicians began by superficially explaining the gate control theory of pain. This theory posits that the activation of small, unmyelinated fibers (i.e., C fibers) inactivates inhibitory interneurons while simultaneously stimulating a projection neuron, which 'opens the gate' and causes pain; conversely, the activation of larger, myelinated fibers (i.e., Aβ fibers) stimulates the inhibitory interneurons, which inhibits the activity of the projection neuron and 'closes the gate' so that pain is not experienced (Kandel et al., 2013). Likewise, participants were taught that certain thoughts, behaviors, and emotions would either promote or inhibit jaw pain. Therefore, participants learned how to recognize non-constructive thoughts and then combat them with alternative ones.

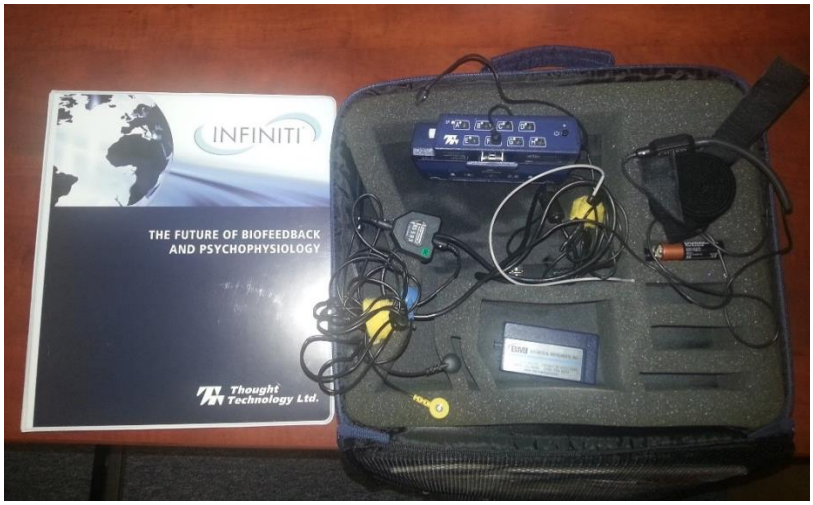

Figure 2-2 BFB Equipment

These CBT practices were then coupled with BFB, which was administered with the ProComp Infiniti and BioGraph systems (Figure 2-2) using three different modalities

(Figure 2-3): surface electromyography (SEMG), respiration, and surface temperature. Sensors were placed on patients' frontalis muscle (i.e., the forehead), and a SEMG

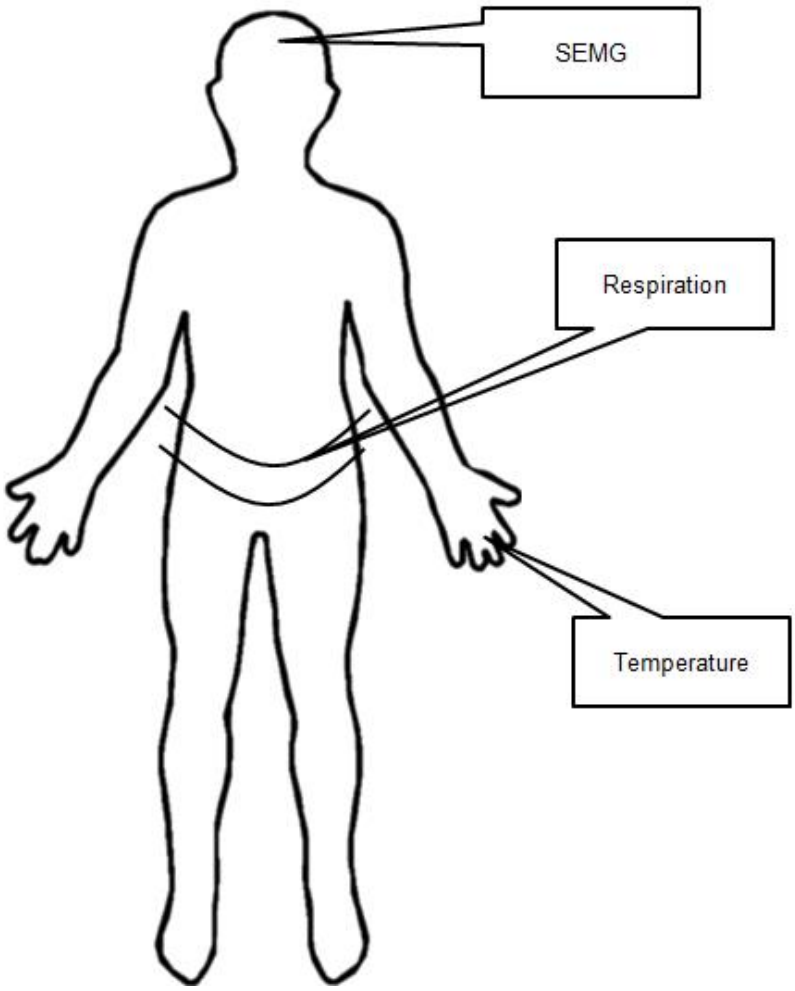

Figure 2-3 Diagram of BFB Setup

graph, depicted on a laptop screen, provided a graphical display of the amount of tension present in the his or her forehead. Such tension has been shown to be indicative of the amount of effort expended to execute a task (e.g., stress; Veldhuizen, Gaillard, & de Vries, 2003); in fact, researchers found that the frontalis muscle of patients with

myogenous TMJMD was more responsive to stress when compared to controls (Kapel, Glaros, & McGlynn, 1989).

For respiration measurements, a strain gauge, which is a rubber band-type instrument, was placed around the patients' abdominal area to measure both the quality and the frequency of breaths taken by the patient, which was also depicted in a graphical display. TMJMD sufferers may have a tendency to breath from their upper body (e.g., chest), which can prevent the flow of oxygen in the bloodstream and lead to a mild form of hyperventilation. Fortunately, BFB can help train TMJMD patients to breath from their diaphragm, which decreases the amount of energy expended to breath as well as increase the flow of oxygen in the blood.

For surface temperature, a sensor was placed on the index finger of the patients' hand to get a measurement of peripheral blood flow, which can give an indication of one's mindset and emotions (e.g., nervousness can produce hot, sweaty palms); essentially, a warm temperature represents a relaxed state via better blood flow.

Self-Care Intervention

The patients in the HR/SC group received an education-based intervention and were meant to serve as a type of attentional control group. Such an intervention was incorporated in order to account for the effect of attention provided by the study clinicians as well as to evaluate the effectiveness of an education-based intervention that promoted self-management of symptoms with limited guidance from a clinician, which has been shown to offer some relief to TMJMD patients (Dworkin et al., 1994). The clinicians educated the patients in the HR/SC group with regard to various topics: TMJMD etiology and diagnosis, self-care activities (e.g., correcting the posture of the jaw), medication, communicating with health professionals, treatments, and nutrition. This education came in the form of reading materials, and patients were encouraged to engage in dialogue

with the clinicians regarding how the aforementioned topics applied to them personally. Additionally, the HR/SC patients were asked to complete a daily log for the duration of the intervention phase, which asked that they provide a pain rating four times a day (i.e., morning, noon, afternoon, and evening) as well as specify in which area of their body this pain was experienced (i.e., jaw, neck/shoulder, head, or general tension).

Non-Intervention

The participants in the LR/NI group did not receive an intervention. Instead, this group served as a comparison group to which the intervention groups (i.e., HR/BB and HR/SC) could be compared. These participants gave T1 measures upon recruitment into the Parent Study and then were asked to provide follow-up data every three months for two years. The time period between the first evaluation (T1) and the follow-up evaluations was about three weeks and was intended to mimic the amount of time the patients in the HR/BB and HR/SC groups underwent their respective interventions.

Chapter 3

Results

Before any analyses were conducted, all data were screened, and it was found that the somatization measures were positively skewed. These measures were, therefore, transformed using the square root transformation. Both the transformed and the untransformed versions of the variables were analyzed. Distributions for all other variables were acceptable. Overall, our sample was middle-aged. It mainly consisted of people who were college-educated, Caucasians, females, married, and who had a combined household income of at least $50,000. As was expected, there were no significant differences among the demographic variables across the conditions of the study (Table 3-1). With regard to participant retention, over 40% of all people enrolled in the Parent Study completed the assessments across the major time points (Figure 3-1), and the most common reason for missing data was the termination of the Parent Study (Table 3-2).

Reconstructing Variables

To improve the construct validity of the chewing pain and masticatory performance measures, the variables were altered according to recommendations obtained from personal communication with an expert on the assessment of CutterSil® (Dr. Peter H. Buschang). These alterations included the following: MPS measures were capped at the size of the largest mesh sieve (5.6); BD measures were capped at 37.918; participants with MPS measures of 5.6 were given a BD value of 37.918 and vice versa; and measures that were missing from participants who claimed to not be able to chew the CutterSil® due to pain were assigned scores that represented this claim (i.e., a pain level of 10, a MPS of 5.6, and a BD of 37.918).

Table 3-1 Descriptive Statistics, *N* = 435

	HR/BB, *n* = 168		HR/SC, *n* = 131		LR/NI, *n* = 136				
Variable	n/*M*	(%)/(*SD*)	n/*M*	(%)/(*SD*)	n/*M*	(%)/(*SD*)	χ^2/*F*	*df*	*p*
Education†‡	15.33	(2.17)	15.09	(2.29)	15.27	(2.25)	.46	2, 425	.63
Age†‡	44.14	(14.99)	42.95	(14.41)	44.61	(17.95)	.39	2, 430	.68
Race							4.41	8	.82
Caucasian	119	(70.8)	92	(70.2)	93	(68.4)			
Latino/a	21	(12.5)	13	(9.9)	18	(13.2)			
African American	17	(10.1)	17	(13)	17	(12.5)			
Asian	5	(3)	6	(4.6)	2	(1.5)			
Other	6	(3.6)	3	(2.3)	6	(4.4)			
Gender							2.07	2	.36
Male	30	(17.9)	25	(19.1)	33	(24.3)			
Female	138	(82.1)	106	(80.9)	103	(75.7)			
Marital Status							14.94	8	.06
Single	52	(31)	37	(28.2)	49	(36)			
Married	92	(54.8)	70	(53.4)	65	(47.8)			
Divorced or Separated	20	(11.9)	21	(16)	14	(10.3)			
Widowed	4	(2.4)	3	(2.3)	3	(2.2)			
Not Reported					5	(3.7)			
Combined Household Income‡							2.96	8	.94
$0-14,999	16	(9.5)	16	(12.2)	14	(10.3)			
$15,000-24,999	12	(7.1)	12	(9.2)	10	(7.4)			
$25,000-34,999	14	(8.3)	10	(7.6)	15	(11)			
$35,000-49.999	17	(10.1)	10	(7.6)	10	(7.4)			
$50,000 or more	106	(63.1)	78	(59.5)	80	(58.8)			

†this variable is measured in terms of years; ‡this variable has system missing values

As described earlier, measures of chewing pain and masticatory performance were recorded for both sides of the mouth. However, assessing these measures for both

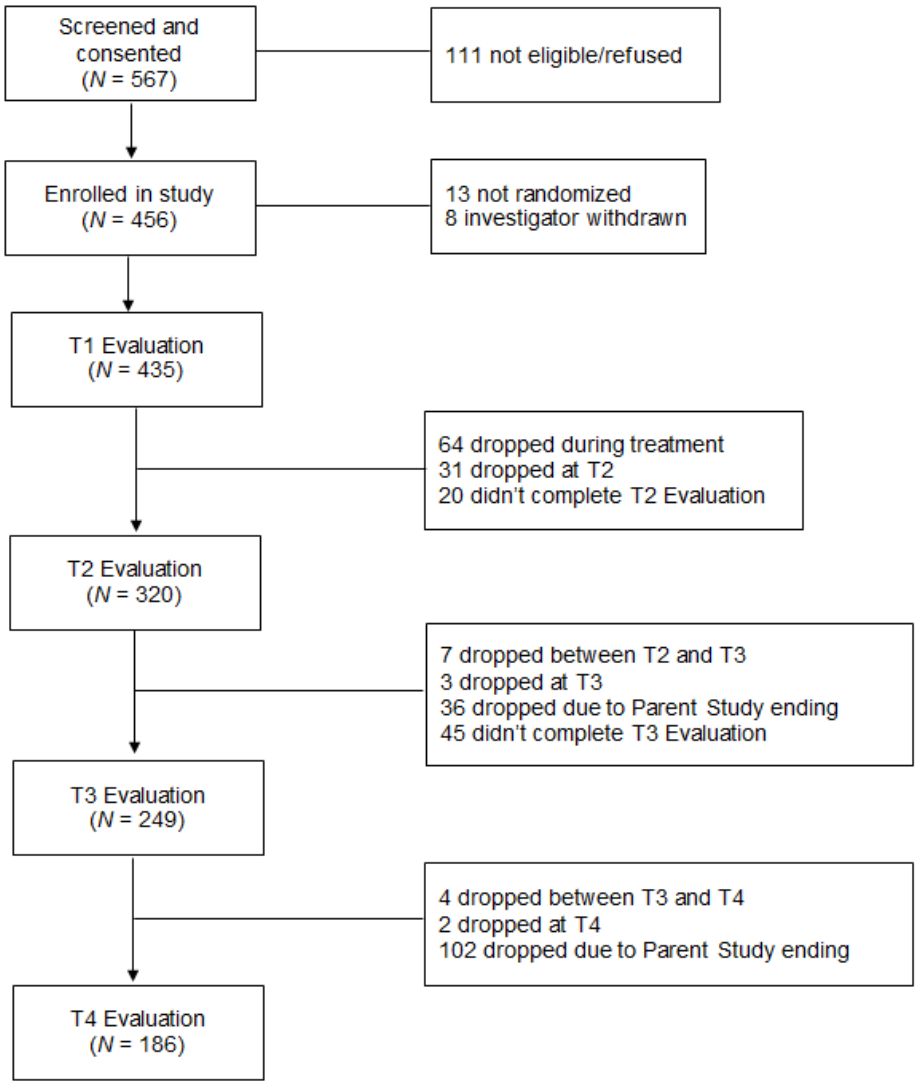

Figure 3-1 Participant Flowchart

sides of the mouth would inflate Type I error; furthermore, there is no evidence to support assessing one side of the mouth over the other. Therefore, these measures were revised to only include the recording from the most uncomfortable side of the mouth. The details

of constructing these variables are described elsewhere (cf. Sanders, 2013). Similar to the chewing pain and masticatory performance variables, the RDC/TMD Axis I diagnoses for DDs and DJDs were made separately for each side of the mouth. However, I had no empirically-based justification to analyze the diagnostic data according to the side of mouth involved; therefore, I again revised the data so that they represented the presence or absence of each diagnosis. Furthermore, I accounted for people who had more than one diagnosis.

Table 3-2 Attrition of Active Cohort by Group

	Intervention Group			
Phase of Study	HR/BB	HR/SC	LR/NI	TOTAL
Treatment	43	21	N/A	64
T2	10	13	8	31
Between T2 and T3	3	1	3	7
T3	0	1	2	3
Between T3 and T4	1	0	3	4
T4	0	0	2	2
In-Progress†	63	44	31	138
TOTAL	120	80	49	249

†These participants were still active in the study when the Parent Study was terminated

Analysis of Subgroups

All analyses were conducted using SPSS, Version 22. The outcome measures for the analyses were psychological distress (PSS, BDI-II, MCS, and non-painful somatization), pain (CPI, chewing pain, painful somatization, and GCPS), and functionality (PCS, MPS, and BD) as assessed across the four major time points: pre-intervention (T1), immediate post-intervention (T2), one-year follow-up (T3), and two-year follow-up (T4). Also, the participants in the current study were grouped based on both the RDC/TMD Axis I diagnosis given at T1 (no diagnosis, muscle disorder, DD, DJD, multiple diagnoses including muscle disorder, or multiple diagnoses excluding muscle disorder) as well as their treatment group (HR/BB, HR/SC, or LR/NI). By grouping the

participants in this way, not only was I able to effectively test my hypotheses but I was also able to combat the potential confound of regression towards the mean. Because my hypotheses hinged on the expectation that the most improvement will be evident in those patients who had the most severe symptom presentation (i.e., people with myogenous TMJMD), I compared this subset of patients across the various treatment groups; therefore, I can have confidence in the findings that revealed differences among myogenous TMJMD patients who were in different treatment groups because (1) the groups were randomly assigned, (2) repetitive assessments were administered, and (3) a large dataset was used (McBride, 2013).

Multilevel Linear Modeling

To test the hypotheses for the current study, subgroup analyses (Wang et al., 2007) via two-level hierarchical Multilevel Linear Models (MLMs) were conducted (Figure 3-2). Hierarchical MLM an appropriate statistical procedure in this case because it permits the analysis of data that have been collected across participants at different time points without violating the assumption of independence (Tabachnick & Fidell, 2007). In other words, the repeated assessments were not independent of one another, and MLM has the ability to control for these "dependencies by estimating variance associated with group differences in average response (intercepts) and group differences in associations (slopes) between predictors and DVs. This is accomplished by declaring intercepts and/or slopes to be random effects" (Tabachnick & Fidell, 2007). Furthermore, utilizing MLM provides an increase in power, a reduction in Type I error, and protection against a loss of information because it can tolerate unequal sample sizes as well as missing values (Tabachnick & Fidell, 2007).

In the hypothesized models, the intercepts were declared to be random effects in order to assess variability among individuals. First-level units were the time points at

which the participants completed the biopsychosocial evaluations, with the participants limited to those who were actively enrolled in the study, resulting in a total of 1,204 time points for analysis.

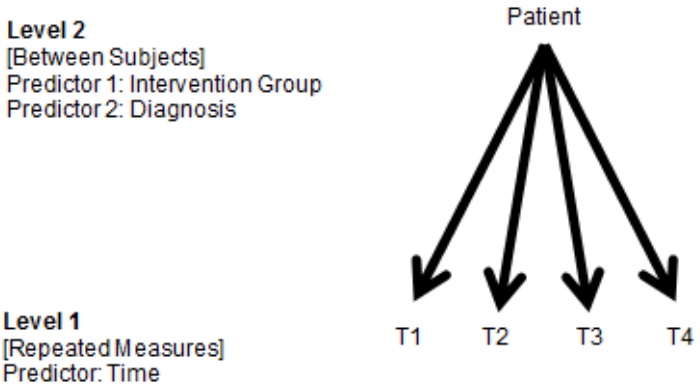

Figure 3-2 Layout of Data for Hypotheses

Second-level units were 435 participants. One predictor, time, initially was entered as a random effect based on the hypothesis that the outcome measures would change throughout the duration of the study. In most of the analyses, this predictor inhibited the models from converging; in these cases, all predictors were entered as fixed effects. For all outcome measures, a minimum of thirteen models were created. These models included the following: intercepts only; intercepts with individual and combined Level 2 predictors, respectively (fixed and random); intercepts and time (fixed and random); intercepts, Level 2 predictors, and time (fixed and random); and the full model, which included all predictors along with the interaction of interest. For simplicity, only the models that were the most relevant to testing my hypotheses were assessed and compared.

For the most complex models that were significant, post-hoc analyses were conducted to determine which levels of the variables were different from one another. To combat the likelihood of a Type I error as a result of the multiple comparisons made

across the different levels of each variable, both Bonferroni's correction and Holm-Bonferroni's correction (which is the more powerful correction) were applied to the post-hoc analyses (Holm, 1979).

Hypothesis 1

It was hypothesized that both diagnosis and treatment would be related to a reduction in psychological distress over time. Specifically, it was expected that HR/BB patients with a muscle disorder, either alone or in combination with other diagnoses, would report the most improved outcomes when compared to the other myogenous TMJMD patients. Furthermore, it was expected that HR/BB patients with a single myogenous diagnosis would have better outcomes than HR/BB patients with multiple diagnoses including a muscle disorder following the intervention. For this hypothesis, four outcome measures were assessed: PSS, BDI-II, MCS, and non-painful somatization. Ultimately, this hypothesis was not supported.

Perceived Stress

Table 3-3 PSS Means and Standard Errors for Main Effects

Predictor	*M*	(*SE*)
Treatment Group		
HR/BB	13.10	(.91)
HR/SC	13.65	(.91)
LR/NI	13.09	(.74)
Diagnosis		
None	13.41	(.78)
Muscle Disorder	15.60[a]	(.70)
DD	13.33[a]	(1.55)
DJD	12.17	(1.00)
Multiple Including Muscle Disorder	14.72	(.53)
Multiple Excluding Muscle Disorder	10.15	(2.12)
Time Point		
T1	14.67[a,b,c]	(.55)
T2	13.06[a]	(.58)
T3	12.29[b]	(.68)
T4	13.06[c]	(.69)

[a,b,c]Same letter indicates significance down columns (per predictor)

The full model for PSS was significantly better than one in which only the intercepts and predictors were included (Table A-1). Thus, the addition of the interaction among treatment group, diagnosis, and time improved the model beyond one that

Table 3-4 PSS Means and Standard Errors for Interaction

Diagnosis	HR/BB		HR/SC		LR/NI	
	M	(*SE*)	*M*	(*SE*)	*M*	(*SE*)
None						
T1	13.40	(1.57)	13.69	(1.38)	11.74	(1.21)
T2	13.30	(1.87)	13.05	(1.50)	13.97	(1.24)
T3	12.77	(2.11)	12.39	(1.65)	14.85	(1.41)
T4	14.59	(2.90)	12.09	(2.01)	15.04	(1.37)
Muscle Disorder						
T1	18.22	(1.24)	17.30	(1.57)	15.98	(1.07)
T2	15.60	(1.33)	16.84	(1.73)	13.69	(1.12)
T3	13.02	(1.60)	16.26	(1.86)	14.10	(1.17)
T4	16.16	(1.58)	15.54	(1.88)	14.48	(1.15)
DD						
T1	20.00	(2.49)	17.60	(3.14)	16.43	(2.66)
T2	12.67	(3.05)	13.20	(3.14)	12.28	(2.91)
T3	11.24	(4.13)	11.76	(3.44)	10.45	(3.53)
T4	9.44	(5.03)	13.10	(3.95)	11.84	(3.08)
DJD						
T1	10.67	(1.82)	15.00	(1.95)	14.33	(1.82)
T2	10.93	(1.88)	12.95	(1.99)	13.75	(1.87)
T3	8.46	(2.25)	11.96	(2.22)	13.78	(2.08)
T4	7.96	(3.48)	14.09	(2.50)	12.22	(1.93)
Multiple Including Muscle Disorder						
T1	17.60	(.74)	17.21	(.88)	15.09	(1.25)
T2	14.87	(.83)	14.48	(.98)	14.10	(1.36)
T3	13.60	(.92)	13.37	(1.17)	13.73	(1.54)
T4	14.15	(1.02)	14.10	(1.14)	14.29	(1.46)
Multiple Excluding Muscle Disorder						
T1	10.67	(4.06)	10.50	(4.97)	8.60	(3.14)
T2	13.88	(4.54)	6.50	(4.96)	9.00	(3.14)
T3	9.50	(4.78)	10.87	(6.26)	9.18	(3.41)
T4	11.73	(5.51)	N/A	(N/A)	11.20	(3.07)

Included only the individual predictors. There were individual differences in intercepts (i.e., average perceived stress varied across participants). There were also significant effects of diagnosis and time (Table 3-3).

People with a muscle disorder had a significantly greater PSS mean than people with a DD, and the PSS scores decreased significantly from T1 to each of the remaining time points of the study. All other comparisons were not significant. Also, neither the interaction nor the treatment group were significantly associated with PSS (Table 3-4); thus, perceived stress was influenced neither by treatment alone nor by the combined effect of treatment, diagnosis, and time. Instead, perceived stress was affected only by the individual effects of diagnosis and time.

Depressive Symptoms

Table 3-5 BDI-II Means and Standard Errors for Main Effects

Predictor	*M*	(*SE*)
Treatment Group		
HR/BB	4.97	(.92)
HR/SC	5.61	(.93)
LR/NI	5.70	(.76)
Diagnosis		
None	5.40	(.80)
Muscle Disorder	7.47	(.72)
DD	4.02	(1.58)
DJD	5.16	(1.02)
Multiple Including Muscle Disorder	7.14	(.54)
Multiple Excluding Muscle Disorder	3.18	(2.17)
Time Point		
T1	$7.38^{a,b,c}$	(.59)
T2	5.39^{a}	(.59)
T3	4.44^{b}	(.67)
T4	4.44^{c}	(.65)

^{a,b,c}Same letter indicates significance down columns (per predictor)

The full model for BDI-II was significantly better than the one in which only the intercepts and predictors were included (Table A-2). Thus, the addition of the interaction among treatment group, diagnosis, and time improved the model beyond one that included only the individual predictors. There were individual differences in intercepts (i.e., average depressive symptoms varied across participants). There were also significant effects of diagnosis and time (Table 3-5). Post hoc comparisons did not reveal

any significant differences among the different diagnostic categories, but mean BDI-II scores decreased significantly from T1 to each of the following time points. The interaction was also significant (Table 3-6), and the post hoc analyses revealed that,

Table 3-6 BDI-II Means and Standard Errors for Interaction

Diagnosis	HR/BB		HR/SC		LR/NI	
	M	(*SE*)	*M*	(*SE*)	*M*	(*SE*)
None						
T1	6.26[a]	(1.72)	4.89[a]	(1.47)	5.88	(1.29)
T2	4.92	(1.89)	5.44	(1.51)	5.48	(1.25)
T3	4.77	(2.16)	4.46	(1.66)	6.81	(1.35)
T4	6.59	(2.68)	2.90	(1.96)	6.38	(1.30)
Muscle Disorder						
T1	10.00	(1.33)	9.30	(1.68)	9.41	(1.16)
T2	7.67	(1.33)	8.02	(1.74)	5.76	(1.12)
T3	4.00	(1.64)	7.21	(1.84)	6.99	(1.19)
T4	6.70	(1.62)	8.94	(1.75)	5.60	(1.12)
DD						
T1	11.13	(2.65)	6.30	(3.54)	6.71	(2.84)
T2	3.80	(3.06)	1.80	(3.15)	7.28	(2.92)
T3	-.99	(4.01)	2.82	(3.39)	4.69	(3.44)
T4	.41	(4.57)	2.48	(3.71)	1.75	(2.94)
DJD						
T1	3.60[b]	(1.94)	7.74	(2.12)	8.89	(1.97)
T2	2.27	(1.89)	8.62	(2.00)	6.62	(1.88)
T3	1.01[▲]	(2.21)	2.87	(2.25)	8.28[▲]	(2.05)
T4	-.79	(3.13)	5.98	(2.35)	6.84	(1.86)
Multiple Including Muscle Disorder						
T1	11.07[▲,a,b]	(.80)	10.99[a]	(.93)	7.19[▲]	(1.33)
T2	6.23	(.85)	7.74	(.98)	6.89	(1.34)
T3	5.59	(.93)	6.27	(1.13)	6.45	(1.48)
T4	5.15	(.96)	6.49	(1.08)	5.67	(1.42)
Multiple Excluding Muscle Disorder						
T1	7.67	(4.33)	4.00	(5.31)	1.80	(3.36)
T2	4.45	(4.55)	2.00	(4.98)	2.00	(3.15)
T3	5.49	(4.74)	1.90	(6.11)	1.26	(3.58)
T4	2.24	(5.14)	N/A	(N/A)	2.20	(2.98)

[a,b,c]Same letter indicates significance down columns; [▲,Δ] Same symbol indicates significance across rows

of the people with multiple diagnoses including a muscle disorder, HR/BB patients had a significantly higher BDI-II mean than did LR/NI patients at T1. Of the people with a DJD, HR/BB patients had a significantly lower BDI-II mean than did the LR/NI patients at T3.

For HR/BB patients at T1, people with multiple diagnoses including a muscle disorder had a significantly higher BDI-II mean than either people without a diagnosis or people who were diagnosed with a DJD. For HR/SC patients at T1, people with multiple diagnoses including a muscle disorder had a significantly higher BDI-II mean than people without a diagnosis. All other comparisons were not significant. Also, the treatment group was not significantly associated with BDI-II; thus, depressive symptoms were not influenced by treatment alone. Instead, depressive symptoms were affected individually by diagnosis and time and were affected collectively by the interaction among treatment, diagnosis, and time.

Mental Wellbeing

Table 3-7 MCS Means and Standard Errors for Main Effects

Predictor†	*M*	(*SE*)
Treatment Group		
HR/BB	50.64	(.89)
HR/SC	50.08	(.95)
LR/NI	50.71	(.86)
Diagnosis		
None	49.61[a]	1.00
Muscle Disorder	47.32[b]	.91
DD	49.49	2.00
DJD	51.46	1.32
Multiple Including Muscle Disorder	48.14[c]	.680
Multiple Excluding Muscle Disorder	56.83[a,b,c]	2.70
Time Point		
T1	48.00[a,b,c]	.70
T2	51.13[a]	.74
T3	51.91[b]	.78
T4	50.86[c]	.84

[a,b,c]Same letter indicates significance down columns (per predictor); †These means and standard errors come from Model 5

The full model for MCS was not significantly better than the one that included only the intercepts and predictors (Table A-3); accordingly, the interaction was not significant. The model containing only the predictors (i.e., Model 5) was, however,

significantly better than the intercepts only model. There were individual differences in intercepts (i.e., the average mental wellbeing varied across participants), and, in this model, there were also significant effects of diagnosis and time (Table 3-7). People with multiple diagnoses excluding a muscle disorder had a significantly higher MCS mean than people without a diagnosis, people diagnosed with only a muscle disorder, as well as people with multiple diagnoses including a muscle disorder, respectively.

Also, there was a marginally significant difference (p = .01) suggesting that people with a DJD had a higher MCS mean than people with a muscle disorder. In terms of time effects, the mean of MCS at T1 was significantly lower than each of the following time points. All other comparisons were not significant. Furthermore, the treatment group was not significantly associated with MCS; thus, mental wellbeing was not influenced by treatment alone. Instead mental wellbeing was only related to diagnosis and time.

Non-Painful Somatization

Table 3-8 Non-Painful Somatization Means and Standard Errors for Main Effects

Predictor†	*M*	(*SE*)
Treatment Group		
HR/BB	.32	(.05)
HR/SC	.46	(.05)
LR/NI	.39	(.04)
Diagnosis		
None	.34[a,c]	(.05)
Muscle Disorder	.55[a,b]	(.04)
DD	.33	(.09)
DJD	.35[b]	(.06)
Multiple Including Muscle Disorder	.50[c]	(.03)
Multiple Excluding Muscle Disorder	.25	(.12)
Time Point		
T1	.45[a]	(.03)
T2	.36[a]	(.03)
T3	.39	(.04)
T4	.35	(.04)

[a,b]Same letter indicates significance down columns (per predictor); †These are square-root transformed

As mentioned earlier, the non-painful somatization variable was positively skewed and, therefore, was transformed using the square root transformation. When modeled, the transformed variable was more normally distributed than the original

Table 3-9 Non-Painful Somatization Means and Standard Errors for Interaction

Diagnosis†	HR/BB		HR/SC		LR/NI	
	M	(*SE*)	*M*	(*SE*)	*M*	(*SE*)
None						
T1	.39	(.10)	.47	(.08)	.37	(.07)
T2	.33	(.11)	.33	(.09)	.36	(.07)
T3	.31	(.13)	.18	(.10)	.45	(.08)
T4	.37	(.19)	.17	(.13)	.40	(.08)
Muscle Disorder						
T1	.61	(.07)	.78	(.09)	.54	(.06)
T2	.61	(.08)	.69	(.10)	.37	(.07)
T3	.51	(.10)	.60	(.11)	.50	(.07)
T4	.31	(.10)	.59	(.11)	.45	(.07)
DD						
T1	.31	(.15)	.15	(.19)	.39	(.16)
T2	.28	(.18)	.21	(.18)	.15	(.17)
T3	.04	(.26)	.36	(.20)	.68	(.21)
T4	.11	(.32)	.68	(.24)	.27	(.19)
DJD						
T1	.35	(.11)	.49	(.12)	.42	(.11)
T2	.17	(.11)	.38	(.12)	.38	(.11)
T3	.19	(.14)	.38	(.13)	.40	(.12)
T4	.16	(.22)	.52	(15)	.42	(.11)
Multiple Including Muscle Disorder						
T1	.66	(.04)	.72	(.05)	.46	(.07)
T2	.45	(.05)	.67	(.06)	.41	(.08)
T3	.41	(.06)	.50	(.07)	.45	(.09)
T4	.32	(.06)	.48	(.07)	.44	(.09)
Multiple Excluding Muscle Disorder						
T1	.25	(.24)	.57	(.30)	.15	(.19)
T2	.15	(.27)	4.27^{E-15}	(.29)	.33	(.18)
T3	.31	(.28)	.57	(.38)	.14	(.20)
T4	.04	(.34)	N/A	(N/A)	.18	(.18)

†These measures are square-root transformed

variable, and this variable was used in the analyses. The full model for non-painful somatization was significantly better than one in which only the intercepts and predictors were included (Table A-4). Thus, the addition of the interaction among treatment group, diagnosis, and time improved the model beyond that produced by the predictors

individually. There were individual differences in intercepts (i.e., average non-painful somatization varied across participants). Furthermore, there were significant effects of diagnosis and time (Table 3-8).

People without a diagnosis reported significantly lower non-painful somatization than people with a muscle disorder, alone and combined with other diagnoses, respectively. People with a muscle disorder reported significantly greater non-painful somatization than people with a DJD. Also, there was a marginally significant difference (p = .02), which suggested that people diagnosed with a muscle disorder reported greater non-painful somatization than people with multiple diagnoses excluding a muscle disorder. Examined across time, the mean of non-painful somatization was significantly lower at T2 when compared to the mean at T1. All other comparisons were not significant. Furthermore, the interaction was not significant (Table 3-9), and the treatment group was also not significantly associated with non-painful somatization. Thus, non-painful somatization is neither influenced by treatment alone nor is it influenced by the combination of treatment and diagnosis over time. Instead, non-painful somatization is influenced by the individual influences of diagnosis and time.

Hypothesis 2

It was hypothesized that diagnosis and treatment would have a combined influence on the reduction of pain over time. Specifically, it was expected that HR/BB patients with a muscle disorder, either alone or in combination with other diagnoses, would report the most improved outcomes when compared to the other myogenous TMJMD participants. Furthermore, it was expected that HR/BB patients with a single myogenous diagnosis would have better outcomes than HR/BB patients with multiple diagnoses including a muscle disorder following the intervention. For this hypothesis,

four outcome measures were assessed: CPI, chewing pain, painful somatization, and GCPS. Overall, this hypothesis was only supported with regard to chewing pain.

Facial Pain

The full model for CPI included time as a random factor and was significantly better than one in which only the intercepts and predictors were included (Table A-5). Thus, the addition of the interaction among treatment group, diagnosis, and time improved the model beyond one that included only the individual predictors. There were individual differences in intercepts (i.e., average facial pain varied across

Table 3-10 CPI Means and Standard Errors for Main Effects

Predictor	*M*	(*SE*)
Treatment Group		
HR/BB	38.08[a]	(2.41)
HR/SC	39.43[b]	(2.17)
LR/NI	22.42[a,b]	(1.71)
Diagnosis		
None	27.55[a]	(2.01)
Muscle Disorder	33.90	(1.68)
DD	34.01	(4.02)
DJD	30.93	(2.47)
Multiple Including Muscle Disorder	37.74[a]	(1.28)
Multiple Excluding Muscle Disorder	35.41	(5.07)
Time Point		
T1	53.85[a,b,c]	(1.06)
T2	37.28[a,b,c]	(1.79)
T3	19.86[b]	(2.15)
T4	21.25[c]	(2.40)

[a,b,c]Same letter indicates significance down columns (per predictor)

participants), and all factors were significant (Table 3-10). Both high risk groups, respectively, had significantly greater CPI means than the LR/NI group, and people with multiple diagnoses including a muscle disorder had a significantly greater CPI mean than people without a diagnosis. Also, the mean at T2 was significantly lower than the mean at T1. Furthermore, the means at T3 and T4 were significantly lower than the means at T1 and T2, respectively.

The interaction was also significant (Table 3-11). The post hoc analyses of the interaction revealed that, for people diagnosed with a DD, the high risk patients, respective by intervention group, had a significantly greater CPI mean than LR/NI patients at T1; a similar interaction was revealed with regard to DJDs at T1. For people

Table 3-11 CPI Means and Standard Errors for Interaction

Diagnosis	HR/BB		HR/SC		LR/NI	
	M	(*SE*)	*M*	(*SE*)	*M*	(*SE*)
None						
T1	60.29$^{\Delta}$	(3.08)	66.41$^{\blacktriangle}$	(2.65)	30.78$^{\Delta,\blacktriangle,a}$	(2.31)
T2	38.94$^{\Delta}$	(5.82)	48.20$^{\blacktriangle}$	(4.67)	20.70$^{\Delta,\blacktriangle,c}$	(3.79)
T3	5.899	(6.80)	13.56	(5.16)	8.81	(4.21)
T4	8.99	(10.73)	18.61	(7.11)	9.39	(4.44)
Muscle Disorder						
T1	65.31$^{\Delta}$	(2.39)	67.50$^{\blacktriangle}$	(3.02)	34.81$^{\Delta,\blacktriangle}$	(2.06)
T2	39.97$^{\Delta}$	(4.09)	43.46$^{\blacktriangle}$	(5.43)	23.49$^{\Delta,\blacktriangle,d}$	(3.48)
T3	21.86	(5.28)	33.22$^{\Delta}$	(5.77)	13.46$^{\Delta}$	(3.55)
T4	16.05	(5.57)	31.64	(5.93)	16.00	(3.59)
DD						
T1	67.08$^{\Delta}$	(4.77)	60.00$^{\blacktriangle}$	(6.04)	28.57$^{\Delta,\blacktriangle}$	(5.10)
T2	30.91	(9.98)	25.33^{a}	(9.31)	29.28	(9.09)
T3	25.34	(14.03)	21.43	(10.32)	8.44	(11.42)
T4	41.49	(18.84)	43.50	(13.40)	26.77	(9.95)
DJD						
T1	60.00$^{\Delta}$	(3.48)	59.49$^{\blacktriangle}$	(3.74)	38.00$^{\Delta,\blacktriangle}$	(3.48)
T2	44.38	(5.71)	34.71^{b}	(5.97)	32.27	(5.68)
T3	14.66	(7.14)	13.42	(6.80)	23.08	(6.18)
T4	11.59	(13.02)	19.56	(8.51)	20.04	(5.97)
Multiple Including Muscle Disorder						
T1	68.82$^{\Delta}$	(1.42)	66.56$^{\blacktriangle}$	(1.67)	39.69$^{\Delta,\blacktriangle,a,b}$	(2.39)
T2	45.69	(2.63)	51.88$^{\Delta,a,b}$	(3.08)	37.85$^{\Delta,c,d}$	(4.14)
T3	21.88	(2.90)	29.13	(3.72)	22.78	(4.74)
T4	24.25	(3.54)	26.34	(3.88)	17.97	(4.73)
Multiple Excluding Muscle Disorder						
T1	70.00$^{\Delta}$	(7.79)	63.33$^{\blacktriangle}$	(9.54)	22.67$^{\Delta,\blacktriangle,b}$	(6.04)
T2	66.03$^{\Delta}$	(14.32)	36.67	(14.72)	21.33$^{\Delta}$	(9.31)
T3	35.56	(14.79)	32.93	(19.98)	11.99	(10.19)
T4	29.01	(18.99)	N/A	(N/A)	1.92^{E-11}	(8.97)

^{a,b,c,d}Same letter indicates significance down columns; $^{\blacktriangle,\Delta}$ = same symbol indicates significance across rows

without a diagnosis, the high risk patients had a significantly greater CPI mean than LR/NI patients at both T1 and T2. Likewise, for people diagnosed with a muscle disorder, the high risk patients had a significantly greater CPI mean than LR/NI patients at both T1 and T2; however, at T3, only the HR/SC patients had a significantly greater CPI mean than the LR/NI patients.

For people with multiple diagnoses including a muscle disorder, the high risk patients had a significantly greater CPI mean than the LR/NI patients at T1, but, at T2, only the HR/SC patients had a significantly greater CPI mean than LR/NI patients. For people with multiple diagnoses excluding muscle disorders, high risk patients had a significantly greater CPI mean than LR/NI patients at T1, but, at T2, only the HR/BB patients had a significantly greater CPI mean than the LR/NI patients.

For HR/SC patients at T2, people with multiple diagnoses including a muscle disorder had a significantly greater CPI mean than both people diagnosed with a DD and people diagnosed with a DJD, respectively. Also, there was a marginally significant difference (p = .01) suggesting that, of the HR/SC patients at T3, those who were diagnosed with a muscle disorder had a greater CPI mean than those without a diagnosis. For LR/NI patients at T1, people with multiple diagnoses including a muscle disorder had a significantly greater CPI mean than both people without a diagnosis and people with multiple diagnoses excluding a muscle disorder, respectively. For LR/NI patients at T2, people with multiple diagnoses including a muscle disorder had a greater CPI mean than both people without a diagnosis and people diagnosed with only a muscle disorder, respectively.

There was also a marginally significant difference (p = .01), which suggested that, of the HR/BB patients at T1, people with multiple diagnoses including a muscle disorder had a greater CPI mean than people without a diagnosis. All other comparisons

were not significant. Thus, facial pain was influenced by the combined effect of both treatment and diagnosis over time but not in the manner that was hypothesized.

Chewing Pain

The full model for chewing pain was significantly better than one in which only the intercepts and predictors were included (Table A-6). Thus, the addition of the interaction among treatment group, diagnosis, and time improved the model beyond one that included only the individual predictors. There were individual differences in intercepts (i.e., average chewing pain varied across participants). Furthermore, all factors were significant, but post hoc comparisons did not reveal any significant differences among the

Table 3-12 Chewing Pain Means and Standard Errors for Main Effects

Predictor	*M*	(*SE*)
Treatment Group		
HR/BB	2.46	(.27)
HR/SC	2.53	(.27)
LR/NI	1.76	(.20)
Diagnosis		
None	1.64[a]	(.23)
Muscle Disorder	2.26[b]	(.20)
DD	2.05	(.47)
DJD	1.83[c]	(.29)
Multiple Including Muscle Disorder	3.13[a,b,c]	(.15)
Multiple Excluding Muscle Disorder	2.59	(.60)
Time Point		
T1	3.50[a,b,c]	(.19)
T2	2.25[a,d]	(.20)
T3	1.51[b,d]	(.19)
T4	1.68[c]	(.24)

[a,b,c,d]Same letter indicates significance down columns (per predictor)

treatment groups (Table 3-12). People with multiple diagnoses including a muscle disorder reported significantly greater chewing pain than people without a diagnosis, people diagnosed with only a muscle disorder, and people diagnosed with a DJD, respectively. There was also a marginally significant difference (p = .03), which

suggested that people with multiple diagnoses including a muscle disorder reported a greater chewing pain mean than people with a DD. With regard to time, the chewing pain mean at T1 was significantly greater than at each of the following time points, and the chewing pain mean at T3 was significantly lower than the mean at T2.

Table 3-13 Chewing Pain Means and Standard Errors for Interaction

Diagnosis	HR/BB		HR/SC		LR/NI	
	M	(*SE*)	*M*	(*SE*)	*M*	(*SE*)
None						
T1	2.19[a,b]	(.53)	2.77[a,b,c]	(.46)	1.61[a]	(.40)
T2	1.58	(.63)	2.17[d]	(.49)	1.88	(.40)
T3	.36[h]	(.59)	2.05	(.46)	.68	(.37)
T4	.68	(1.01)	2.40	(.72)	1.34	(.45)
Muscle Disorder						
T1	3.20[▲,c,e]	(.42)	5.78[▲,Δ,a,f]	(.55)	2.41[Δ]	(.36)
T2	1.42[g]	(.43)	3.16	(.59)	1.79	(.37)
T3	.94[▲]	(.47)	2.79[▲,Δ]	(.52)	1.24[Δ]	(.33)
T4	.77	(.58)	2.06	(.63)	1.60	(.37)
DD						
T1	3.58	(.86)	2.50[f]	(1.16)	1.64	(.88)
T2	2.00	(1.04)	1.00[g]	(1.09)	1.98	(1.03)
T3	3.01	(1.20)	1.94	(1.04)	-.07	(.98)
T4	4.78	(1.79)	.39	(1.76)	1.81	(.98)
DJD						
T1	2.89[▲,d,f]	(.64)	5.68[▲,Δ,b]	(.66)	2.79[Δ]	(.61)
T2	2.26	(.60)	2.59	(.63)	2.08	(.59)
T3	.37	(.65)	.95[h]	(.62)	1.30	(.56)
T4	-.22	(1.22)	.53[e]	(.82)	.76	(.60)
Multiple Including Muscle Disorder						
T1	5.39[▲,a,c,d]	(.25)	5.04[Δ,c]	(.30)	3.53[▲,Δ,a]	(.41)
T2	2.84[▲,g]	(.28)	3.97[▲,d,g]	(.32)	3.02	(.43)
T3	2.07[h]	(.26)	2.80[h]	(.33)	1.69	(.41)
T4	1.86[▲]	(.35)	3.11[▲,e]	(.38)	2.21	(.49)
Multiple Excluding Muscle Disorder						
T1	7.17[▲,b,e,f]	(1.34)	2.5	(1.64)	2.42[▲]	(1.13)
T2	3.51	(1.93)	1.50	(1.55)	1.80	(.98)
T3	2.88	(1.29)	.53	(1.72)	1.60	(.85)
T4	3.43	(1.82)	N/A	(N/A)	1.10	(.91)

[a,b,c,d,e,f,g,h]Same letter indicates significance down columns; [▲,Δ]Same symbol indicates significance across rows

There was also a significant interaction (Table 3-13). The post hoc analyses revealed that, of people with a muscle disorder, HR/SC patients reported significantly greater chewing pain than HR/BB patients and LR/NI patients, respectively, at both T1 and T3, which was expected. There was also a marginally significant difference (p = .02), which suggested that, of people diagnosed with a muscle disorder, HR/BB patients reported lower chewing pain than HR/SC patients at T2, which was also expected. Of people with a DJD, HR/SC patients reported significantly greater chewing pain than both HR/BB patients and LR/NI patients, respectively, at T1. Of people with multiple diagnoses including a muscle disorder, LR/NI patients reported significantly lower chewing pain than the high risk patients, respectively, at T1, but, at both T2 and T4, HR/BB patients reported significantly lower chewing pain than HR/SC patients, which was expected. Of people with multiple diagnoses excluding a muscle disorder, LR/NI patients reported significantly lower chewing pain than HR/BB patients at T1.

For HR/BB patients at T1, people with multiple diagnoses both including and excluding a muscle disorder, respectively, reported significantly greater chewing pain than each of the following: people without a diagnosis, people diagnosed with a muscle disorder alone, and people with a DJD alone. There was also a marginally significant difference (p = .03), which suggested that, for HR/BB patients at T1, people who were diagnosed with a DD reported lower chewing pain than people diagnosed with multiple diagnoses excluding a muscle disorder. For HR/BB patients at T2, people with only a muscle disorder reported significantly lower chewing pain than people with multiple diagnoses including a muscle disorder, which was expected. For HR/BB patients at T3, people who were diagnosed with multiple diagnoses including a muscle disorder reported significantly greater chewing pain than people without a diagnosis.

For HR/SC patients at T1, people without a diagnosis reported significantly lower chewing pain than people who were diagnosed with a muscle disorder, a DJD, and multiple diagnoses including a muscle disorder, respectively. Also for HR/SC patients at T1, people who were diagnosed with a muscle disorder reported significantly greater chewing pain than people who were diagnosed with a DD. For HR/SC patients at T2, people with multiple diagnoses including a muscle disorder reported significantly greater chewing pain than both people without a diagnosis and people who were diagnosed with a DD, respectively. For HR/SC patients at both T3 and T4 who were diagnosed with multiple diagnoses including a muscle diagnoses reported significantly greater chewing pain than people who were diagnosed with a DJD. Lastly, for LR/NI patients at T1, people who were diagnosed with multiple diagnoses including a muscle disorder reported significantly greater chewing pain than people without a diagnosis. All other comparisons were not significant. Overall, it can be concluded that chewing pain was influenced by treatment, diagnosis, and time both individually and in combination in the manner hypothesized.

Painful Somatization

As mentioned previously, the painful somatization measure was positively skewed and, therefore, was transformed using the square root transformation. However, when both the transformed and untransformed versions of this measure were modeled, both resulted in similar outcomes so the untransformed variable was used in the analyses. The full model for painful somatization in which time was a random factor was significantly better than one in which only the intercepts and predictors were included (Table A-7).

Thus, the addition of the interaction among treatment group, diagnosis, and time improved the model beyond that produced by the predictors individually. There were

Table 3-14 Painful Somatization Means and Standard Errors for Main Effects

Predictor	*M*	(*SE*)
Treatment Group		
HR/BB	.44	(.07)
HR/SC	.58	(.07)
LR/NI	.45	(.06)
Diagnosis		
None	.44[a,b]	(.06)
Muscle Disorder	.72[a,c,d,e]	(.05)
DD	.38[d]	(.12)
DJD	.43[c,f]	(.07)
Multiple Including Muscle Disorder	.66[b,f]	(.04)
Multiple Excluding Muscle Disorder	.30[e]	(.16)
Time Point		
T1	.57	(.04)
T2	.48	(.04)
T3	.47	(.05)
T4	.44	(.05)

[a,b,c,d,e,f]Same letter indicates significance down columns (per predictor)

individual differences in intercepts (i.e., average painful somatization varied across participants). Furthermore, the effects of diagnosis and time were significant (Table 3-14). People with a muscle disorder reported significantly greater painful somatization than people without a diagnosis and people with a DJD, a DD, and multiple diagnoses excluding a muscle disorder, respectively. People with multiple diagnoses including a muscle disorder reported significantly greater painful somatization than both people without a diagnosis and people with a DJD, respectively.

Post hoc analyses did not reveal any significant differences among the time points, but there was a marginally significant difference (p = .02) that suggested the mean at T1 was greater than the mean at T4. All other comparisons were not significant. Also, there was not a significant effect of treatment group, and the interaction was not significant (Table 3-15). Thus, painful somatization was not influenced by the treatment group alone or in combination with diagnosis and time; instead, painful somatization was influenced only by the individual effects of diagnosis and time.

Table 3-15 Painful Somatization Means and Standard Errors for Interaction

Diagnosis	HR/BB		HR/SC		LR/NI	
	M	(*SE*)	*M*	(*SE*)	*M*	(*SE*)
None						
T1	.51	(.13)	.51	(.11)	.40	(.10)
T2	.48	(.14)	.46	(.11)	.38	(.09)
T3	.39	(.15)	.30	(.12)	.58	(.10)
T4	.41	(.21)	.36	(.15)	.50	(.10)
Muscle Disorder						
T1	.86	(.10)	1.05	(.13)	.61	(.09)
T2	.71	(.10)	.94	(.13)	.49	(.09)
T3	.68	(.12)	.83	(.14)	.56	(.09)
T4	.39	(.12)	.93	(.14)	.53	(.09)
DD						
T1	.51	(.20)	.30	(.25)	.36	(.21)
T2	.56	(.24)	.27	(.23)	.60	(.22)
T3	.03	(.30)	.36	(.25)	.64	(.26)
T4	.27	(.37)	.48	(.29)	.20	(.23)
DJD						
T1	.36	(.15)	.62	(.16)	.52	(.15)
T2	.21	(.14)	.51	(.15)	.44	(.14)
T3	.25	(.16)	.49	(.16)	.40	(.15)
T4	.24	(.26)	.58	(.18)	.48	(.14)
Multiple Including Muscle Disorder						
T1	.90	(.06)	.96	(.07)	.60	(.10)
T2	.58	(.06)	.85	(.07)	.54	(.10)
T3	.55	(.07)	.70	(.08)	.53	(.11)
T4	.52	(.08)	.65	(.08)	.51	(.11)
Multiple Excluding Muscle Disorder						
T1	.33	(.33)	.50	(.40)	.32	(.25)
T2	.20	(.35)	.17	(.37)	.22	(.23)
T3	.45	(.35)	.44	(.45)	.22	(.25)
T4	.20	(.41)	N/A	(N/A)	.25	(.23)

Pain-Related Disability

The full model for GCPS was significantly better than one in which only the intercepts and predictors were included (Table A-8). Thus, the addition of the interaction among treatment group, diagnosis, and time improved the model beyond one that included only the individual predictors. There were individual differences in intercepts (i.e., average pain-related disability varied across participants). Furthermore, all factors were significant (Table 3-16).

High risk patients, respective to their treatment group, had a significantly greater GCPS mean than LR/NI patients. People with a multiple diagnoses including a muscle diagnosis had a significantly greater mean than both people without a diagnosis and people diagnosed with a DJD, respectively, and people with a muscle disorder also had a significantly greater mean than people without a diagnosis. In terms of the time effect, the mean at T2 was significantly lower than the mean at T1, and the means at T3 and T4 were significantly lower than the means at T1 and T2, respectively.

Table 3-16 GCPS Means and Standard Errors for Main Effects

Predictor	*M*	(*SE*)
Treatment Group		
HR/BB	1.26[a]	(.09)
HR/SC	1.33[b]	(.08)
LR/NI	.84[a,b]	(.07)
Diagnosis		
None	.96[a,b]	(.08)
Muscle Disorder	1.21[b]	(.06)
DD	1.10	(.15)
DJD	1.06[c]	(.09)
Multiple Including Muscle Disorder	1.37[a,c]	(.05)
Multiple Excluding Muscle Disorder	1.14	(.19)
Time Point		
T1	1.80[a,b,c]	(.05)
T2	1.26[a,b,c]	(.07)
T3	.70[b]	(.07)
T4	.78[c]	(.09)

[a,b,c]Same letter indicates significance down columns (per predictor)

The interaction was also significant, and post hoc analyses (Table 3-17) revealed that, for people diagnosed with a DD, the high risk patients, respective to treatment, had a significantly greater GCPS mean than the LR/NI patients at T1. Of people diagnosed with a DJD, HR/SC patients had a significantly greater GCPS mean than the LR/NI patients at T1. Of people with multiple diagnoses, both including and excluding a muscle disorder, the high risk patients had a significantly greater GCPS mean than the LR/NI patients, respectively, at T1. Of people without a diagnosis, the high risk patients had a

significantly greater GCPS mean than the LR/NI patients at T1, but only the HR/SC patients maintained a significantly greater mean when compared the LR/NI patients at T2. Of people with a muscle disorder, the high risk patients had a significantly greater GCPS mean than the LR/NI patients at T1, but, at T3, only the HR/SC patients had a significantly greater mean when compared the LR/NI patients.

Table 3-17 GCPS Means and Standard Errors for Interaction

Diagnosis	HR/BB		HR/SC		LR/NI	
	M	(*SE*)	*M*	(*SE*)	*M*	(*SE*)
None						
T1	2.01$^{▲}$	(.14)	2.19^{Δ}	(.12)	.91$^{▲,Δ,a}$	(.11)
T2	1.29	(.24)	1.57$^{▲}$	(.19)	.81$^{▲}$	(.15)
T3	.44	(.23)	.60	(.18)	.43	(.15)
T4	.36	(.39)	.63	(.26)	.33	(.16)
Muscle Disorder						
T1	2.19$^{▲}$	(.11)	2.25^{Δ}	(.14)	1.19$^{▲,Δ}$	(.09)
T2	1.35	(.17)	1.38	(.22)	.88	(.14)
T3	.77	(.18)	1.23$^{▲}$	(.20)	.63$^{▲}$	(.12)
T4	.61	(.20)	1.20	(.22)	.85	(.13)
DD						
T1	2.00^{Δ,a}	(.22)	2.00$^{▲}$	(.28)	.86$^{▲,Δ}$	(.23)
T2	.87	(.41)	.80^{a}	(.38)	1.23	(.37)
T3	.45	(.48)	.71	(.36)	.41	(.40)
T4	1.19	(.68)	1.40	(.49)	1.31^{b}	(.36)
DJD						
T1	1.80	(.16)	2.00$^{▲}$	(.17)	1.40$^{▲}$	(.16)
T2	1.40	(.23)	1.17	(.24)	1.05	(.23)
T3	.55	(.25)	.45	(.23)	.80	(.21)
T4	.58	(.48)	.91	(.31)	.60	(.22)
Multiple Including Muscle Disorder						
T1	2.39$^{▲,a}$	(.07)	2.31^{Δ}	(.08)	1.41$^{▲,Δ,a}$	(.11)
T2	1.67	(.11)	1.86^{a}	(.13)	1.41	(.17)
T3	.84	(.10)	.99	(.13)	.89	(.16)
T4	.95	(.13)	.98	(.14)	.69	(.17)
Multiple Excluding Muscle Disorder						
T1	2.67$^{▲}$	(.36)	2.00^{Δ}	(.44)	.80$^{▲,Δ}$	(.28)
T2	2.09	(.58)	1.00	(.60)	.80	(.38)
T3	1.06	(.50)	1.00	(.69)	.43	(.35)
T4	.65	(.69)	N/A	(N/A)	4.97$^{E-13\ b}$	(.33)

^{a,b}Same letter indicates significance down columns; $^{▲,Δ}$Same symbol indicates significance across rows

For HR/BB patients at T1, people with multiple diagnoses including a muscle disorder had a significantly greater mean when compared to people diagnosed with a DD. For HR/SC patients at T2, people diagnosed with multiple diagnoses including a muscle disorder had a significantly greater mean than people diagnosed with only a DD. There were also marginally significant differences (p = .01) that suggested, for HR/SC patients at T2, people with multiple diagnoses including a muscle disorder had a greater mean than people diagnosed with only a DJD, and, at T3, patients who were diagnosed with a muscle disorder alone had a greater mean than people diagnosed with a DJD.

For LR/NI patients at T1, people with multiple diagnoses including a muscle disorder had a significantly greater mean than people without a diagnosis, and, at T4, patients who had a DD had a significantly greater mean than people with multiple diagnoses excluding a muscle disorder. There was also a marginally significant difference (p = .01) suggesting that, for LR/NI patients at T1, people with a DJD had a greater mean than people without a diagnosis. Additional marginally significant differences (p = .01) suggested that, for LR/NI patients at T4, people with a muscle disorder as well as people with a DD, respectively, had greater means than people without a diagnosis. All other comparisons were not significant. Thus, pain-related disability was influenced by time, diagnosis, and treatment both individually and in combination with one another but not in the manner hypothesized.

Hypothesis 3

It was hypothesized that diagnosis and treatment would have a combined influence on the functionality of acute TMJMD patients over time. Specifically, it was expected that HR/BB patients with a muscle disorder, either alone or in combination with other diagnoses, would report the most improved outcomes when compared to the other myogenous TMJMD participants. Furthermore, it was expected that HR/BB patients with

a single myogenous diagnosis would have better outcomes than HR/BB patients with multiple diagnoses including a muscle disorder following the intervention. For this hypothesis, three outcome measures were assessed: PCS, MPS, and BD. Ultimately, this hypothesis was only supported in terms of the PCS measure.

Physical Wellbeing

Table 3-18 PCS Means and Standard Errors for Main Effects

Predictor	*M*	(*SE*)
Treatment Group		
HR/BB	49.99	(1.10)
HR/SC	47.29[a]	(1.10)
LR/NI	51.07[a]	(.89)
Diagnosis		
None	50.52	(.94)
Muscle Disorder	48.36	(.84)
DD	51.54	(1.87)
DJD	51.00	(1.20)
Multiple Including Muscle Disorder	48.33	(.63)
Multiple Excluding Muscle Disorder	46.91	(2.56)
Time Point		
T1	48.17[a,b]	(.72)
T2	48.89	(.70)
T3	50.47[a]	(.82)
T4	50.45[b]	(.81)

[a,b]Same letter indicates significance down columns (per predictor)

The full model for PCS was significantly better than one in which only the intercepts and predictors were included (Table A-9). Thus, the addition of the interaction among treatment group, diagnosis, and time improved the model beyond that produced by the predictors individually. There were individual differences in intercepts (i.e., average physical wellbeing varied across participants). Furthermore, the effects of treatment group and time, as well as the interaction, were significant. HR/SC patients had a significantly lower PCS mean than LR/NI patients, and the PCS mean at T1 was significantly lower than the means at T3 and T4, respectively (Table 3-18).

The post hoc analyses of the interaction (Table 3-19) revealed that, of people diagnosed with a muscle disorder, LR/NI patients had a significantly higher mean than HR/SC patients at both T1 and T4. Of people with multiple diagnoses including a muscle disorder, HR/BB patients had a greater mean than HR/SC patients at T2, which was expected. There was a marginally significant difference (p = .02) suggesting that, of people with multiple diagnoses including a muscle disorder, HR/BB patients had a greater mean than HR/SC patients at T4, which also would have been expected.

Table 3-19 PCS Means and Standard Errors for Interaction

Diagnosis	HR/BB		HR/SC		LR/NI	
	M	(*SE*)	*M*	(*SE*)	*M*	(*SE*)
None						
T1	50.29	(2.05)	47.31	(1.80)	52.53	(1.57)
T2	50.93	(2.26)	46.61	(1.80)	51.27	(1.47)
T3	52.92	(2.58)	52.76	(2.01)	49.42	(1.68)
T4	50.47	(3.37)	49.73	(2.34)	51.96	(1.60)
Muscle Disorder						
T1	46.12	(1.62)	44.34▲	(2.05)	50.37▲	(1.40)
T2	49.58	(1.59)	46.96	(2.13)	50.83	(1.33)
T3	50.10	(1.99)	45.02	(2.27)	48.93	(1.42)
T4	51.15	(1.90)	44.94▲	(2.16)	52.01▲	(1.34)
DD						
T1	50.92	(3.24)	50.31	(4.09)	53.09	(3.46)
T2	43.33	(3.70)	46.98	(3.72)	52.83	(3.49)
T3	61.76	(5.07)	53.34	(4.14)	48.15	(4.30)
T4	52.87	(5.84)	48.94	(4.59)	53.00	(3.61)
DJD						
T1	51.38	(2.36)	45.58	(2.60)	51.89	(2.36)
T2	54.44	(2.24)	46.96	(2.41)	51.20	(2.18)
T3	54.63	(2.73)	51.70	(2.68)	49.91	(2.51)
T4	55.91	(4.02)	47.95	(2.91)	50.43	(2.34)
Multiple Including Muscle Disorder						
T1	45.71	(.97)	45.56	(1.14)	50.14	(1.62)
T2	49.95▲	(1.00)	45.73▲	(1.18)	49.85	(1.60)
T3	48.87	(1.12)	47.54	(1.42)	49.35	(1.83)
T4	50.59	(1.19)	46.43	(1.31)	50.29	(1.70)
Multiple Excluding Muscle Disorder						
T1	44.87	(5.29)	35.55	(6.47)	51.05	(4.09)
T2	40.82	(5.46)	46.88	(5.88)	51.80	(3.72)
T3	45.10	(5.81)	47.44	(7.59)	51.47	(3.89)
T4	47.16	(6.43)	N/A	(N/A)	53.88	(3.58)

▲,Δ Same symbol indicates significance across rows

There were other marginally significant differences (p = .01) suggesting that, for HR/BB patients at T2, people diagnosed with a DJD had a greater mean than people diagnosed with a DD, and, at T3, people diagnosed with a DD had a greater mean than people with multiple diagnoses including a muscle disorder. For HR/SC patients at T3, there was a marginally significant difference (p = .01) suggesting that people without a diagnosis had a greater mean than people who were diagnosed with a muscle disorder. All other comparisons were not significant. Also, there was not a significant effect of diagnosis; thus, physical wellbeing was only influenced by treatment, time, and the combined interaction among treatment, diagnosis, and time.

Masticatory Performance

Median particle size

The full model for MPS was significantly better than one in which only the intercepts and predictors were included (Table A-10). Thus, the addition of the interaction among treatment group, diagnosis, and time improved the model beyond

Table 3-20 MPS Means and Standard Errors for Main Effects

Predictor	*M*	(*SE*)
Treatment Group		
HR/BB	3.81	(.17)
HR/SC	3.87	(.16)
LR/NI	3.55	(.13)
Diagnosis		
None	3.36[a]	(.14)
Muscle Disorder	3.99[a]	(.13)
DD	3.51	(.29)
DJD	3.58	(.18)
Multiple Including Muscle Disorder	3.70	(.09)
Multiple Excluding Muscle Disorder	4.41	(.37)
Time Point		
T1	3.97[a,b]	(.09)
T2	3.96[c,d]	(.11)
T3	3.61[a,c]	(.12)
T4	3.39[b,d]	(.14)

[a,b,c,d]Same letter indicates significance down columns (per predictor)

that produced by the predictors individually. There were individual differences in intercepts (i.e., average MPS varied across participants). Furthermore, the effects of diagnosis and time (Table 3-20), including the interaction (Table 3-21), were significant. People with a muscle disorder had a significantly greater mean than people without a diagnosis. Also, the means at both T1 and T2 were significantly greater than the means at T3 and T4, respectively.

Table 3-21 MPS Means and Standard Errors for Interaction

Diagnosis	HR/BB		HR/SC		LR/NI	
	M	(*SE*)	*M*	(*SE*)	*M*	(*SE*)
None						
T1	3.86	(.27)	$3.26^{a,b}$	(.23)	3.59	(.20)
T2	3.97	(.34)	$2.99^{c,d,e}$	(.27)	3.63	(.23)
T3	$3.88^{▲}$	(.38)	$2.50^{▲,f,g}$	(.30)	3.25	(.24)
T4	3.77	(.56)	2.30^{h}	(.44)	3.31	(.28)
Muscle Disorder						
T1	3.92	(.21)	$4.62^{▲,a}$	(.27)	$3.64^{▲}$	(.18)
T2	3.85	(.24)	4.51^{c}	(.32)	3.99	(.21)
T3	3.51	(.30)	4.49^{f}	(.33)	3.81	(.21)
T4	4.00	(.39)	4.15^{h}	(.37)	3.42	(.23)
DD						
T1	3.37^{a}	(.43)	4.29	(.59)	3.74	(.44)
T2	$2.50^{b,c}$	(.54)	4.02	(.63)	3.56	(.52)
T3	2.55	(.72)	4.23	(.76)	3.36	(.60)
T4	1.96	(.99)	4.63	(1.08)	3.90	(.58)
DJD						
T1	4.32	(.32)	3.69	(.33)	3.76	(.31)
T2	4.54^{b}	(.35)	3.66	(.36)	3.66	(.36)
T3	3.61	(.41)	3.31	(.40)	3.76	(.36)
T4	2.58	(.67)	2.97	(.51)	3.14	(.38)
Multiple Including Muscle Disorder						
T1	4.00	(.13)	4.26^{b}	(.15)	3.69	(.21)
T2	3.61	(.15)	4.14^{d}	(.18)	3.81	(.24)
T3	3.54	(.17)	3.86^{g}	(.21)	3.71	(.26)
T4	3.07	(.21)	3.38	(.22)	3.36	(.28)
Multiple Excluding Muscle Disorder						
T1	5.60^{a}	(.68)	4.20	(.83)	3.69	(.55)
T2	5.60^{c}	(1.00)	5.60^{e}	(.89)	3.60	(.59)
T3	5.22	(1.09)	N/A	(N/A)	2.87	(.62)
T4	4.71	(1.13)	N/A	(N/A)	2.97	(.56)

^{a,b,c,d,e,f,g,h}Same letter indicates significance down columns; $^{▲,Δ}$Same symbol indicates significance across rows

Furthermore, the post hoc analyses of the interaction revealed that, of people without a diagnosis, HR/BB patients had a greater mean than HR/SC patients at T3. Of people with a muscle disorder, HR/SC patients had a greater mean than LR/NI patients at T1. For HR/BB patients at T1, people who were diagnosed with a DD had a significantly lower mean than people who had multiple diagnoses excluding a muscle disorder. For HR/BB patients at T2, people who were diagnosed with a DD had a significantly lower mean than people with either a DJD or multiple diagnoses excluding a muscle disorder, respectively. For HR/SC patients at T1, people without a diagnosis had a significantly lower mean than people who had a muscle disorder alone and in combination with other diagnoses, respectively, and, at T2, people without a diagnosis maintained a significantly lower mean compared to both people with a muscle disorder and people with multiple diagnoses including and excluding a muscle disorder, respectively.

For HR/SC patients at T3, people without a diagnosis had a significantly lower mean than people who had a muscle disorder alone and in combination with other diagnoses, respectively. For HR/SC patients at T4, people without a diagnosis had a significantly lower mean than people who were diagnosed with a muscle disorder. All other comparisons were not significant, and there was not a significant effect of treatment. Thus, MPS was not influenced by treatment group alone but was influenced by diagnosis, time, and the interaction among treatment, diagnosis, and time. However, these effects were not influential in the manner that was hypothesized.

Broadness of the distribution

The full model for BD was significantly better than one in which only the intercepts and predictors were included (Table A-11). Thus, the addition of the interaction among treatment group, diagnosis, and time improved the model beyond that

produced by the predictors individually. There were individual differences in intercepts (i.e., average BD varied across participants). Furthermore, all factors were significant (Table 3-22). HR/SC patients had a significantly higher BD mean than LR/NI patients.

Table 3-22 BD Means and Standard Errors for Main Effects

Predictor	*M*	(*SE*)
Treatment Group		
HR/BB	16.02	(1.72)
HR/SC	17.52[a]	(1.65)
LR/NI	12.37[a]	(1.37)
Diagnosis		
None	11.42[b,d]	(1.46)
Muscle Disorder	18.04[a,b,c]	(1.31)
DD	14.64	(3.03)
DJD	12.19[c,e]	(1.87)
Multiple Including Muscle Disorder	12.76[a,f]	(.98)
Multiple Excluding Muscle Disorder	23.81[d,e,f]	(3.98)
Time Point		
T1	18.18[a,b]	(1.11)
T2	18.59[c,d]	(1.32)
T3	12.89[a,c]	(1.23)
T4	10.92[b,d]	(1.32)

[a,b,c,d,e,f]Same letter indicates significance down columns (per predictor)

People without a diagnosis had a significantly a significantly lower mean than people with a muscle disorder and people with multiple diagnoses excluding a muscle disorder, respectively. People with a muscle disorder had a significantly higher mean than people diagnosed with a DJD and people with multiple diagnoses including a muscle disorder, respectively. People with multiple diagnoses excluding a muscle disorder had a greater mean than people diagnosed with a DJD and people with multiple diagnoses including a muscle disorder, respectively. Also, the means at both T1 and T2 were significantly greater than the means at T3 and T4, respectively. The interaction was not significant (Table 3-23); thus, BD was influenced only by treatment, diagnosis, and time as individual predictors.

Table 3-23 BD Means and Standard Errors for Interaction

Diagnosis	HR/BB		HR/SC		LR/NI	
	M	(*SE*)	*M*	(*SE*)	*M*	(*SE*)
None						
T1	13.53	(3.13)	8.03	(2.71)	14.04	(2.40)
T2	17.97	(4.05)	9.66	(3.13)	14.40	(2.63)
T3	17.55	(3.91)	6.58	(3.03)	9.70	(2.42)
T4	10.28	(5.07)	6.76	(3.93)	8.57	(2.54)
Muscle Disorder						
T1	19.41	(2.48)	26.42	(3.18)	15.33	(2.15)
T2	14.96	(2.84)	28.18	(3.78)	18.58	(2.41)
T3	13.16	(3.03)	21.83	(3.33)	12.76	(2.14)
T4	19.11	(3.52)	15.70	(3.35)	11.01	(2.08)
DD						
T1	13.08	(5.08)	22.72	(6.90)	17.20	(5.22)
T2	8.81	(6.50)	20.05	(7.26)	14.52	(6.08)
T3	8.32	(7.46)	19.72	(7.76)	9.14	(6.14)
T4	5.62	(9.10)	28.84	(9.83)	7.69	(5.36)
DJD						
T1	17.61	(3.77)	17.52	(3.83)	12.20	(3.65)
T2	20.40	(4.04)	13.59	(4.12)	14.17	(4.31)
T3	9.45	(4.18)	10.30	(4.04)	11.11	(3.66)
T4	2.71	(6.02)	8.83	(4.65)	8.35	(3.50)
Multiple Including Muscle Disorder						
T1	15.78	(1.50)	17.89	(1.77)	16.20	(2.44)
T2	13.29	(1.79)	16.70	(2.13)	15.96	(2.78)
T3	12.72	(1.69)	11.03	(2.10)	9.87	(2.63)
T4	7.52	(1.88)	11.00	(2.03)	5.18	(2.59)
Multiple Excluding Muscle Disorder						
T1	37.92	(7.97)	26.08	(9.76)	16.28	(6.57)
T2	37.92	(12.25)	37.92	(10.26)	17.63	(6.84)
T3	26.97	(11.21)	N/A	(N/A)	8.94	(6.28)
T4	20.37	(10.39)	N/A	(N/A)	8.07	(5.17)

Exploratory Analyses

As previously stated, I sought to analyze additional measures that I suspected could objectively support the results from the tests of my hypotheses. These measures were health care utilization and medication use. Factorial Analyses of Variance (ANOVAs) were used to analyze the data from the pre-intervention items on the health care utilization form, and MLMs were used to analyze the data from the remaining items on the health care utilization form as well as the data from the medication use items

(Figure 3-2). Where feasible, the variables for health care utilization and medication use were left in their original, untransformed state for the purpose of interpretability. Also, as with the tests of my research hypotheses, both the Bonferroni correction and the Holm-Bonferroni correction were used for post hoc comparisons.

Unfortunately, the model for the anti-psychotic medications would not converge; this was likely due to the fact that a large majority of the participants in the Parent Study were not taking anti-psychotic medications: at T1, there was one count each of one and two medications being taken; at T2, there were two counts of one being taken; at T3, no one reported taking any; and, at T4, there was one count of one being taken. Of the five participants who were taking anti-psychotic medications, four of them were HR/BB patients with muscle disorders, and the one remaining was a LR/NI patient with DJD who only reported taking one at T2. A mixed ANOVA was subsequently attempted; however, the test for equality of covariance matrices, the test of sphericity, and the Levene's test of homogeneity of variance could not be produced across all time points. Although, the Levene's test was produced for the data at T2, it was significant, which violates a necessary assumption of a mixed ANOVA. Therefore, it was concluded that this measure of anti-psychotic medications was inappropriate for statistical analyses. All other analyses met the assumptions of their respective statistical procedures.

Overall, these analyses revealed that study participants made significantly fewer total visits and TMJMD-related visits to health care providers over time, and all participants took significantly fewer medications after the intervention. However, there were no significant differences with regard to diagnosis or the interaction among treatment, diagnosis, and time.

Health Care Utilization

For health care utilization, I first analyzed the number of visits made to health care professionals at T1. These analyses violated the assumption of homogeneity of variance, so the measures were transformed using the square root transformation. It was expected that, at T1, there would be no differences among the groups, which would support the idea that the groups were comparable prior to the intervention (Table 3-24).

Table 3-24 Pre-Intervention Health Care Utilization Means and Standard Errors

Variable†	HR/BB		HR/SC		LR/NI		Total	
	M	(*SE*)	*M*	(*SE*)	*M*	(*SE*)	*M*	(*SE*)
Total visits								
No Diagnosis	.96	(.25)	1.32	(.22)	1.11	(.19)	1.13	(.13)
MD	1.41	(.20)	1.72	(.26)	1.19	(.18)	1.44	(.12)
DD	1.05	(.38)	1.35	(.54)	1.56	(.44)	1.32	(.27)
DJD	1.82	(.28)	1.33	(.34)	1.17	(.31)	1.44	(.18)
Mult. w/ MD	1.17	(.12)	1.30	(.14)	.74	(.20)	1.07	(.09)
Mult. w/o MD	3.18	(.63)	1.00	(.77)	1.21	(.48)	1.80	(.37)
	1.60	(.14)	1.34	(.18)	1.16	(.13)		
Visits related to TMJMD								
No Diagnosis	.14	(.12)	.04	(.10)	.04	(.09)	.08	(.06)
MD	.07	(.09)	.63	(.11)	.10	(.08)	.27	(.06)
DD	.13	(.18)	1.04^{E-17}	(.26)	.17	(.21)	.10	(.13)
DJD	.20	(.13)	.25	(.15)	.19	(.14)	.21	(.08)
Mult. w/ MD	.10	(.06)	.16	(.07)	.03	(.09)	.10	(.04)
Mult. w/o MD	.58	(.30)	-7.11^{E-16}	(.36)	4.83^{E-16}	(.23)	.19	(.17)
	.20	(.07)	.18	(.08)	.09	(.06)		
Visits unrelated to TMJMD								
No Diagnosis	.84	(.24)	1.28	(.21)	1.06	(.18)	1.06	(.12)
MD	1.39	(.19)	1.28	(.25)	1.10	(.17)	1.26	(.12)
DD	1.00	(.37)	1.08	(.47)	1.52	(.43)	1.20	(.25)
DJD	1.71	(.27)	1.13	(.33)	1.00	(.29)	1.28	(.17)
Mult. w/ MD	1.07	(.12)	1.20	(.14)	.73	(.19)	1.00	(.09)
Mult. w/o MD	3.06	(.61)	1.00	(.74)	1.21	(.47)	1.76	(.36)
	1.51	(.14)	1.16	(.17)	1.11	(.13)		

†measures are transformed using the square root transformation; MD = Muscle Disorder; mult. = multiple diagnoses; w/ = with; w/o = without

This expectation was supported with regard to total visits to health care providers: by group, $F(2, 376) = 2.47$, $p = .09$, partial $\eta^2 = .01$; by diagnosis, $F(5, 376) = 2.08$, $p = .07$,

partial η^2 = .03; and by the interaction, $F(10, 376) = 1.32$, $p = .22$, partial η^2 = .03. Similar results were revealed in terms of visits that were unrelated to TMJMD: by group, $F(2, 383) = 2.59$, $p = .08$, partial η^2 = .01; by diagnosis, $F(5, 383) = 1.53$, $p = .18$, partial η^2 = .02; and by the interaction, $F(10, 383) = 1.41$, $p = .17$, partial η^2 = .04.

Furthermore, there were no differences for visits that were related to TMJMD: by group, $F(2, 391) = .87$, $p = .42$, partial η^2 = .004; by diagnosis, $F(5, 391) = 1.64$, $p = .15$, partial η^2 = .02; and by the interaction, $F(10, 391) = 1.71$, $p = .08$, partial η^2 = .04. However, these results for visits related to TMJMD should be interpreted with caution due to the violation of homogeneity of variance that occurred in spite of transformation. All possible transformations were attempted in addition to nonparametric testing (Higgins, Blair, & Tashtoush,1990; Higgins & Tashtoush, 1994; Wobbrock, Findlater, Gergle, & Higgins, 2011), but the violation persisted.

Total post-intervention health care visits

Table 3-25 Total Post Health Care Utilization Means and Standard Errors for Main Effects by Predictor

Predictor	*M*	(*SE*)
Treatment Group		
HR/BB	5.06	(.81)
HR/SC	5.95	(.74)
LR/NI	4.28	(.55)
Diagnosis		
None	5.67	(.67)
Muscle Disorder	5.30	(.55)
DD	5.16	(1.32)
DJD	5.32	(.92)
Multiple Including Muscle Disorder	5.78	(.43)
Multiple Excluding Muscle Disorder	3.12	(1.68)
Time Point		
T1	5.78[a]	(.66)
T2	3.76[a]	(.51)
T3	5.96	(.85)
T4	4.83	(.90)

[a]Same letter indicates significance down columns (per predictor)

The full model for total visits to health care providers made following the intervention was significantly better than one in which only the intercepts and predictors were included (Table B-1). Thus, the addition of the interaction among treatment group, diagnosis, and time improved the model beyond that produced by the predictors individually. There were individual differences in intercepts (i.e., average total

Table 3-26 Total Post Health Care Utilization Means and Standard Errors for Interaction by Predictor

Diagnosis	HR/BB		HR/SC		LR/NI	
	M	(*SE*)	*M*	(*SE*)	*M*	(*SE*)
None						
T1	7.10	(1.83)	5.80	(1.67)	2.85	(1.45)
T2	9.06	(1.74)	3.43	(1.36)	1.65	(1.11)
T3	6.17	(2.69)	7.98	(2.08)	7.85	(1.72)
T4	1.31	(3.90)	7.41	(2.76)	7.40	(1.56)
Muscle Disorder						
T1	9.47	(1.45)	8.48	(2.04)	5.54	(1.28)
T2	3.97	(1.16)	4.86	(1.55)	2.61	(.99)
T3	3.45	(2.15)	7.04	(2.24)	4.40	(1.37)
T4	3.89	(1.96)	5.94	(2.06)	3.91	(1.27)
DD						
T1	3.13	(2.89)	7.56	(4.08)	3.00	(3.09)
T2	3.49	(2.89)	3.00	(2.59)	3.24	(2.59)
T3	14.94	(5.68)	6.05	(4.04)	4.05	(4.64)
T4	4.90	(6.75)	5.25	(4.80)	3.33	(3.41)
DJD						
T1	4.80	(2.11)	6.05	(2.46)	5.45	(2.19)
T2	2.38	(1.61)	9.01	(1.67)	2.62	(1.61)
T3	3.46	(2.85)	4.92	(2.85)	6.49	(2.43)
T4	2.76	(6.73)	10.48	(3.03)	5.38	(2.06)
Multiple Including Muscle Disorder						
T1	6.42	(.89)	5.77	(1.06)	5.50	(1.47)
T2	4.76	(.78)	5.33	(.90)	3.94	(1.21)
T3	6.16	(1.16)	9.02	(1.55)	5.17	(1.90)
T4	7.69	(1.31)	6.12	(1.36)	3.44	(1.82)
Multiple Excluding Muscle Disorder						
T1	9.67	(4.72)	3.50	(5.79)	4.00	(3.66)
T2	.47	(4.09)	1.00	(4.10)	2.80	(2.59)
T3	1.47	(5.71)	2.80	(8.04)	5.80	(3.62)
T4	.47	(6.78)	N/A	N/A	2.40	(3.07)

health care utilization varied across participants). Furthermore, there was a significant effect of time (Table 3-25). Overall, the mean at T2 was significantly lower than the mean at T1. All other comparisons were not significantly different. Also, the effect of the treatment, diagnosis, and the interaction (Table 3-26) were not significant; thus, total health care utilization was only influenced by time.

TMJMD-related post-intervention health care visits

The full model for TMJMD-related visits to health care providers following the intervention was significantly better than one in which only the intercepts and predictors were included (Table B-2). Thus, the addition of the interaction among treatment group, diagnosis, and time improved the model beyond that produced by the predictors individually. There were individual differences in intercepts (i.e., average post-intervention TMJMD-related health care utilization varied across participants). Furthermore, there was a significant time effect (Table 3-27). Overall, the mean at T1

Table 3-27 Post TMJMD-Related Health Care Utilization Means and Standard Errors for Main Effects

Predictor	*M*	(*SE*)
Treatment Group		
HR/BB	1.19	(.40)
HR/SC	2.20	(.38)
LR/NI	1.01	(.29)
Diagnosis		
None	1.06	(.33)
Muscle Disorder	1.83	(.28)
DD	1.55	(.66)
DJD	1.55	(.44)
Multiple Including Muscle Disorder	1.85	(.22)
Multiple Excluding Muscle Disorder	.85	(.87)
Time Point		
T1	2.93[a,b,c]	(.37)
T2	1.38[a]	(.27)
T3	.92[b]	(.41)
T4	.55[c]	(.38)

[a,b,c]Same letter indicates significance down columns (per predictor)

was significantly greater than the means at the remaining time points, respectively. No other comparisons were significant. Also, the interaction (Table 3-28), the effect of treatment, and the effect of diagnosis were not statistically significant. Thus, post-intervention health care utilization that was related to TMJMD differed only across time.

Table 3-28 Post TMJMD-Related Health Care Utilization Means and Standard Errors for Interaction

Diagnosis	HR/BB		HR/SC		LR/NI	
	M	(*SE*)	*M*	(*SE*)	*M*	(*SE*)
None						
T1	4.25	(1.04)	2.57	(.95)	1.32	(.82)
T2	1.12	(.94)	1.69	(.73)	.17	(.60)
T3	.14	(1.30)	.24	(1.01)	.41	(.82)
T4	.08	(1.62)	.45	(1.15)	.22	(.66)
Muscle Disorder						
T1	3.97	(.83)	4.66	(1.10)	1.71	(.73)
T2	1.16	(.62)	2.86	(.83)	1.30	(.53)
T3	.69	(1.04)	3.86	(1.09)	.38	(.66)
T4	.12	(.82)	.50	(.87)	.80	(.53)
DD						
T1	2.00	(1.65)	6.79	(2.32)	1.29	(1.76)
T2	1.50	(1.56)	1.60	(1.40)	.42	(1.39)
T3	.34	(2.76)	2.82	(1.96)	.13	(2.25)
T4	-.51	(2.80)	2.02	(2.00)	.17	(1.44)
DJD						
T1	2.53	(1.21)	3.84	(1.40)	2.19	(1.25)
T2	1.01	(.87)	2.59	(.90)	1.18	(.86)
T3	.36	(1.38)	.51	(1.38)	1.48	(1.18)
T4	-1.04	(2.77)	2.48	(1.27)	1.44	(.87)
Multiple Including Muscle Disorder						
T1	4.36	(.51)	2.94	(.60)	2.00	(.83)
T2	1.87	(.41)	2.20	(.48)	2.70	(.65)
T3	1.41	(.57)	1.27	(.75)	.99	(.92)
T4	1.31	(.54)	.88	(.57)	.33	(.76)
Multiple Excluding Muscle Disorder						
T1	1.67	(2.69)	3.00	(3.30)	1.60	(2.09)
T2	.05	(2.20)	1.00	(2.21)	.40	(1.40)
T3	.07	(2.78)	-.17	(3.90)	1.60	(1.76)
T4	.07	(2.83)	N/A	N/A	-4.56^{E-15}	(1.30)

Non-TMJMD-related post-intervention health care visits

The full model for post-intervention health care utilization unrelated to TMJMD was significantly better than one in which only the intercepts and predictors were included (Table B-3). Thus, the addition of the interaction among treatment group, diagnosis, and time improved the model beyond that produced by the predictors individually. There were individual differences in intercepts (i.e., average post-intervention health care utilization unrelated to TMJMD varied across participants).

Table 3-29 Post Non-TMJMD-Related Health Care Utilization Means and Standard Errors for Main Effects

Predictor	*M*	(*SE*)
Treatment Group		
HR/BB	3.89	(.70)
HR/SC	3.73	(.63)
LR/NI	3.28	(.47)
Diagnosis		
None	4.64	(.58)
Muscle Disorder	3.47	(.46)
DD	3.60	(1.13)
DJD	3.76	(.80)
Multiple Including Muscle Disorder	3.91	(.37)
Multiple Excluding Muscle Disorder	2.31	(1.43)
Time Point		
T1	2.82[b]	(.54)
T2	2.39[a]	(.43)
T3	5.06[a,b]	(.76)
T4	4.29	(.81)

[a,b,c]Same letter indicates significance down columns (per predictor)

Furthermore, there was a significant effect of time (Table 3-29). Overall, both of the means at T1 and T2 were significantly lower than the mean at T3. No other comparisons were significant. Also, the effect of treatment, diagnosis, and the interaction (Table 3-30) were not significant; thus, post-intervention health care utilization unrelated to TMJMD differed only across time.

Table 3-30 Post Non-TMJMD-Related Health Care Utilization Means and Standard Errors for Interaction

Diagnosis	HR/BB		HR/SC		LR/NI	
	M	(*SE*)	*M*	(*SE*)	*M*	(*SE*)
None						
T1	2.85	(1.53)	3.23	(1.40)	1.53	(1.21)
T2	7.93	(1.47)	1.76	(1.15)	1.50	(.94)
T3	6.09	(2.39)	7.78	(1.85)	7.45	(1.53)
T4	1.52	(3.51)	6.87	(2.49)	7.19	(1.40)
Muscle Disorder						
T1	5.50	(1.21)	3.59	(1.66)	3.82	(1.07)
T2	2.80	(.98)	2.01	(1.31)	1.57	(.84)
T3	2.95	(1.91)	3.18	(1.99)	4.00	(1.21)
T4	3.68	(1.76)	5.43	(1.84)	3.12	(1.14)
DD						
T1	1.13	(2.42)	.40	(3.06)	1.71	(2.59)
T2	1.99	(2.44)	1.40	(2.19)	2.81	(2.18)
T3	14.61	(5.05)	3.23	(3.58)	3.90	(4.12)
T4	5.56	(6.08)	3.19	(4.31)	3.22	(3.06)
DJD						
T1	2.27	(1.77)	2.32	(2.06)	3.26	(1.83)
T2	1.37	(1.36)	6.42	(1.41)	1.44	(1.36)
T3	3.11	(2.53)	4.52	(2.53)	5.00	(2.16)
T4	3.49	(6.07)	7.98	(2.73)	3.95	(1.84)
Multiple Including Muscle Disorder						
T1	2.07	(.74)	2.80	(.88)	3.45	(1.23)
T2	2.86	(.66)	3.11	(.76)	1.26	(1.02)
T3	4.75	(1.03)	7.78	(1.38)	4.13	(1.69)
T4	6.37	(1.17)	5.29	(1.22)	3.01	(1.63)
Multiple Excluding Muscle Disorder						
T1	8.00	(3.95)	.50	(4.84)	2.40	(3.06)
T2	.41	(3.45)	-3.28^{E-14}	(3.46)	2.40	(2.19)
T3	1.44	(5.07)	2.98	(7.15)	4.20	(3.21)
T4	.66	(6.09)	N/A	N/A	2.40	(2.74)

Medication Use

For medication use, I sought to determine if there were differences due to the interplay among treatment, diagnosis, and time with regard to total medications that were taken as well as with regard to specific categories of medication: NSAIDs, muscle relaxants, opioids, other, anxiolytics, sedatives, and antidepressants. Medications that

were categorized as 'other' typically consisted of things such as vitamins, blood pressure medications, allergy medications, and birth control pills.

Total medications

The full model for total medications taken was not significantly better than one in which only the intercepts and predictors were included (Table B-4). Thus, the addition of the interaction among treatment, diagnosis, and time did not improve the model. However, the model that included only the predictors was significantly better than the one that included only the intercepts. There were individual differences in intercepts (i.e., average total medications taken varied across participants).

Table 3-31 Total Medications Means and Standard Errors for Main Effects

Predictor	*M*	(*SE*)
Treatment Group		
HR/BB	2.53	(.25)
HR/SC	2.82	(.26)
LR/NI	2.69	(.24)
Diagnosis		
None	2.46	(.28)
Muscle Disorder	2.91	(.25)
DD	2.53	(.56)
DJD	2.65	(.37)
Multiple Including Muscle Disorder	2.92	(.19)
Multiple Excluding Muscle Disorder	2.60	(.76)
Time Point		
T1	$3.15^{a,b,c}$	(.20)
T2	2.58^{a}	(.21)
T3	2.55^{b}	(.22)
T4	2.43^{c}	(.23)

^{a,b,c}Same letter indicates significance down columns (per predictor)

Furthermore, there was a significant effect of time. Overall, the mean at T1 was significantly greater than the means at the remaining time points, respectively (Table 3-31). All other comparisons were not significant, and the effects of treatment and diagnosis were not significant. Thus, the total medication taken varied only across time.

Non-steroidal anti-inflammatory drugs

The full model for NSAIDs was not significantly better than one in which only the intercepts and predictors were included (Table B-5). Thus, the addition of the interaction among treatment, diagnosis, and time did not improve the model; however, the model that included only the predictors was significantly better than the one which included only the intercepts. There were individual differences in intercepts (i.e., average amount of NSAIDs taken varied across participants). Furthermore, all factors were significant (Table 3-32). Overall, HR/BB patients reported taking significantly more NSAIDs than LR/NI patients. People diagnosed with a muscle disorder reported taking significantly

Table 3-32 NSAIDs Means and Standard Errors for Main Effects

Predictor	*M*	(*SE*)
Treatment Group		
HR/BB	.67[a]	(.06)
HR/SC	.60	(.06)
LR/NI	.49[a]	(.05)
Diagnosis		
None	.40[a]	(.06)
Muscle Disorder	.72[a]	(.06)
DD	.61	(.13)
DJD	.57	(.08)
Multiple Including Muscle Disorder	.57	(.04)
Multiple Excluding Muscle Disorder	.64	(.17)
Time Point		
T1	.68[a]	(.05)
T2	.60	(.05)
T3	.59	(.05)
T4	.48[a]	(.06)

[a]Same letter indicates significance down columns (per predictor)

more NSAIDs than people without a diagnosis, and the mean at T1 was significantly greater than the mean at T4. All other comparisons were not significant; thus, the use of NSAIDs was influenced only by treatment, diagnosis, and time individually.

Muscle relaxants

The full model for muscle relaxants was significantly better than one in which only the intercepts and predictors were included (Table B-6). Thus, the addition of the interaction among treatment, diagnosis, and time improved the model beyond the one including only the predictors. There were individual differences in intercepts (i.e., average amount of muscle relaxants taken varied across participants). Furthermore, there was a significant effect of time (Table 3-33). Overall, the mean at T1 was significantly greater than the means at T2 and T4, respectively; also, the mean at T2

Table 3-33 Muscle Relaxants Means and Standard Errors for Main Effects

Predictor	*M*	(*SE*)
Treatment Group		
HR/BB	.12	(.05)
HR/SC	.19	(.05)
LR/NI	.12	(.03)
Diagnosis		
None	.09	(.04)
Muscle Disorder	.16	(.03)
DD	.15	(.08)
DJD	.14	(.05)
Multiple Including Muscle Disorder	.22	(.03)
Multiple Excluding Muscle Disorder	.10	(.10)
Time Point		
T1	.24[a,b]	(.04)
T2	.18[c]	(.03)
T3	.10[b]	(.04)
T4	.06[a,c]	(.04)

[a,b,c]Same letter indicates significance down columns (per predictor)

was significantly greater than the mean at T4. All other comparisons were not significant. Also, the effect of treatment, diagnosis, and the interaction (Table 3-34) were not significant; thus, the use of muscle relaxants varied only across time.

Table 3-34 Muscle Relaxants Means and Standard Errors for Interaction

Diagnosis	HR/BB		HR/SC		LR/NI	
	M	(*SE*)	*M*	(*SE*)	*M*	(*SE*)
None						
T1	.17	(.12)	.12	(.10)	.18	(.09)
T2	.11	(.11)	.09	(.08)	.06	(.07)
T3	.003	(.14)	-.02	(.10)	.07	(.09)
T4	-.01	(.17)	.28	(.11)	.04	(.07)
Muscle Disorder						
T1	.28	(.09)	.30	(.11)	.16	(.08
T2	.26	(.07)	.20	(.10)	.07	(.06)
T3	.13	(.11)	.25	(.12)	.08	(.07)
T4	-.06	(.09)	.22	(.10)	.06	(.06)
DD						
T1	.13	(.18)	.80	(.22)	.14	(.19)
T2	.21	(.18)	.20	(.16)	.18	(.16)
T3	-.13	(.28)	.23	(.21)	.08	(.23)
T4	-.03	(.30)	-.10	(.21)	.03	(.18)
DJD						
T1	.27	(.13)	.28	(.14)	.13	(.13)
T2	.09	(.10)	.33	(.11)	.07	(.10)
T3	.11	(.14)	.14	(.14)	-.01	(.12)
T4	.001	(.21)	.20	(.14)	.09	(.10)
Multiple Including Muscle Disorder						
T1	.38	(.05)	.25	(.06)	.45	(.09)
T2	.18	(.05)	.23	(.05)	.18	(.07)
T3	.21	(.06)	.24	(.08)	.12	(.10)
T4	.08	(.06)	.15	(.06)	.12	(.08)
Multiple Excluding Muscle Disorder						
T1	-2.42^{E-15}	(.29)	1.50^{E-16}	(.35)	.20	(.22)
T2	.50	(.25)	2.05^{E-16}	(.26)	.20	(.16)
T3	-1.05^{E-14}	(.30)	5.41^{E-16}	(.40)	.20	(.19)
T4	.02	(.30)	N/A	N/A	-.02	(.16)

Opioids

The full model for opioids was significantly better than one in which only the intercepts and predictors were included (Table B-7). Thus, the addition of the interaction among treatment, diagnosis, and time improved the model beyond the one including only the predictors. There were individual differences in intercepts (i.e., average amount of opioids taken varied across participants).

Table 3-35 Opioids Means and Standard Errors for Main Effects

Predictor	*M*	(*SE*)
Treatment Group		
HR/BB	.05	(.03)
HR/SC	.10	(.03)
LR/NI	.04	(.02)
Diagnosis		
None	.03	(.03)
Muscle Disorder	.05	(.02)
DD	.07	(.05)
DJD	.11	(.03)
Multiple Including Muscle Disorder	.10	(.02)
Multiple Excluding Muscle Disorder	-2.35^{E-16}	(.07)
Time Point		
T1	.09	(.03)
T2	.07	(.02)
T3	.05	(.03)
T4	.04	(.03)

However, there were no significant differences for any of the predictors (Table 3-35) or for the interaction (Table 3-36). Thus, the use of opioids were not influenced by treatment, diagnosis, or time, individually or collectively.

Table 3-36 Opioids Means and Standard Errors for Interaction

Diagnosis	HR/BB		HR/SC		LR/NI	
	M	(*SE*)	*M*	(*SE*)	*M*	(*SE*)
None						
T1	.11	(.08)	.12	(.07)	.03	(.06)
T2	.01	(.08)	.09	(.06)	-.002	(.05)
T3	.002	(.08)	.11	(.06)	-.001	(.05)
T4	.01	(.12)	-.07	(.08)	-.001	(.05)
Muscle Disorder						
T1	.10	(.06)	.15	(.07)	.07	(.05)
T2	.06	(.06)	.08	(.08)	.04	(.05)
T3	.07	(.06)	-.001	(.07)	.001	(.04)
T4	.02	(.06)	-.003	(.07)	.001	(.04)
DD						
T1	.13	(.12)	-5.48^{E-17}	(.15)	.29	(.13)
T2	.04	(.13)	.20	(.12)	.16	(.12)
T3	.02	(.17)	-.02	(.13)	.06	(.14)
T4	.01	(.21)	-.02	(.15)	.01	(.12)
DJD						
T1	.07	(.09)	.15	(.10)	-5.07^{E-17}	(.09)
T2	.02	(.08)	.25	(.08)	.000	(.08)
T3	.01	(.09)	.40	(.08)	-.003	(.08)
T4	.01	(.14)	.37	(.09)	.09	(.07)
Multiple Including Muscle Disorder						
T1	.20	(.04)	.15	(.04)	.06	(.06)
T2	.13	(.04)	.17	(.04)	.05	(.06)
T3	.12	(.04)	.02	(.05)	.03	(.06)
T4	.07	(.04)	.08	(.04)	.13	(.05)
Multiple Excluding Muscle Disorder						
T1	-1.63^{E-16}	(.19)	-3.73^{E-16}	(.23)	-6.34^{E-16}	(.15)
T2	-3.27^{E-16}	(.19)	-6.92^{E-16}	(.20)	2.67^{E-15}	(.12)
T3	-5.74^{E-16}	(.18)	-2.80^{E-15}	(.24)	9.90^{E-16}	(.11)
T4	-2.19^{E-15}	(.21)	N/A	N/A	1.51^{E-15}	(.11)

Other medications, anxiolytics, sedatives, and antidepressants

The full models for miscellaneous medications (i.e., other; Table B-8), anxiolytics (Table B-9), sedatives (Table B-10), and antidepressants (Table B-11) were not significantly better than the respective models that only included the intercepts. On the contrary, the models that included the intercepts as well as time as a predictor were significantly better than the one only including the intercepts. For miscellaneous medications, the mean at T1 was significantly greater than the mean at T2 (Table 3-37).

All other comparisons were not significant; thus, there was not a significant effect of time for the remaining medication categories.

Table 3-37 Medication Means and Standard Errors for Model 4

Measure	*M*	(*SE*)
Other		
T1	1.74[a]	(.11)
T2	1.40[a]	(.12)
T3	1.42	(.15)
T4	1.49	(.14)
Anxiolytics		
T1	.09	(.02)
T2	.07	(.02)
T3	.08	(.02)
T4	.10	(.03)
Sedatives		
T1	.09	(.01)
T2	.09	(.02)
T3	.10	(.02)
T4	.12	(.02)
Antidepressants		
T1	.26	(.03)
T2	.25	(.03)
T3	.26	(.03)
T4	.23	(.03)

[a]Same letter indicates significance down columns (per measure)

Chapter 4

Discussion

The purpose of the present study was to assess whether a biobehavioral intervention would be more effective for acute TMJMD patients with myogenous TMJMD in terms of reducing psychological distress, reducing pain, and improving functionality when compared to other patients with myogenous TMJMD receiving either a self-care intervention or no intervention. I also sought to determine whether biobehavioral patients with a single diagnosis of myogenous TMJMD would fare better than patients who had multiple diagnoses including a muscle disorder. Overall, the present study found that a biobehavioral intervention was indeed more effective for acute patients with myogenous TMJMD in reducing chewing pain as well as in improving physical functioning when compared to other myogenous TMJMD patients. I also found that biobehavioral patients with a single diagnosis of myogenous TMJMD did in fact have less chewing pain than patients with multiple diagnoses including a muscle disorder. However, significant differences were not found with regard to psychological distress.

Though not all of my hypotheses were supported for all measures assessed in the current study, there may be an overarching reason that can explain this. Some researchers have found that the interaction between the patient and the health care professional is predictive of favorable outcomes (Scrivani et al., 2008). Although I attempted to account for this phenomenon by implementing an attentional control group via the self-care intervention, it might be the case that simply being in an environment where one not only is made aware of his or her symptoms but also is empowered to actively remedy them is even more effective than the treatment itself, which, in some cases for some individuals.

Psychological Distress

Given the high levels of pain and dysfunction that myogenous TMJMD sufferers report (Galdon et al., 2006; Manfredini et al., 2011; Reissman et al., 2007; Reissmann et al., 2008; Wieckiewicz et al., 2014), I suspected that such reports would be indicative of psychological distress, and the current study was actually able to show that people with myogenous TMJMD reported greater stress and greater somatization than other participants. In terms of depressive symptoms, people with multiple diagnoses including a muscle disorder differed at baseline with the high risk groups having worse outcomes than the comparison group, but all groups were comparable at the remaining time points. In other words, people in the biobehavioral group were reporting a greater level of depression prior to the intervention, but, after the intervention, their level of depression became comparable to that of the comparison group. Also, all participants reported reductions in both stress and depressive symptoms as well as an increase in mental wellness over time, and, of the arthrogenous TMJMD participants, patients who received the biobehavioral intervention reported less depressive symptoms one year after the intervention when compared to people who were in the comparison group, a finding that may support the idea that the biobehavioral intervention was effective. However, this effect for the arthrogenous group must be interpreted with caution because the biobehavioral group appeared to have characteristically low depressive symptoms both before and after the intervention relative to the comparison group.

Contrary to past research findings, which suggested that a biobehavioral intervention is beneficial for people with TMJMD in relieving psychological distress (Turk, Zaki, & Rudy, 1993), the current study did not find that a biobehavioral intervention was effective in reducing stress, depressive symptoms, and somatization or in improving mental wellness for myogenous TMJMD patients when compared to the other

myogenous TMJMD participants in this study. Nor did I find that biobehavioral patients with a single diagnosis of myogenous TMJMD improved compared to people with multiple diagnoses including a muscle disorder. It is therefore noteworthy that findings from the studies that led to and came from the Parent Study, though, mirror these results. In a study conducted prior to the Parent study, Robinson (2007) was not able to find differences between groups of TMJMD patients that did and did not receive treatment with regard to depressive symptoms. It is also noteworthy that another study using the same participants found that there were no differences with regard to pain and masticatory functioning between depressed and non-depressed TMJMD participants, and the researchers suggested that depressed TMJMD patients have quite possibly become desensitized to their TMJMD-related symptoms (Gatchel, Stowell, & Buschang, 2006). Also, in preliminary results of the Parent Study, Lorduy (2012) found no differences between the intervention groups with regard to depressive symptoms or mental wellbeing.

Other researchers have found similar results. Much like the current study, Mora, Weber, Neff, and Rief (2013) compared two different treatment groups (i.e., one included both BFB and CBT, and the other involved the application of splints) in TMJMD patients and found that the patients reported improvements in psychological distress over time yet group differences were not found. In two separate studies, Dworkin and colleagues (1994; 2002a) found that TMJMD patients who were and were not treated for their symptoms did not differ in terms of depressive symptoms and somatization, which they suspected may be due to the lack of specificity in CBT to address these issues as well as to the fact that the same study personnel assessed both groups. Dworkin and colleagues (2002a) also explained that the specialists who were evaluating their patients all maintained a belief that symptoms could be relieved through biopsychosocial practices, a

fact that was also present in the current study. Accordingly, this may have been unknowingly conveyed to participants, which possibly aided in making the groups comparable. Furthermore, Dworkin and colleagues (2002a) posited that such psychological dysfunctions may need more rigorous psychotherapy in order to reveal noticeable improvements when comparisons are made to people not receiving treatment. Reissmann and colleagues (2008) found that reports of somatization and depression were comparable among the three major TMJMD diagnostic groups. Manfredini and colleagues (2009), however, found that people with myogenous TMJMD reported more psychological problems than others, wheras people with arthrogenous or mixed diagnoses were not significantly different when compared to other participants.

Pain Reduction

Because TMJMD is typically regarded as a chronic pain condition, it was natural to expect that an early intervention treatment program would be effective in reducing pain, particularly for patients with myogenous TMJMD because these patients tend to suffer inordinately from pain (Manfredini et al., 2011; Reissmann et al., 2008; Wieckiewicz et al., 2014). Indeed, I found that people with myogenous TMJMD reported greater pain in all four pain measures than other participants; notably, people with combination myogenous TMJMD reported more chewing pain than people who were diagnosed with myogenous TMJMD alone, a finding that supports the idea that combination diagnoses, especially those that involve a muscle disorder, produce more severe symptom presentations. For facial pain and pain-related disability, high risk patients with myogenous TMJMD had worse outcomes prior to the intervention compared to the comparison group participants, but all participants were comparable two years following the intervention. In other words, myogenous TMJMD patients in the biobehavioral group reported higher levels of facial pain and pain-related disability prior to

the intervention, but, after the intervention, their levels of pain had become comparable to the people in the comparison group. I also found that all pain measures were reduced over time for all participants.

Most importantly, though, I found support for my hypothesis in that, as expected, biobehavioral patients with a single TMJMD diagnosis of a muscle disorder had less chewing pain than patients with multiple diagnoses including a muscle disorder immediately after the intervention. Also, I found that myogenous TMJMD patients with multiple diagnoses who received the biobehavioral intervention reported less chewing pain than people who received the self-care intervention immediately after the intervention and two years after the intervention. Although the patients with a single diagnosis of myogenous TMJMD who received the biobehavioral intervention reported less pain than the patients who received the self-care intervention one-year after the intervention, this finding should be interpreted with caution because the pain levels between these groups of patients also differed prior to the intervention. This finding was unexpected given the fact that these groups were randomized. It seems to suggest that these groups of patients with a single diagnosis of myogenous TMJMD were inherently different, and, thus, the difference revealed immediately after the intervention was quite possibly independent of the treatments administered.

Unfortunately, I did not find that there was a reduction in facial pain, painful somatization, or pain-related disability for myogenous TMJMD patients receiving the biobehavioral intervention in comparison to other participants. Nor did I find that biobehavioral patients with a single diagnosis of myogenous TMJMD improved in these areas compared to people with multiple diagnoses including a muscle disorder. However, this outcome is similar to related findings in the Parent Study. For instance, Mishra, Gatchel, and Gardea (2000) found that there were no differences in treated

versus non-treated TMJMD patients with regard to pain-related disability; they speculated that the emphasis on psychological techniques in the biobehavioral intervention may have conflicted with the patients' physiological view of their disorder, thereby hindering the intervention's efficacy. In that same year, Bernstein and Gatchel (2000) found no difference between treatment groups in facial pain, and they suggested that the measure used to gauge facial pain (i.e., the CPI) may have been lacking in sensitivity. Likewise, Lorduy (2012) found no differences between the intervention groups in facial pain or pain-related disability, and Robinson (2007) found no differences between treatment and non-treatment groups with regard to facial pain.

This discrepancy in the findings among the different pain measures may be due to the fact that chewing pain was tied to a function for which they had an immediate reference (i.e, the report of chewing pain was given directly after the chewing task) whereas the reports of facial pain, painful somatization, and pain-related disability were likely not as immediately experiential. Furthermore, the pain-related disability measure had a relatively low reliability statistic for our sample, which may partially explain why some of my predictions were not supported.

Other studies have found null results in regard to non-functional pain. In a study similar to the present study, Michelotti and colleagues (2004) found that people with myogenous TMJMD who received physical therapy in addition to education were not different from controls in terms of pain intensity or pain pressure thresholds. A review conducted by Crider, Glaros, & Gervitz (2005) discussed findings (i.e., Dalen, Ellertsen, Espelid, & Gronningsaeter, 1986; Dohrmann & Laskin, 1978) relating BFB training to reduced pain over time. However, there were no differences between people receiving BFB and people not receiving it, which the authors suggest may be due to methodological issues. Dworkin and colleagues (1994; 2002a) compared groups of

TMJMD patients who were either in a treatment group or in a control group whereas Mora and colleagues (2013) compared two different treatment groups of TMJMD patients, and both studies found that, although there was a reduction in pain over time, the groups did not differ in pain or pain-related disability, which, once again, was ascribed to a lack of specificity of the CBT treatment as well as to the biopsychosocial perspectives of the specialists.

Crockett, Foreman, Alden, and Blasburg (1986) also found that people who received BFB did not differ in pain levels compared to people receiving a physical intervention, and Reissmann and colleagues (2008) found that people diagnosed with the three major TMJMD diagnostic groups were comparable in terms of pain severity. Interestingly, in a long-term study, Ohrbach and Dworkin (1998) found that about half of the TMJMD patients in their study remitted (i.e., reported an absence of pain) at a five-year follow-up, which supports the assertion that TMJMD pain may be cyclical in nature and resolve on its own (Reissmann et al., 2008; Romero-Reyes & Uyanik, 2014).

Improved Functionality

Past research has shown that the presence of myogenous TMJMD disrupts one's ability to function properly (Galdon et al., 2006; John et al., 2007; Reissmann et al., 2007; van Selms, Lobbezoo, Visscher, & Naeije, 2008; Wieckiewicz et al., 2014); this finding is supported by the finding in the current study that the myogenous TMJMD patients reported poorer masticatory performance than other participants. I hypothesized that this deficiency in functionality would extend beyond mastication and that a biobehavioral intervention could provide relief. I found that both physical wellbeing and masticatory performance improved over time for all participants. Most importantly, I found that people with myogenous TMJMD who received the biobehavioral intervention reported a greater improvement in physical wellbeing than people who received the self-

care intervention both immediately following the intervention and two years after the intervention, which supports my hypothesis, but, interestingly, this occurred only when the muscle disorder was diagnosed in combination with other diagnoses.

Unfortunately, I did not find that masticatory performance improved for the myogenous TMJMD patients receiving the biobehavioral intervention when compared to the other participants. Nor did I find that biobehavioral patients with a single myogenous TMJMD diagnosis improved compared to people with multiple diagnoses including a muscle disorder, but it is important to note that other studies have found similar results. For instance, Wright and colleagues (2004) found that there were no differences in chewing performance between high risk and low risk patients with acute TMJMD, and Sanders (2013) found that there were no differences in masticatory performance between the high risk groups who were receiving treatment. Furthermore, Dougall and colleagues (2012) found that acute, high risk TMJMD patients as well as people with multiple RDC/TMD Axis I diagnoses did not differ from acute, low risk TMJMD patients and people without multiple diagnoses, respectively, with regard to masticatory performance.

Contrary to expectation, people diagnosed with myogenous TMJMD alone reported a greater BD (i.e., poorer masticatory performance) than people who had myogenous TMJMD in combination with other diagnoses. Also contrary to expectation was the fact that, of the two combination diagnoses groups, the one that excluded muscle disorders had a greater BD. Considering these contradictory findings in addition to the evidence that has not shown differences with regard to masticatory performance, it is suspected that CutterSil® may not have been able to detect the differences between the interventions used in the Parent Study. In particular, CutterSil® helps identify treatment differences related to occlusion (P. Buschang, personal communication, February 2015), which is the alignment of the teeth when both the top and bottom jaws are in contact and,

therefore, dictates the chewing pattern (Yamashita et al, 1999). The CutterSil® assessments used in the current study may not have been produce significant effects because the treatments provided in this study were either therapeutic or educational in nature as opposed to involving a method that could affect occlusion more directly (e.g., manual therapy). Nonetheless, it is noteworthy that all study participants reported improved masticatory performance over time.

Decreased Health Care Utilization & Medication Use

In addition to testing my research hypotheses, I also sought to determine if health care utilization and medication use would mirror the expectations represented by my hypotheses, and thereby add further objective support for my hypotheses. Specifically, I predicted that myogenous TMJMD patients that received a biobehavioral intervention would have fewer visits to health care providers and take fewer medications when compared to other myogenous TMJMD patients. Although the results did not show this, I found that visits to health care providers and medication use did decrease for all participants over time, which quite possibly has important implications for reduced healthcare costs. Interestingly, there were more non-TMJMD-related visits made to health care providers over time; however, these visits tended to be made for benign reasons (e.g., routine dental check-ups, monitoring the progress of a pregnancy, etc.) and, thus, are likely inconsequential to the purposes of this study. Also, people with myogenous TMJMD reported taking more NSAIDs than people who had no diagnosis, which supports the idea that myogenous TMJMD sufferers may need to use more NSAIDs to relieve their symptoms.

Limitations & Strengths

Though the current study contributes to the breadth of the literature on acute TMJMD patient populations, it has some limitations. The first and most obvious limitation

is that a large amount of the attrition in the Parent Study occurred in the group that received the biobehavioral intervention; particularly, the bulk of this attrition occurred due to the termination of the Parent Study (Table 3-2). However, the termination was beyond our control, and the data were analyzed using MLM, which is superior to other multivariate analyses when applied to longitudinal data with missing information (Tabachnick & Fidell, 2007).

A second limitation of the current study is that the diagnostic criteria for TMJMD were revised while the Parent Study was still in progress; however, at the commencement of the Parent Study, the most current, accurate measures were used. The creators of the RDC/TMD did forewarn that the assessment tool would need further revisions to increase accuracy and validity (Schiffman et al., 2014), and these revisions have culminated into the DC/TMD, which are vastly different from the RDC/TMD. Most notably, the somatization measures have been removed, and the items that measured facial pain and pain-related disability have changed their time references from the past six months to now the past thirty days. Such changes would have likely altered the results of the current study, especially considering the fact that the outcome measures that were either altered or removed were the very ones that rendered null findings.

A third and final limitation is the possibility of regression towards the mean. My hypotheses posited that the most improvement would occur in subgroups of patients that was expected to have the worst outcomes. However, all of the necessary precautions were taken to combat this confound: the groups were randomly assigned, repetitive assessments were administered, and a large dataset was used (McBride, 2013).

Conclusions & Future Directions

The overall purpose of the current study was to build upon past research which showed that early interventions, particularly those that are biobehavioral, are effective for

acute TMJMD patients. This was accomplished through the use of subgroup analyses, which assessed the treatment effects according to the diagnoses given to patients prior to the intervention. Overall, the current study was able to show the following: early interventions are effective in acute TMJMD populations; myogenous TMJMD tends to result in more severe symptom presentations, particularly if diagnosed in combination with other TMJMD diagnoses; TMJMD-related symptoms, medication use, and TMJMD-related health care visits tend to decrease over time; and, most importantly, a biobehavioral intervention is particularly effective in reducing chewing pain and in improving overall physical wellbeing for acute TMJMD patients with a muscle disorder either alone or in combination with other diagnoses.

To extend these findings, other subgroup analyses should be conducted. For instance, it would be interesting to determine if treatment effects differ according other baseline patient characteristics. In future studies, it would be beneficial to replicate the Parent Study using the DC/TMD to discover how or if the revised diagnostic criteria dictate the effectiveness of early interventions. Particularly, these future studies should include measures of compliance with or adherence to the intervention since this determines the success of any treatment (Mora, Weber, Neff, & Rief, 2013). It would also be interesting to incorporate technology into treatment protocols in future research; for instance, researchers could possibly use mobile device and tablet applications to make the components of the interventions more accessible and interactive.

Appendix A

MLM Comparisons for Hypotheses

Table A-1 PSS MLM Comparisons

	Total Parameters	-2LL	Model Difference†	Numerator df	Denominator df	*F*	*p*
Model 1	3	7598.47					
Intercepts				1	424.80	2154.75	<.001
Model 2	5	7595.80	2.67				
Intercepts				1	423.86	2140.50	<.001
Treatment Group				2	423.97	1.34	.26
Model 3	8	7578.64	19.83**				
Intercepts				1	412.85	816.22	<.001
Diagnosis				5	418.74	4.05	.001
Model 4	10	7537.25	61.22***				
Intercepts				1	435.46	2005.39	<.001
Time				3	271.85	14.18	<.001
Model 5	13	7532.19	66.28***				
Intercepts				1	427.38	775.81	<.001
Treatment Group				2	430.76	.36	.70
Diagnosis				5	421.82	3.69	.003
Time				3	796.17	15.40	<.001
Model 6	77	7447.72	84.47*				
Intercepts				1	452.28	676.92	<.001
Treatment Group				2	448.75	.07	.93
Diagnosis				5	455.23	2.81	.02
Time				3	282.97	6.38	<.001
Treatment Group X Diagnosis X Time				60	425.64	1.23	.13

*p < .05; **p < .01; ***p < .001; †Model 2, Model 3, Model 4, and Model 5 are each compared to Model 1 whereas Model 6 is compared to Model 5.

Table A-2 BDI-II MLM Comparisons

	Total Parameters	-2LL	Model Difference†	Numerator df	Denominator df	*F*	*p*
Model 1	3	7503.43					
Intercepts				1	407.23	475.62	<.001
Model 2	5	7501.66	1.77				
Intercepts				1	406.384	471.97	<.001
Treatment Group				2	406.56	.89	.41
Model 3	8	7486.86	16.57**				
Intercepts				1	396.66	147.54	<.001
Diagnosis				5	402.09	3.37	.01
Model 4	10	7382.91	120.52***				
Intercepts				1	408.62	405.16	<.001
Time				3	268.87	27.80	<.001
Model 5	13	7395.17	108.26***				
Intercepts				1	412.88	124.32	<.001
Treatment Group				2	414.17	.14	.87
Diagnosis				5	406.76	3.10	.01
Time				3	753.73	31.85	<.001
Model 6	77	7278.28	116.89***				
Intercepts				1	421.29	107.95	<.001
Treatment Group				2	419.81	.19	.83
Diagnosis				5	423.15	2.36	.04
Time				3	285.25	10.49	<.001
Treatment Group X Diagnosis X Time				60	406.36	1.59	.01

*p < .05; **p < .01; ***p < .001; †Model 2, Model 3, Model 4, and Model 5 are each compared to Model 1 whereas Model 6 is compared to Model 5.

Table A-3 MCS MLM Comparisons

	Total Parameters	-2LL	Model Difference†	Numerator df	Denominator df	*F*	*p*
Model 1	3	8684.74					
Intercepts				1	402.40	12271.90	<.001
Model 2	5	8683.56	1.18				
Intercepts				1	401.79	12190.96	<.001
Treatment Group				2	401.64	.59	.55
Model 3	8	8666.42	18.32**				
Intercepts				1	383.82	5819.07	<.001
Diagnosis				5	392.55	3.74	.003
Model 4	10	8606.76	77.98***				
Intercepts				1	397.09	12745.07	<.001
Time				3	286.07	16.41	<.001
Model 5	13	8613.03	71.71***				
Intercepts				1	403.00	5861.54	<.001
Treatment Group				2	409.73	.20	.82
Diagnosis				5	397.98	3.49	.004
Time				3	806.06	18.03	<.001
Model 6	77	8538.21	74.82				
Intercepts				1	410.68	5458.59	<.001
Treatment Group				2	407.90	.01	.99
Diagnosis				5	410.93	3.35	.01
Time				3	295.97	5.72	.001
Treatment Group X Diagnosis X Time				60	478.38	.91	.67

*p < .05; **p < .01; ***p < .001; †Model 2, Model 3, Model 4, and Model 5 are each compared to Model 1 whereas Model 6 is compared to Model 5.

Table A-4 Non-Painful Somatization MLM Comparisons

	Total Parameters	-2LL	Model Difference†	Numerator df	Denominator df	*F*	*p*
Model 1	3	1065.55					
Intercepts				1	409.56	687.97	<.001
Model 2	5	1057.66	7.89*				
Intercepts				1	408.66	700.86	<.001
Treatment Group				2	408.70	3.98	.02
Model 3	8	1036.35	29.20***				
Intercepts				1	395.43	212.33	<.001
Diagnosis				5	402.29	6.02	<.001
Model 4	11	1002.37	63.18***				
Intercepts				1	409.84	600.44	<.001
Time				3	276.01	13.09	<.001
Model 5	13	988.63	76.92***				
Intercepts				1	410.58	194.83	<.001
Treatment Group				2	414.67	3.35	.04
Diagnosis				5	404.40	5.91	<.001
Time				3	802.25	13.84	<.001
Model 6	78	891.33	97.30**				
Intercepts				1	436.84	179.21	<.001
Treatment Group				2	433.59	1.59	.21
Diagnosis				5	435.12	4.43	.001
Time				3	284.75	3.10	.03
Treatment Group X Diagnosis X Time				60	436.67	1.32	.06

*$p < .05$; **$p < .01$; ***$p < .001$; †Model 2, Model 3, Model 4, and Model 5 are each compared to Model 1 whereas Model 6 is compared to Model 5.

Table A-5 CPI MLM Comparisons

	Total Parameters	-2LL	Model Difference†	Numerator df	Denominator df	*F*	*p*
Model 1	3	11129.66					
Intercepts				1	378.50	1793.89	<.001
Model 2	5	10980.53	149.13***				
Intercepts				1	390.03	2425.87	<.001
Treatment Group				2	389.19	85.94	<.001
Model 3	8	11087.79	41.87***				
Intercepts				1	366.11	721.38	<.001
Diagnosis				5	375.82	8.68	<.001
Model 4	10	10463.29	666.37***				
Intercepts				1	405.85	1495.49	<.001
Time				3	324.93	247.81	<.001
Model 5	13	10349.60	780.06***				
Intercepts				1	437.81	926.95	<.001
Treatment Group				2	445.85	66.85	<.001
Diagnosis				5	430.73	3.59	.003
Time				3	906.90	282.40	<.001
Model 6	78	10054.32	295.28***				
Intercepts				1	389.92	696.39	<.001
Treatment Group				2	389.65	23.06	<.001
Diagnosis				5	374.94	4.07	.001
Time				3	304.97	98.66	<.001
Treatment Group X Diagnosis X Time				60	510.80	2.85	<.001

*$p < .05$; **$p < .01$; ***$p < .001$; †Model 2, Model 3, Model 4, and Model 5 are each compared to Model 1 whereas Model 6 is compared to Model 5.

Table A-6 Chewing Pain MLM Comparisons

	Total Parameters	-2LL	Model Difference†	Numerator df	Denominator df	*F*	*p*
Model 1	3	5153.80					
Intercepts				1	364.20	714.90	<.001
Model 2	5	5113.32	40.48***				
Intercepts				1	363.56	786.63	<.001
Treatment Group				2	363.29	21.12	<.001
Model 3	8	5093.03	60.77***				
Intercepts				1	358.65	269.93	<.001
Diagnosis				5	363.92	12.89	<.001
Model 4	10	4870.28	283.52***				
Intercepts				1	375.84	609.26	<.001
Time				3	277.53	76.77	<.001
Model 5	13	4837.27	316.53***				
Intercepts				1	387.75	253.56	<.001
Treatment Group				2	387.23	11.97	<.001
Diagnosis				5	378.27	10.90	<.001
Time				3	764.72	85.74	<.001
Model 6	77	4673.46	163.81***				
Intercepts				1	434.38	230.30	<.001
Treatment Group				2	427.17	3.36	.04
Diagnosis				5	423.51	7.97	<.001
Time				3	276.89	30.05	<.001
Treatment Group X Diagnosis X Time				60	429.66	2.23	<.001

*$p < .05$; **$p < .01$; ***$p < .001$; †Model 2, Model 3, Model 4, and Model 5 are each compared to Model 1 whereas Model 6 is compared to Model 5.

Table A-7 Painful Somatization MLM Comparisons

	Total Parameters	-2LL	Model Difference†	Numerator df	Denominator df	*F*	*p*
Model 1	3	1590.05					
Intercepts				1	407.80	624.56	<.001
Model 2	5	1576.20	13.85***				
Intercepts				1	406.27	642.17	<.001
Treatment Group				2	406.38	7.03	.001
Model 3	8	1554.68	35.37***				
Intercepts				1	396.36	185.91	<.001
Diagnosis				5	402.26	7.34	<.001
Model 4	10	1521.96	68.09***				
Intercepts				1	400.77	567.26	<.001
Time				3	270.59	14.37	<.001
Model 5	13	1498.33	91.72***				
Intercepts				1	408.78	175.00	<.001
Treatment Group				2	411.85	4.80	.01
Diagnosis				5	403.22	6.68	<.001
Time				3	783.41	15.60	<.001
Model 6	77	1408.15	90.18*				
Intercepts				1	421.83	166.03	<.001
Treatment Group				2	420.29	1.07	.34
Diagnosis				5	421.56	5.44	<.001
Time				3	273.10	2.81	.04
Treatment Group X Diagnosis X Time				60	420.61	1.28	.09

*$p < .05$; **$p < .01$; ***$p < .001$; †Model 2, Model 3, Model 4, and Model 5 are each compared to Model 1 whereas Model 6 is compared to Model 5.

Table A-8 GCPS MLM Comparisons

	Total Parameters	-2LL	Model Difference†	Numerator df	Denominator df	*F*	*p*
Model 1	3	3208.29					
Intercepts				1	372.29	1626.10	<.001
Model 2	5	3096.98	111.31***				
Intercepts				1	372.89	2066.72	<.001
Treatment Group				2	372.19	62.53	<.001
Model 3	8	3158.22	50.07***				
Intercepts				1	357.16	635.59	<.001
Diagnosis				5	366.66	10.52	<.001
Model 4	10	2737.63	470.66***				
Intercepts				1	388.82	1402.77	<.001
Time				3	345.25	187.21	<.001
Model 5	13	2631.42	576.87***				
Intercepts				1	408.43	708.42	<.001
Treatment Group				2	416.34	41.06	<.001
Diagnosis				5	401.68	5.82	<.001
Time				3	878.25	184.60	<.001
Model 6	77	2433.33	198.09***				
Intercepts				1	439.73	582.32	<.001
Treatment Group				2	433.55	12.72	<.001
Diagnosis				5	434.11	4.94	<.001
Time				3	342.11	83.39	<.001
Treatment Group X Diagnosis X Time				60	480.03	2.98	<.001

*$p < .05$; **$p < .01$; ***$p < .001$; †Model 2, Model 3, Model 4, and Model 5 are each compared to Model 1 whereas Model 6 is compared to Model 5.

Table A-9 PCS MLM Comparisons

	Total Parameters	-2LL	Model Difference†	Numerator df	Denominator df	*F*	*p*
Model 1	3	8151.78					
Intercepts				1	411.54	16180.93	<.001
Model 2	5	8133.34	18.44***				
Intercepts				1	407.15	16780.21	<.001
Treatment Group				2	407.13	9.46	<.001
Model 3	8	8139.62	12.16*				
Intercepts				1	398.30	7154.10	<.001
Diagnosis				5	405.54	2.46	.03
Model 4	10	8108.58	43.20***				
Intercepts				1	413.54	15890.94	<.001
Time				3	275.26	6.03	.001
Model 5	13	8106.78	45.00***				
Intercepts				1	409.20	7331.71	<.001
Treatment Group				2	414.44	7.86	<.001
Diagnosis				5	404.39	2.06	.07
Time				3	793.42	5.54	.001
Model 6	77	7995.35	111.43***				
Intercepts				1	430.75	6522.62	<.001
Treatment Group				2	428.17	3.75	.02
Diagnosis				5	432.47	1.91	.09
Time				3	290.86	3.46	.02
Treatment Group X Diagnosis X Time				60	433.32	1.54	.01

*$p < .05$; **$p < .01$; ***$p < .001$; †Model 2, Model 3, Model 4, and Model 5 are each compared to Model 1 whereas Model 6 is compared to Model 5.

Table A-10 MPS MLM Comparisons

	Total Parameters	-2LL	Model Difference†	Numerator df	Denominator df	*F*	*p*
Model 1	3	3196.52					
Intercepts				1	418.66	4461.19	<.001
Model 2	5	3193.00	3.52				
Intercepts				1	417.05	4459.17	<.001
Treatment Group				2	417.16	1.76	.17
Model 3	8	3184.80	11.72*				
Intercepts				1	415.75	1921.85	<.001
Diagnosis				5	416.76	2.37	.04
Model 4	10	3099.60	96.92***				
Intercepts				1	429.98	3847.02	<.001
Time				3	249.04	15.30	<.001
Model 5	13	3121.20	75.32***				
Intercepts				1	430.88	1795.86	<.001
Treatment Group				2	422.00	1.19	.30
Diagnosis				5	417.88	2.63	.02
Time				3	704.19	21.01	<.001
Model 6	76	3003.94	117.26***				
Intercepts				1	456.64	1673.65	<.001
Treatment Group				2	455.47	1.67	.19
Diagnosis				5	451.15	3.11	.01
Time				3	293.48	5.63	.001
Treatment Group X Diagnosis X Time				59	398.51	1.41	.03

*$p < .05$; **$p < .01$; ***$p < .001$; †Model 2, Model 3, Model 4, and Model 5 are each compared to Model 1 whereas Model 6 is compared to Model 5.

Table A-11 BD MLM Comparisons

	Total Parameters	-2LL	Model Difference†	Numerator df	Denominator df	*F*	*p*
Model 1	3	8451.01					
Intercepts				1	413.84	581.37	<.001
Model 2	5	8448.52	2.49				
Intercepts				1	411.78	581.35	<.001
Treatment Group				2	411.84	1.25	.29
Model 3	8	8436.99	14.02*				
Intercepts				1	412.37	285.11	<.001
Diagnosis				5	413.06	2.84	.02
Model 4	11	8324.93	126.08***				
Intercepts				1	407.02	486.26	<.001
Time				3	212.73	24.64	<.001
Model 5	13	8349.29	101.72***				
Intercepts				1	428.21	241.26	<.001
Treatment Group				2	418.19	1.26	.28
Diagnosis				5	413.80	3.46	.004
Time				3	709.63	29.80	<.001
Model 6	76	8243.98	105.31***				
Intercepts				1	440.58	257.77	<.001
Treatment Group				2	440.03	3.59	.03
Diagnosis				5	432.80	4.22	.001
Time				3	339.84	10.45	<.001
Treatment Group X Diagnosis X Time				59	429.96	1.10	.29

*$p < .05$; **$p < .01$; ***$p < .001$; †Model 2, Model 3, Model 4, and Model 5 are each compared to Model 1 whereas Model 6 is compared to Model 5.

Appendix B

MLM Comparisons for Exploratory Analyses

Table B-1 Total Post-Intervention Health Care Utilization MLM Comparison

	Total Parameters	-2LL	Model Difference†	Numerator df	Denominator df	*F*	*p*
Model 1	3	7858.63					
Intercept				1	386.50	479.61	<.001
Model 2	5	7848.26	10.37**				
Intercept				1	384.22	498.74	<.001
Treatment Group				2	383.17	5.28	.01
Model 3	8	7855.06	3.57				
Intercept				1	354.88	180.44	<.001
Diagnosis				5	370.86	.72	.61
Model 4	11	7801.05	57.58***				
Intercept				1	329.35	448.09	<.001
Time				3	304.97	6.81	<.001
Model 5	13	7831.01	27.62**				
Intercept				1	370.51	187.08	<.001
Treatment Group				2	391.55	4.59	.01
Diagnosis				5	370.26	.37	.87
Time				3	886.56	5.16	.002
Model 6	77	7730.27	100.74**				
Intercept				1	429.18	144.64	<.001
Treatment Group				2	427.97	1.42	.24
Diagnosis				5	407.65	.53	.76
Time				3	308.55	3.12	.03
Treatment Group X Diagnosis X Time				60	495.63	.96	.56

*$p < .05$; **$p < .01$; ***$p < .001$; †Model 2, Model 3, Model 4, and Model 5 are each compared to Model 1 whereas Model 6 is compared to Model 5.

Table B-2 Post-Intervention Health Care Utilization Related to TMJMD MLM Comparisons

	Total Parameters	-2LL	Model Difference†	Numerator df	Denominator df	*F*	*p*
Model 1	3	6486.37					
Intercept				1	379.04	192.25	<.001
Model 2	5	6468.93	17.44***				
Intercept				1	382.62	201.19	<.001
Treatment Group				2	381.49	8.86	<.001
Model 3	8	6477.41	8.96	1	347.76	66.46	<.001
Intercept				5	362.92	1.82	.11
Diagnosis							
Model 4	10	6326.40	159.97***				
Intercept				1	384.00	150.90	<.001
Time				3	349.58	21.79	<.001
Model 5	13	6401.18	85.19***				
Intercept				1	371.81	50.37	<.001
Treatment Group				2	390.37	4.59	.01
Diagnosis				5	370.34	.88	.49
Time				3	868.32	21.98	<.001
Model 6	77	6269.27	131.91***				
Intercept				1	436.67	46.51	<.001
Treatment Group				2	435.55	2.82	.06
Diagnosis				5	421.64	1.10	.36
Time				3	336.34	8.51	<.001
Treatment Group X Diagnosis X Time				60	507.06	.71	.95

*$p < .05$; **$p < .01$; ***$p < .001$; †Model 2, Model 3, Model 4, and Model 5 are each compared to Model 1 whereas Model 6 is compared to Model 5

Table B-3 Post-Intervention Health Care Utilization Unrelated to TMJMD MLM Comparisons

	Total Parameters	-2LL	Model Difference†	Numerator df	Denominator df	*F*	*p*
Model 1	3	7555.28					
Intercept				1	364.67	295.07	<.001
Model 2	5	7553.56	1.72				
Intercept				1	363.46	298.75	<.001
Treatment Group				2	362.46	.87	.42
Model 3	8	7552.28	3.00				
Intercept				1	328.75	116.89	<.001
Diagnosis				5	346.34	.60	.70
Model 4	10	7474.74	80.54***				
Intercept				1	359.52	310.88	<.001
Time				3	324.83	11.78	<.001
Model 5	13	7515.40	39.88***				
Intercept				1	349.42	135.49	<.001
Treatment Group				2	374.53	1.37	.26
Diagnosis				5	351.37	.64	.67
Time				3	887.43	11.96	<.001
Model 6	77	7405.03	110.37***				
Intercept				1	411.94	100.34	<.001
Treatment Group				2	410.84	.31	.74
Diagnosis				5	388.96	.73	.60
Time				3	306.43	4.06	.01
Treatment Group X Diagnosis X Time				60	493.63	1.08	.33

*$p < .05$; **$p < .01$; ***$p < .001$; †Model 2, Model 3, Model 4, and Model 5 are each compared to Model 1 whereas Model 6 is compared to Model 5

Table B-4 Total Medications MLM Comparisons

	Total Parameters	-2LL	Model Difference†	Numerator df	Denominator df	*F*	*p*
Model 1	3	5402.18					
Intercept				1	434.70	599.73	<.001
Model 2	5	5401.37	.81				
Intercept				1	433.36	599.39	<.001
Treatment Group				2	433.32	.40	.67
Model 3	8	5399.74	2.44				
Intercept				1	417.86	235.73	<.001
Diagnosis				5	425.53	.49	.79
Model 4	10	5342.56	59.62***				
Intercept				1	445.13	519.14	<.001
Time				3	290.16	8.17	<.001
Model 5	13	5373.73	28.45**				
Intercept				1	433.14	210.87	<.001
Treatment Group				2	437.61	.52	.60
Diagnosis				5	426.39	.50	.78
Time				3	805.04	8.52	<.001
Model 6	77	5303.94	69.79				
Intercept				1	470.394	183.81	<.001
Treatment Group				2	467.461	1.05	.35
Diagnosis				5	466.804	.56	.73
Time				3	292.591	3.85	.01
Treatment Group X Diagnosis X Time				60	459.507	.61	.99

*$p < .05$; **$p < .01$; ***$p < .001$; †Model 2, Model 3, Model 4, and Model 5 are each compared to Model 1 whereas Model 6 is compared to Model 5

Table B-5 NSAIDs MLM Comparisons

	Total Parameters	-2LL	Model Difference†	Numerator df	Denominator df	*F*	*p*
Model 1	3	2457.81					
Intercept				1	405.28	492.94	<.001
Model 2	5	2448.55	9.26**				
Intercept				1	403.87	496.49	<.001
Treatment Group				2	403.42	4.68	.01
Model 3	8	2443.31	14.50*				
Intercept				1	384.65	215.89	<.001
Diagnosis				5	394.63	2.94	.01
Model 4	10	2426.23	31.58***				
Intercept				1	393.29	434.74	<.001
Time				3	292.93	4.38	.01
Model 5	13	2421.96	38.58***				
Intercept				1	403.03	196.96	<.001
Treatment Group				2	410.88	3.39	.04
Diagnosis				5	395.47	2.87	.02
Time				3	843.27	4.38	.01
Model 6	77	2338.42	83.54				
Intercept				1	421.58	182.23	<.001
Treatment Group				2	419.93	.07	.94
Diagnosis				5	412.71	3.08	.01
Time				3	287.18	1.93	.13
Treatment Group X Diagnosis X Time				60	505.27	1.13	.24

*p < .05; **p < .01; ***p < .001; †Model 2, Model 3, Model 4, and Model 5 are each compared to Model 1 whereas Model 6 is compared to Model 5

Table B-6 Muscle Relaxants MLM Comparisons

	Total Parameters	-2LL	Model Difference†	Numerator df	Denominator df	*F*	*p*
Model 1	3	1303.04					
Intercept				1	375.83	131.28	<.001
Model 2	5	1297.74	5.30				
Intercept				1	374.75	132.60	<.001
Treatment Group				2	374.29	2.67	.07
Model 3	8	1289.28	13.76*				
Intercept				1	357.85	43.93	<.001
Diagnosis				5	367.57	2.78	.02
Model 4	10	1179.36	123.68***				
Intercept				1	366.58	114.58	<.001
Time				3	393.63	10.06	<.001
Model 5	13	1251.92	51.12***				
Intercept				1	378.32	31.05	<.001
Treatment Group				2	385.86	.52	.60
Diagnosis				5	371.00	2.05	.07
Time				3	819.03	12.10	<.001
Model 6	77	1119.55	132.37***				
Intercept				1	394.97	32.72	<.001
Treatment Group				2	395.76	.73	.48
Diagnosis				5	381.64	1.68	.14
Time				3	374.32	4.00	.01
Treatment Group X Diagnosis X Time				60	508.59	.83	.81

*$p < .05$; **$p < .01$; ***$p < .001$; †Model 2, Model 3, Model 4, and Model 5 are each compared to Model 1 whereas Model 6 is compared to Model 5

Table B-7 Opiods MLM Comparisons

	Total Parameters	-2LL	Model Difference†	Numerator df	Denominator df	*F*	*p*
Model 1	3	346.31					
Intercept				1	335.70	60.36	<.001
Model 2	5	336.21	10.1**				
Intercept				1	331.89	61.83	<.001
Treatment Group				2	331.62	5.12	.01
Model 3	8	334.87	11.44*				
Intercept				1	316.77	17.37	<.001
Diagnosis				5	325.05	2.31	.04
Model 4	10	279.41	66.9***				
Intercept				1	325.90	53.48	<.001
Time				3	341.90	3.47	.02
Model 5	13	319.67	26.64**				
Intercept				1	332.03	14.90	<.001
Treatment Group				2	338.15	2.43	.09
Diagnosis				5	325.31	1.35	.24
Time				3	749.66	3.20	.02
Model 6	77	212.46	107.21***				
Intercept				1	350.64	13.19	<.001
Treatment Group				2	351.85	.89	.41
Diagnosis				5	338.99	1.69	.14
Time				3	331.80	.83	.48
Treatment Group X Diagnosis X Time				60	502.68	.85	.78

*$p < .05$; **$p < .01$; ***$p < .001$; †Model 2, Model 3, Model 4, and Model 5 are each compared to Model 1 whereas Model 6 is compared to Model 5

Table B-8 Medications in Other Category MLM Comparisons

	Total Parameters	-2LL	Model Difference†	Numerator df	Denominator df	*F*	*p*
Model 1	3	4998.76					
Intercept				1	433.95	266.87	<.001
Model 2	5	4995.25	3.51				
Intercept				1	432.55	270.85	<.001
Treatment Group				2	432.45	1.76	.17
Model 3	8	4998.01	.75	1	415.35	109.78	<.001
Intercept				5	423.54	.15	.98
Diagnosis							
Model 4	10	4949.99	48.77***				
Intercept				1	424.71	248.85	<.001
Time				3	330.41	2.89	.04
Model 5	13	4985.22	13.54				
Intercept				1	430.92	98.81	<.001
Treatment Group				2	436.06	2.01	.14
Diagnosis				5	423.82	.15	.98
Time				3	814.03	3.10	.03
Model 6	77	4913.93	84.83				
Intercept				1	454.07	90.99	<.001
Treatment Group				2	452.71	1.35	.26
Diagnosis				5	446.16	.10	.99
Time				3	338.11	2.14	.10
Treatment Group X Diagnosis X Time				60	504.17	.55	1.00

*p < .05; **p < .01; ***p < .001; †Model 2, Model 3, Model 4, Model 5, and Model 6 are each compared to Model 1

Table B-9 Anxiolytics MLM Comparisons

	Total Parameters	-2LL	Model Difference†	Numerator df	Denominator df	*F*	*p*
Model 1	3	489.36					
Intercept				1	389.85	51.63	<.001
Model 2	5	489.33	.03				
Intercept				1	388.66	51.36	<.001
Treatment Group				2	388.27	.02	.98
Model 3	8	486.44	2.92				
Intercept				1	367.66	20.86	<.001
Diagnosis				5	377.23	.58	.71
Model 4	10	459.87	29.49***				
Intercept				1	432.90	45.99	<.001
Time				3	260.04	.49	.69
Model 5	13	484.89	4.47				
Intercept				1	386.01	20.56	<.001
Treatment Group				2	393.39	.001	1.00
Diagnosis				5	378.61	.58	.71
Time				3	821.07	.52	.67
Model 6	77	409.28	80.08				
Intercept				1	465.88	13.07	<.001
Treatment Group				2	462.13	.12	.89
Diagnosis				5	455.83	.41	.84
Time				3	256.40	.34	.80
Treatment Group X Diagnosis X Time				60	430.80	.80	.85

*p < .05; **p < .01; ***p < .001; †Model 2, Model 3, Model 4, Model 5, and Model 6 are each compared to Model 1

Table B-10 Sedatives MLM Comparisons

	Total Parameters	-2LL	Model Difference†	Numerator df	Denominator df	*F*	*p*
Model 1	3	413.94					
Intercept				1	402.29	64.37	<.001
Model 2	5	413.41	.53				
Intercept				1	401.66	64.93	<.001
Treatment Group				2	401.29	.26	.77
Model 3	8	409.55	4.39				
Intercept				1	380.99	26.70	<.001
Diagnosis				5	390.57	.88	.49
Model 4	10	388.35	25.59***				
Intercept				1	404.79	60.44	<.001
Time				3	282.09	.73	.54
Model 5	13	406.97	6.97				
Intercept				1	399.43	28.19	<.001
Treatment Group				2	406.65	.35	.71
Diagnosis				5	391.93	.92	.47
Time				3	827.60	.61	.61
Model 6	77	333.48	80.46				
Intercept				1	425.02	20.41	<.001
Treatment Group				2	419.95	.32	.72
Diagnosis				5	421.61	1.18	.32
Time				3	268.68	.95	.42
Treatment Group X Diagnosis X Time				60	431.24	.84	.80

*p < .05; **p < .01; ***p < .001; †Model 2, Model 3, Model 4, Model 5, and Model 6 are each compared to Model 1

Table B-11 Antidepressants MLM Comparisons

	Total Parameters	-2LL	Model Difference†	Numerator df	Denominator df	*F*	*p*
Model 1	3	1202.89					
Intercept				1	430.59	115.05	<.001
Model 2	5	1200.12	2.77				
Intercept				1	429.34	114.97	<.001
Treatment Group				2	429.45	1.39	.25
Model 3	8	1200.04	2.85				
Intercept				1	419.70	37.62	<.001
Diagnosis				5	.57	.57	.72
Model 4	10	1188.01	14.88*				
Intercept				1	448.08	104.32	<.001
Time				3	246.26	.42	.74
Model 5	13	1195.50	7.39				
Intercept				1	430.21	37.80	<.001
Treatment Group				2	432.50	1.54	.22
Diagnosis				5	425.27	.67	.65
Time				3	768.82	.45	.72
Model 6	77	1128.29	74.6				
Intercept				1	459.40	33.79	<.001
Treatment Group				2	456.77	.18	.83
Diagnosis				5	461.90	.42	.84
Time				3	251.01	.38	.77
Treatment Group X Diagnosis X Time				60	373.29	.91	.66

*p < .05; **p < .01; ***p < .001; †Model 2, Model 3, Model 4, Model 5, and Model 6 are each compared to Model 1

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Celeste Sanders was a graduate teaching assistant at the University of Texas at Arlington (UTA), where she worked on research regarding acute Temporomandibular Joint and Muscle Disorders (TMJMDs). Her research interests consisted of the psychological basis of physiological processes.

Celeste received her Bachelor of Arts in Psychology from Louisiana Tech University in 2011, and, from UTA, she received her Master of Science in Psychology in 2013 as well as her Doctor of Philosophy in Psychology in 2015. She plans to utilize her expertise in a health career for the public sector while excelling in poetry and music production.