PAIN
REPORTS®

Optimizing resilience in orofacial pain: a randomized controlled pilot study on hope

Emily J. Bartley[a,b,*], Natalie R. LaGattuta[c], Michael E. Robinson[d,b,e], Roger B. Fillingim[a,b]

Abstract

Introduction: Over recent years, there has been growing interest in the role of positive, psychological resources that promote resilience and optimal functioning in chronic pain. Although multiple factors comprise resilience, hope is a strength-based motivational state known to contribute to positive psychosocial adjustment and adaptive pain coping. Emerging evidence supports the viability of therapeutic approaches that foster resilience; however, interventions designed to target hope in the context of pain have been remarkably understudied.

Objectives: The objectives of this pilot study were to test the feasibility and preliminary efficacy of a resilience-oriented hope intervention for clinical pain, as well as psychosocial outcomes and experimental pain sensitivity in individuals with orofacial pain.

Methods: Twenty-nine participants with temporomandibular disorder were randomized to a 3-session intervention intended to increase hope or a control intervention (EDU) involving education about pain and stress. Before and after the intervention, participants attended 2 laboratory sessions whereby they completed psychosocial questionnaires and sensitivity to heat, cold, and pressure pain was assessed. Hope was measured using the Adult State Hope Scale.

Results: Compared with EDU, the Hope group exhibited an increase in state hope, lower heat pain sensitivity, higher pressure pain thresholds at the temporomandibular joint, and reductions in pain catastrophizing.

Conclusion: Although preliminary, results suggest that a resilience-based hope intervention may be beneficial in reducing pain sensitivity and catastrophizing and could serve as a target for pain management.

Keywords: Pain, Hope, Resilience, TMD, Quantitative sensory testing, Pain catastrophizing

1. Introduction

Temporomandibular disorder (TMD) is a complex orofacial condition characterized by pain and dysfunction in the masticatory muscles and temporomandibular joint (TMJ). It is estimated that 5% to 12% of the population has TMD, with patients

Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

[a] Department of Community Dentistry and Behavioral Science, University of Florida, Gainesville, FL, USA, [b] Pain Research and Intervention Center of Excellence (PRICE), University of Florida, Gainesville, FL, USA, [c] Hubert Department of Global Health, Rollins School of Public Health, Emory University, Atlanta, GA, USA, [d] Department of Clinical and Health Psychology, University of Florida, Gainesville, FL, USA, [e] Center for Pain Research and Behavioral Health, University of Florida, Gainesville, FL, USA

Corresponding author. Address: Pain Research and Intervention Center of Excellence, College of Dentistry, University of Florida, 1329 SW 16th St, Suite 5192, Gainesville, FL 32610. Tel.: 352-273-8934. E-mail address: EBartley@dental.ufl.edu (E.J. Bartley).

experiencing increased psychological comorbidity.[8,26] Although a number of biomedical interventions exist for TMD, most are costly and invasive (eg, pharmacotherapy, orthopedic splints, occlusal adjustment, and surgery) and often provide insufficient long-term improvement in pain.[28]

Historically, the assessment and management of pain has targeted maladaptive processes (eg, fear avoidance and catastrophizing) that predispose individuals to adverse pain outcomes. Counterbalancing this movement has been the burgeoning of studies over recent years exploring resilience factors that mitigate these effects and promote pain adaptation. Broadly, resilience is the capacity to recover from or respond effectively to adversity. In the context of pain, resilience has been modeled as a dynamic interplay between dispositional resources (eg, trait optimism) and time-varying mechanisms (eg, positive social interactions) that influence pain coping to facilitate recovery, sustainability, and growth.[34,35] Although research on resilience factors in TMD is relatively scarce, studies support the protective role that optimism and self-efficacy have on facial pain,[30] ischemic pain sensitivity,[5] coping strategies, and physical and psychological functioning in this population.[4]

Interventions built on bolstering pain resilience are equally under-represented in the literature, although evidence from several recent studies establishes their viability in the management of pain. For instance, interventions targeting humor[37] and social support[12] demonstrate positive effects on pain severity and

interference, as well as psychological and social functioning. Likewise, benefits to pain-related outcomes have emerged from positive activity interventions (eg, gratitude, savoring, and optimism engagement) for individuals with low-back pain,[9] chronic pain secondary to physical disability (ie, spinal cord injury, multiple sclerosis, neuromuscular disease, and postpolio syndrome),[23] bodily pain,[16] and osteoarthritis.[17,25]

Although many factors underlie resilience, hope has been identified as an important contributor to adaptive pain coping. A fundamental tenet of this construct is that human behavior is goal-directed in nature, and hopeful thinking relies on the perceived ability to generate routes to goals (ie, pathways) and the mobilization of efforts to achieve these pathways (ie, agency).[31,32] Based on Snyder's cognitive theory of hope,[31] goal-oriented cognitions may modify the experience of pain and psychological function by augmenting appetitive reward systems and enhancing behavioral engagement in adaptive coping tactics that reduce pain-related disability and suffering. Although evidence suggests that increasing hope may be a promising target for pain intervention,[3,18] it is unclear whether these effects can be translated to individuals with orofacial pain. Therefore, the primary aims of this pilot study were to develop a brief, hope intervention and examine its feasibility and preliminary efficacy on clinical pain and state hope. We also explored treatment effects on secondary outcomes, including sensory pain measures and several psychological outcomes (ie, affect, depression, pain acceptance, self-efficacy, and catastrophizing) known to be associated with chronic pain.[7]

2. Methods

2.1. Participants

Individuals with TMD were recruited from the community through flyers and radio advertisement from September 2014 to January 2016. Participants were included if they reported moderate orofacial pain (≥3/10) during the preceding 3 months, occurring on at least 15 days during the past month. Participants were excluded for age <18 or >65; use of narcotic analgesics; use of nonsteroidal anti-inflammatory medications 24 hours before pain testing sessions; current cardiovascular, neuroendocrine, neurological disorders; or cognitive impairment.

2.2. Procedure

All procedures were approved by the University of Florida Institutional Review Board, and participants provided written informed consent before enrollment (clintrials.gov NCT02164630). Study procedures involved 5 weekly visits at the UF Clinical Research Center involving sensory pain testing and intervention sessions. Initially, participants were evaluated for inclusion and exclusion criteria through a brief telephone screen. If eligible, participants attended a laboratory session whereby health history and demographic information were attained, psychosocial questionnaires were completed, and a clinical examination (RDC/TMD examination) and sensory pain testing were conducted. Classification of TMD was based on Research Diagnostic Criteria[27] and involved the application of pressure to the orofacial region (ie, temporalis, masseter, posterior mandibular, submandibular, and TMJ) and the assessment of movement-evoked jaw pain by a trained examiner. For study inclusion, participants were required to report pain in at least one TMJ or one orofacial muscle in response to standardized jaw movements or facial palpation.

Before sensory testing, participants received audio instructions for pain rating and were provided a 5-minute rest break to acclimate to the surroundings. Next, the following procedures were administered: heat pain tolerance, heat temporal summation, mechanical pressure pain threshold, punctate pressure pain, and cold pain tolerance. The order of heat and pressure testing was counterbalanced both within and across participants, and a 5-minute break was administered before cold pressor testing. After the first laboratory visit, participants underwent 3 weekly intervention sessions (visits 2–4), and sensory pain testing was repeated during the final visit (visit 5). Approximately 1 week before visit 2 and visit 5, participants completed a daily paper diary for 7 days just before bedtime reporting on their average facial pain intensity and interference for the day. Weekly diaries were returned at the following clinic visit. A $200 honorarium was provided after study completion.

2.3. Measures

Measures of pain/disability (Graded Chronic Pain Scale) and dispositional hope (Adult Dispositional Hope Scale) were administered at preintervention. All other measures of clinical pain and psychological functioning were completed at both preintervention and postintervention. Cronbach's alphas for all measures were in the acceptable to excellent range (α's 0.65–0.91).

2.3.1. Graded Chronic Pain Scale

The 7-item Graded Chronic Pain Scale[38] assesses current, worst, and average facial pain over the past 6 months (characteristic pain intensity score) and the degree to which TMD pain interferes with daily activities (disability score). Items were averaged and multiplied by 10 to generate index scores for pain intensity and disability, with higher scores indicating greater symptomatology.

2.3.2. Adult Dispositional Hope Scale

The 12-item Adult Dispositional Hope Scale[32] measures dispositional hope and consists of 4 pathways (eg, "Even when others get discouraged, I know I can find a way to solve the problem"), 4 agency (eg, "I energetically pursue my goals"), and 4 distracter items. Subscale scores and a total score are derived (range: 8–64).

2.4. Primary outcomes

2.4.1. Daily facial pain

Facial pain intensity and facial pain interference for general activities were reported for a 7-day period immediately after the first and fourth visits using 2 separate paper-based 0 to 100 numerical rating scales (intensity: 0 = no facial pain, 100 = most intense facial pain imaginable; interference: 0 = no facial pain interference, 100 = extreme facial pain interference). Participants were asked to complete diaries at night to provide an average daily symptom level.

2.4.2. Adult State Hope Scale

The 6-item Adult State Hope Scale[33] was administered to assess goal-directed thinking at a given moment in time. It consists of 3 pathways (eg, "I can think of many ways to reach my current goals") and 3 agency (eg, "At this time, I am meeting the goals that I have set for myself") items. Pathways and agency subscale scores are derived, including a total score (range: 6–48) consisting of a sum of these 2 subscales.

2.5. Secondary outcomes

2.5.1. Pain measures

2.5.1.1. Numerical pain rating scale

During each sensory pain testing session, participants verbally rated pain intensity using a 0 to 100 numerical rating scale (0 = no pain, 100 = most intense pain imaginable).

2.5.1.2. Heat pain

Heat stimuli were delivered to 3 areas on the medial aspect of the dorsal forearm using a computer-controlled device (Medoc Pathway Thermal Sensory Analyzer). Using an ascending method of limits and starting at 32°C, temperature increased at a rate of 0.5°C/s (maximum 52°C) until participants could no longer tolerate the pain. Participants provided their response by pressing a computer mouse button. Pain tolerance was calculated by averaging the temperature ratings from the 3 heat trials.

2.5.1.3. Temporal summation of heat pain

Participants verbally rated (0–100 scale) the intensity of pain evoked after 5 repetitive suprathreshold heat pulses. Two target temperatures (46 and 48°C) were delivered by a contact heat-evoked potential stimulator for less than 1 second, with a 2.5-second interpulse interval, during which the temperature of the contactor returned to baseline (32°C). Temporal summation of heat pain (Δ) was calculated by subtracting the first trial rating from the last rating provided during the series of 5 trials.

2.5.1.4. Mechanical pressure pain

A computerized algometer (Algomed; Medoc, Ramat Yishai, Israel) was used to test pressure pain threshold bilaterally on 6 body sites (temporalis, masseter, TMJ, trapezius, epicondyle, and tibialis anterior) with the order counterbalanced across participants. Pressure was delivered at a constant rate of 30 kilopascals (kPa) per second until the participant first reported pain by clicking a button (max = 1,000 kPa). This procedure was discontinued when 2 consecutive trials of ≤20 kPa difference were obtained (5 trials max per site). Pressure pain threshold was calculated by averaging the trials for each site.

2.5.1.5. Punctate pain

Three trials of punctate stimuli were delivered to the medial segment of the third finger using a weighted probe (512 mN). First, a single stimulus was delivered, and the participant provided a rating of pain intensity. Then, 10 consecutive stimuli (1-second intertrial interval) were delivered, and the participant provided an average pain rating of the 10 stimuli. Pain ratings for the 3 trials of each procedure were averaged.

2.5.1.6. Cold pain

Participants immersed their dominant hand in a 5°C cold water bath (Neslab refrigeration unit). The time (in seconds) until the participant could no longer tolerate the cold pain (tolerance) was measured (3-minute max immersion).

2.5.2. Psychological measures

2.5.2.1. Positive and Negative Affect Schedule

The 20-item Positive and Negative Affect Schedule[39] assesses positive affect and negative affect, with subscale scores ranging from 10 to 50. Respondents were asked to report on their feelings and emotions at the present moment.

2.5.2.2. Center for Epidemiological Studies–Depression Scale

The Center for Epidemiological Studies–Depression Scale[1] is a 20-item questionnaire measuring depressive symptomatology. Scores range from 0 to 60, with higher scores indicating greater depressive symptoms.

2.5.2.3. Chronic Pain Acceptance Questionnaire

The Chronic Pain Acceptance Questionnaire[21] consists of 20 items measuring acceptance of pain and has 2 subscales: activity engagement (participation in life activities) and pain willingness (disengaging from pain avoidance and control). The total score ranges from 0 to 120, with higher scores reflecting greater pain acceptance.

2.5.2.4. Pain Self-Efficacy Questionnaire

The 10-item Pain Self-Efficacy Questionnaire[24] assesses a person's belief in their ability to accomplish and enjoy activities despite their pain (eg, household chores and socialize). Respondents rate their level of confidence to undertake each activity. Scores range from 0 to 60, with higher scores denoting stronger self-efficacy beliefs.

2.5.2.5. Pain Catastrophizing Scale

The 13-item Pain Catastrophizing Scale (PCS)[36] measures catastrophic thinking about pain, including magnification (exaggeration of perceived pain-related threat), rumination (tendency to focus on pain), and helplessness (perceived inability to cope with pain). Scores range from 0 to 52. The PCS was administered immediately after cold pain testing to assess situation-specific catastrophizing.

2.6. Intervention protocol

Participants were seen once weekly for 3 sessions and were randomly assigned by the PI following simple randomization procedures (accounting for equal distribution of men and women across groups). They were informed that they had a 50% chance of being allocated to one of the interventions, and that the purpose of the study was to test a new self-management treatment for TMD pain. Using a manualized protocol, both interventions were conducted in-person using an individual-based format and facilitated by a postdoctoral fellow (E.J.B.) with experience in chronic pain treatment. Research assistants who conducted the sensory pain testing sessions were blinded to group assignment, and participants were instructed to refrain from discussing the content of their intervention sessions with examiners.

Hope intervention content was informed by Snyder's cognitive theory of hope[31,32] and targeted: (1) goal pursuit; (2) pathways thinking; and (3) agency. Given the multidimensionality of hope,[19] intervention content also incorporated components deemed important to the construct including positive thinking, self-efficacy, character strengths, and values-based action. Skill-building activities were conducted during each session and at home to facilitate hopeful thinking and goal-directed behavior. To verify homework completion, participants were asked to return activity worksheets during their subsequent visit. Individuals assigned to the pain education group (EDU) received a format similar to the hope group

focusing on pain education; however, skill-building activities related to the content were not included. **Table 1** provides details regarding the intervention protocol.

2.7. Statistical analysis

Because of the feasibility nature of the study, formal sample size calculations were not conducted; however, 30 people were targeted for recruitment. Before data analysis, data were checked for normality, outliers, and missing values. The intervention groups were compared on demographic and clinical characteristics using chi-square and independent sample t tests. A series of repeated-measures analyses of variance were conducted to assess the effects of the 2 interventions on each dependent variable (ie, clinical pain, psychological variables, and sensory pain outcomes). To obtain effect size estimates, partial eta-squared (η_p^2) was calculated from generalized linear model analyses (small = 0.01, medium = 0.06, and large = 0.14). Significance was set at $P \leq 0.05$.

3. Results

3.1. Recruitment and adherence

The consort diagram represents participant flow through the study (**Figure 1**). Among the 73 participants who completed the initial screening, 27 did not meet inclusion criteria, 8 declined to participate, and 3 scheduled individuals failed to attend visit 1. Thirty-five people were eligible; however, 2 participants dropped out before randomization because of time commitment and exacerbation of

TMD pain. Of the 33 randomized participants, one participant discontinued in the Hope group (ie, moved), and 3 discontinued in the EDU group (1 moved, 2 lost to contact) before study completion, leaving 29 completers (Hope group, N = 15). Baseline characteristics did not differ between dropouts and completers.

3.2. Baseline characteristics

There were no group differences in any of the demographic or clinical variables, and session duration was comparable between the 2 groups (**Table 2**). In addition, there were no significant differences across groups at preintervention for measures of pain, quantitative sensory testing, and psychological functioning (P's > 0.05). Participants were mainly female, white/Caucasian, unmarried, employed either full- or part-time and had a high level of education. The average age of the sample was 39 years (range = 19–62 years), and the mean duration of TMD pain was 9.7 years (range = 0.25–30 years). One person failed to complete their postintervention diary; however, the remaining 28 participants completed 100% of their daily recordings. Adherence to homework was high, with a 100% completion rate among participants in the Hope group.

3.3. Primary outcomes

For facial pain, the main effect of time for pain intensity approached significance (P = 0.06), with lower levels of clinical pain reported at postintervention. There were no significant effects observed for pain interference (**Table 3**). As shown in **Table 4**, the group X time interaction for state hope approached significance (P = 0.06), suggesting that participants in the Hope

---

Table 1

Overview of the intervention modules.

Hope intervention
  Session 1: hope and goal setting
    Defining hope and its core components (ie, goals, pathways, and agency)
    Discussion on effective goal setting using S.M.A.R.T. goals[6] (goals should be specific, measurable, achievable, realistic, and time-bound)
    Introduction to life domains assessment, including developing goals based upon highly-valued activities
  Home practice
    Complete life domains assessment and rate each domain across its level of importance and how satisfied you are with that part of your life; designate a personal goal you
      would like to achieve using the S.M.A.R.T. goal framework.
  Session 2: pathways thinking
    Instruction on building pathways thinking (ie, dividing goals into smaller, manageable steps; seeking support for goal attainment; learning fundamental skills to achieve
      desired goals; monitor goal feasibility; and alter goals when necessary)
    Discussion on the importance of self-talk when goal setting and using statements that are positive and hope-inducing
    Adopting a strengths perspective and identifying personal attributes that facilitate goal attainment
  Home practice.
    Identify routes to achieve personal goal and solutions to obstacles that may prevent goal attainment; list personal strengths and sources of resilience; hope-building exercise
      (identify areas of hope in your life or things that inspire hope)
  Session 3: agency
    Instruction on building agency through visualization of goals
    Goal-focused imagery exercise (in-session practice using imagery to envision successful goal attainment)
    Review of hope-building exercise and activities that inspire hopeful thinking
    Discussion of how hope can improve methods of pain management

Pain education intervention
  Session 1: introduction
    Education on TMD etiology and symptomatology and common treatment approaches for pain
    Gate-control theory of pain, including factors that open and close the gate
    Biopsychosocial model of pain, which emphasizes the interaction between biological, psychological, and social factors in pain
  Session 2: stress and pain
    Defining stress, including ways in which stress can be positive or negative
    Education on the stress response and physical, cognitive, and emotional symptoms of stress
    Identification of internal and external stress triggers
    Discussion on the relationship between stress and pain
  Session 3: lifestyle management of pain
    Education on sleep hygiene, including the importance of sleep and sleep-incompatible behaviors
    Discussion on the benefits of physical activity for pain
    Mood changes associated with pain and identifying ways in which to calm the mind

TMD, temporomandibular disorder.
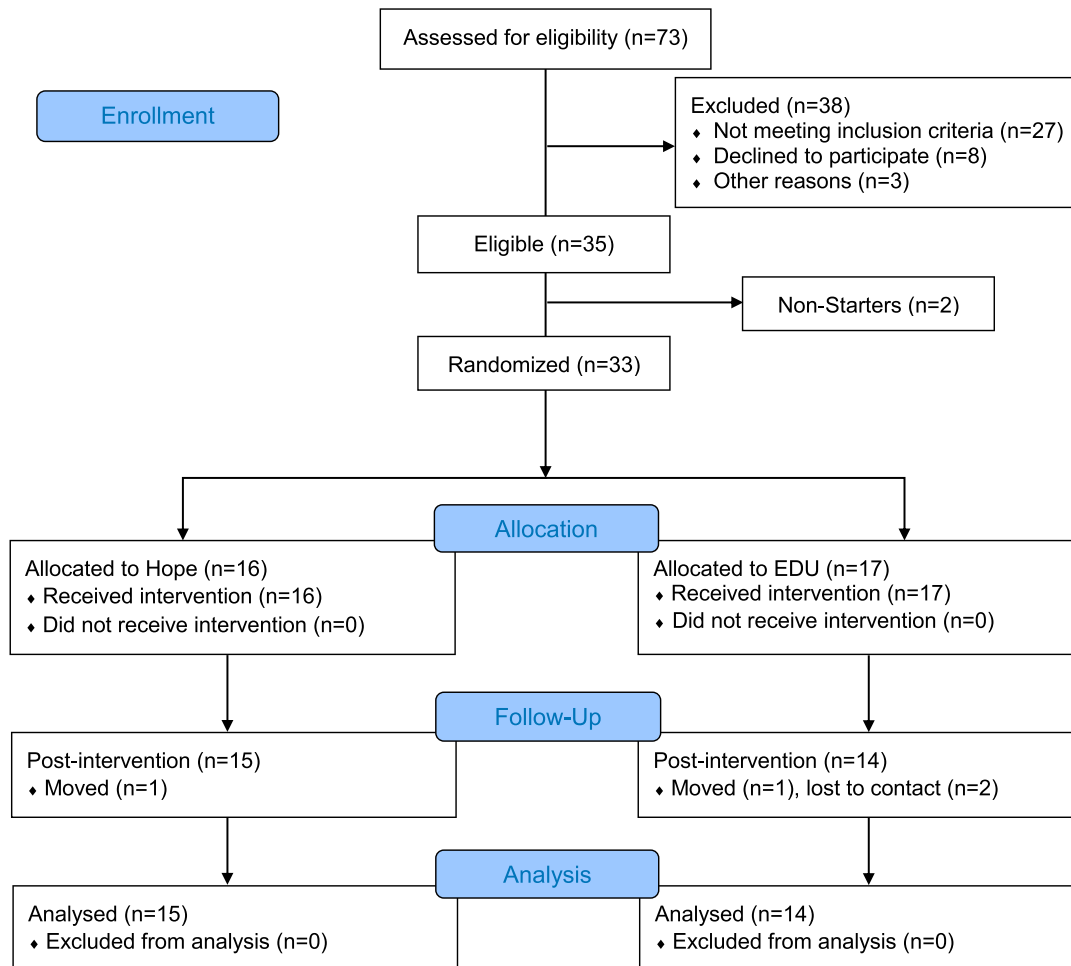
CONSORT 2010 Flow Diagram

Figure 1. Participant flow through the study.

intervention had a greater increase in state hope than the EDU group from preintervention to postintervention ($P = 0.06$). Similarly, there was a significant difference in pathways thinking across groups ($P = 0.03$), such that individuals in the Hope intervention had greater increases in pathways at postintervention than participants in EDU ($P = 0.03$). No significant effects were found for agency.

3.4. Secondary outcomes

3.4.1. Pain measures

The main effect of group was nonsignificant for all pain outcomes. For the main effect of time, cold pain tolerance ($P = 0.03$) and mechanical pressure thresholds at the temporalis ($P = 0.01$), masseter ($P = 0.001$), TMJ ($P = 0.005$), and trapezius ($P = 0.03$) increased from pre-testing to post-testing in both intervention groups. The group X time interaction for TMJ pain thresholds approached significance ($P = 0.07$), suggesting that the

decrease in TMJ mechanical pain sensitivity was larger for the Hope group than EDU ($P < 0.01$). In addition, the group X time interaction for heat tolerance was significant ($P = 0.01$), signifying that the Hope group exhibited a greater increase in heat pain tolerance from preintervention to postintervention ($P = 0.06$), compared with EDU (**Table 3**).

3.4.2. Psychological measures

For pain acceptance, the main effect of group ($P = 0.10$) and the group X time interaction ($P = 0.09$) for the activity engagement subscale approached significance. Specifically, the Hope group had greater increases in activity engagement from preintervention to postintervention than EDU ($P = 0.05$). The interaction for pain willingness was statistically significant ($P = 0.02$), with a greater increase observed over time in the EDU group ($P = 0.03$). There was also a significant time effect for the rumination subscale ($P = 0.02$) of the PCS, and the group X time interactions for the total score ($P = 0.09$) and the

Demographic and clinical characteristics across intervention group.

Characteristic	Hope	EDU	Group comparison
	M (SD) or N	M (SD) or N	P
Age	38.1 (14.3)	39.7 (14.0)	0.77
Sex			0.92
Female	12	10	
Male	3	4	
Race			0.26
White/Caucasian	11	10	
Black/African American	4	2	
Other race	0	2	
Education			0.90
≤High-school degree	4	5	
College degree	11	9	
Income			0.79
0–$29,999	5	6	
$30,000–$59,999	7	5	
≥$60,000	3	2	
Marital status			0.36
Married	4	7	
Not married	11	7	
Employment			0.20
≥40 h weekly	3	7	
<40 h weekly	5	2	
Not employed	7	5	
Session duration (min)	62.2 (6.6)	61.6 (6.1)	0.82
Body mass index (kg/m^2)	25.0 (5.4)	25.4 (3.6)	0.84
TMD pain duration (y)	10.2 (10.8)	9.1 (11.1)	0.78
GCPS (0–100)			
Pain intensity	54.2 (14.8)	53.1 (18.2)	0.86
Disability	24.7 (26.2)	23.3 (23.0)	0.89
ADHS (8–64)	52.9 (5.3)	54.0 (6.5)	0.61
Pathways (4–32)	27.0 (3.5)	27.0 (3.7)	0.96
Agency (4–32)	25.9 (3.3)	26.9 (3.5)	0.41

EDU, pain education intervention; TMD, temporomandibular disorder; GCPS, Graded Chronic Pain Scale; ADHS, Adult Dispositional Hope Scale.

magnification subscale ($P = 0.09$) approached significance. Although both intervention groups exhibited a reduction in ruminative thinking across time, the Hope group demonstrated a greater decrease in total PCS ($P = 0.04$) and magnification ($P = 0.08$) scores from preintervention to postintervention. No other psychological outcomes produced significant findings (**Table 4**).

3.5. Exploratory analysis

Given the results for heat pain tolerance, TMJ pressure pain thresholds, pain catastrophizing, and activity engagement (from the Chronic Pain Acceptance Questionnaire), it is possible that hope may be a mechanism that is driving changes in these outcomes. To explore this, bivariate analyses were conducted to examine the relationship among residualized change scores in these constructs. Intercorrelations of residualized change scores revealed positive associations between hope with heat pain tolerance ($r = 0.37$, $P = 0.05$), TMJ pain thresholds ($r = 0.46$, $P = 0.01$), and activity engagement ($r = 0.42$, $P = 0.02$); however, the effects for pain catastrophizing were nonsignificant ($r = -0.01$, $P = 0.98$). This suggests that changes in hope may mediate changes in pain and psychological functioning. Larger, more adequately powered studies are needed to fully address this.

4. Discussion

Growing evidence suggests that resilience fosters positive pain-related responses including lower clinical pain and disability,[30] decreased experimental pain sensitivity,[5] and higher levels of psychological functioning.[4] However, interventions that bolster resilience in chronic pain are remarkably limited, particularly in individuals with TMD. Our findings suggest that a resilience-based intervention may be feasible for adults with orofacial pain, and the targeting of hope aligns with previous reviews highlighting the need for therapies that optimize resilience, as opposed to reducing vulnerabilities.[2,11,14] Despite the greater time demand for the Hope group due to weekly assignments, approximately 94% completed all study procedures, compared with 82% in the EDU intervention, suggesting that it was well received regardless of the additional burden.

To our knowledge, only 4 previous RCTs have examined the effects of a positive psychology intervention in patients with chronic pain.[15,17,23,25] Although 3 studies observed significant reductions in clinical pain from pre-treatment to post-treatment,[15,17,23] only one found that effects were stronger in the positive activity intervention compared with the active control group.[23] With respect to the current study, participants in both interventions showed a tendency toward improvement in orofacial pain ($P = 0.06$); however, there were no significant group differences between Hope and EDU. Although this suggests that both interventions may be effective in reducing self-reported clinical pain, it is also possible that regression to the mean or other nonspecific effects could be contributing factors. Contrary to our prediction, there were no notable changes in orofacial pain interference, which could be reflective of the specificity of the intervention content or signify the need for a stronger therapeutic dose (ie, longer intervention duration) to obtain greater treatment gains.

Much is known about the contributory effects of central sensitization to chronic pain, yet few studies have addressed whether this sensitization can be modulated through the alteration of cognitive and affective functioning. Therefore, a secondary aim was to examine whether an intervention designed to augment positive, psychological processes could influence centrally mediated pain responses. Overall, significant increases in heat pain tolerance, and a trend toward lower TMJ pressure pain thresholds, were found in the Hope group with medium to large effect sizes. Consistent with these findings, Hanssen et al.[13] found that pain intensity ratings during a cold pressor task were reduced in individuals randomized to an optimism induction. Moreover, another study showed that inducing positive affect by means of pleasant music led to higher cold pain tolerance and lower electrical pain ratings, relative to unpleasant music.[29] Although future research is recommended to investigate whether effects are modality-specific (heat vs pressure pain) and examine mechanisms by which hope facilitates adaptations in pain, these findings suggest that treatments designed to augment hope may alter central and peripheral nervous system processes to influence pain sensation.

As expected, state hope increased among Hope intervention participants, which appeared to be driven by improvements in pathways thinking. Conversely, although mean differences in agency were higher at post-testing for the Hope group, these findings failed to reach significance. Because agency building was not introduced until the final session, the time needed for skill development may have been insufficient. Another potentially important finding is the intervention-specific effects observed in pain catastrophizing, namely given the wealth of evidence

Table 3

Descriptive and inferential statistics for clinical and experimental pain.

	Hope		EDU		Group (G)		Time (T)		GxT	
	Pre	Post	Pre	Post						
	M (SD)	M (SD)	M (SD)	M (SD)	F	η_p^2	F	η_p^2	F	η_p^2
Primary outcomes										
Daily diary (facial pain)										
Intensity (0–100)	39.6 (14.7)	33.5 (18.7)	38.5 (25.2)	33.4 (18.7)	0.01	0.00	†3.67	0.12	0.03	0.00
Interference (0–100)	21.7 (22.2)	18.6 (25.9)	24.9 (23.5)	23.1 (21.9)	0.22	0.01	0.57	0.02	0.03	0.00
Secondary outcomes										
Heat pain tol (s)	45.5 (3.6)	47.1 (2.4)	46.3 (2.0)	44.8 (4.3)	0.58	0.02	0.00	0.00	*7.02	0.21
Heat TS										
TS 46°C pain rating	49.5 (24.1)	41.1 (25.8)	41.2 (24.6)	42.9 (28.5)	0.13	0.01	0.82	0.03	1.89	0.07
TS 46°C (Δ)	5.7 (22.6)	4.6 (15.8)	1.2 (15.8)	7.3 (13.0)	0.03	0.00	0.55	0.02	1.16	0.04
TS 48°C pain rating	56.7 (26.1)	49.0 (27.5)	52.5 (28.6)	54.9 (28.4)	0.01	0.00	0.40	0.01	1.46	0.05
TS 48°C (Δ)	7.9 (17.6)	11.2 (15.2)	15.5 (19.0)	15.2 (11.8)	1.15	0.04	0.30	0.01	0.40	0.02
Mech pressure (kPa)										
Temporalis	111.6 (49.2)	135.0 (57.3)	130.3 (30.3)	154.0 (48.2)	1.46	0.05	*8.20	0.23	0.00	0.00
Masseter	82.0 (35.8)	112.2 (54.7)	102.4 (38.5)	124.4 (39.7)	1.28	0.05	*14.53	0.35	0.36	0.01
TMJ	87.0 (34.8)	115.7 (40.8)	111.5 (41.5)	118.7 (38.4)	1.08	0.04	*9.32	0.26	†3.36	0.11
Trapezius	218.7 (93.4)	302.7 (119.9)	275.8 (75.3)	315.9 (147.5)	1.24	0.04	*5.23	0.16	0.65	0.02
Epicondyle	161.8 (64.5)	205.8 (118.9)	189.0 (56.0)	199.5 (71.6)	0.21	0.01	1.82	0.06	0.69	0.03
Anterior tibialis	268.6 (151.1)	342.7 (183.2)	356.0 (121.1)	346.8 (99.9)	1.07	0.04	1.20	0.04	1.98	0.07
Punctate pain (0–100)										
Single	26.9 (28.4)	24.1 (23.1)	25.4 (24.6)	23.7 (21.9)	0.01	0.00	0.71	0.03	0.04	0.00
10 pulse series	36.0 (28.3)	35.4 (21.9)	41.7 (28.8)	41.8 (24.6)	0.41	0.02	0.01	0.00	0.02	0.00
Cold pain tol (s)	26.0 (17.1)	41.1 (41.2)	30.9 (27.0)	38.7 (42.7)	0.01	0.00	*5.47	0.17	0.57	0.02

* $P \leq 0.05$.
† $P \leq 0.10$.
EDU, pain education intervention; kPa, kilopascals; mech, mechanical; tol, tolerance; TMJ, temporomandibular joint; TS, temporal summation.

suggesting that catastrophizing is a key contributor to negative pain outcomes.[7,22] Although this indicates that augmentation of goal-directed thinking may lessen maladaptive schemas that heighten the pain experience, it is possible that other factors contributed to this effect given the lack of association between changes in catastrophizing and hope. Also noteworthy were the differential results for pain acceptance domains as greater increases in activity engagement were found in the Hope intervention, whereas pain willingness increased in EDU. Because goal pursuit constituted a primary tenet of the Hope intervention, it is not surprising that this facilitated valued life

engagement. Furthermore, simply providing education on pain etiology may result in cognitive changes associated with pain control. However, because overall pain acceptance did not change significantly for either group, these conclusions should be interpreted with caution, as a guiding principle of this construct is that activity engagement and pain willingness function in parallel.[20]

Some limitations warrant mention. First, the sample size was small and may have been underpowered to detect differences in outcomes between the 2 interventions. Generalizability to other populations may also be limited as the sample consisted primarily

Table 4

Descriptive and inferential statistics for psychological outcomes.

	Hope		EDU		Group (G)		Time (T)		GxT	
	Pre	Post	Pre	Post						
	M (SD)	M (SD)	M (SD)	M (SD)	F	η_p^2	F	η_p^2	F	η_p^2
Primary outcomes										
ASHS (6–48)	39.3 (5.2)	41.3 (5.4)	39.3 (4.5)	37.4 (5.2)	1.52	0.05	0.01	0.00	†3.86	0.13
Pathways (3–24)	20.2 (3.0)	21.7 (2.3)	20.6 (2.2)	19.5 (2.7)	1.31	0.05	0.13	0.01	*5.23	0.16
Agency (3–24)	19.1 (3.4)	19.7 (3.5)	18.7 (2.7)	17.9 (3.1)	1.09	0.04	0.05	0.00	1.63	0.06
Secondary outcomes										
PANAS										
Negative affect (10–50)	15.7 (4.7)	14.1 (3.9)	14.2 (4.0)	13.6 (5.0)	0.46	0.02	2.52	0.09	0.42	0.02
Positive affect (10–50)	34.7 (9.5)	35.2 (9.8)	33.9 (9.4)	32.4 (9.7)	0.28	0.01	0.23	0.01	0.91	0.03
CES-D (0–60)	22.1 (5.7)	21.1 (4.6)	19.1 (6.6)	19.9 (5.7)	1.25	0.04	0.01	0.00	1.06	0.04
CPAQ (0–120)	81.8 (16.0)	84.3 (12.5)	76.4 (15.3)	78.6 (21.3)	0.90	0.03	1.69	0.06	0.00	0.00
Activity engagement (0–66)	48.9 (8.6)	53.0 (7.2)	45.7 (11.6)	44.8 (11.6)	†2.90	0.10	1.15	0.04	†2.92	0.10
Pain willingness (0–54)	32.9 (8.6)	31.3 (7.2)	30.6 (11.2)	33.9 (11.6)	0.00	0.00	0.70	0.03	*6.24	0.19
PSEQ (0–60)	48.7 (9.3)	50.5 (8.9)	49.7 (6.7)	47.3 (10.5)	0.14	0.01	0.06	0.00	2.67	0.09
PCS total (0–52)	16.4 (10.1)	12.9 (8.2)	11.9 (7.9)	12.5 (8.5)	0.68	0.03	1.41	0.05	†2.98	0.10
Magnification (0–12)	1.8 (2.0)	0.93 (1.3)	1.0 (0.96)	1.4 (2.0)	0.14	0.01	0.54	0.02	†3.08	0.10
Rumination (0–16)	7.4 (4.7)	5.3 (4.4)	5.5 (3.8)	5.0 (3.3)	0.66	0.02	*5.62	0.17	2.16	0.07
Helplessness (0–24)	7.1 (4.5)	6.7 (4.1)	5.4 (4.4)	6.1 (4.5)	0.58	0.02	0.07	0.00	1.05	0.04

* $P \leq 0.05$.
† $P \leq 0.10$.
ASHS, Adult State Hope Scale; CES-D, Center for Epidemiological Studies-Depression Scale; CPAQ, Chronic Pain Acceptance Questionnaire; EDU, pain education intervention; PANAS, Positive and Negative Affect Schedule; PCS, Pain Catastrophizing Scale; PSEQ, Pain Self-Efficacy Questionnaire.

of highly educated, white female participants. Participants were not questioned on specific coping strategies used during the sensory pain tests; therefore, it is unclear whether they applied techniques learned during the intervention sessions. In addition, we cannot rule out that the use of a single clinician to deliver the intervention resulted in nonspecific treatment effects. We also failed to capture treatment credibility ratings and do not know whether participants found the interventions to be acceptable. Furthermore, although methods were used to increase participant compliance with daily symptom monitoring (ie, written and verbal instructions and email reminders), it is possible that participants may have retrospectively reported their pain symptoms. Studies using electronic diaries with verification of the recording time may help address this concern. Finally, most of our effect sizes were small, and a large number of statistical tests were conducted. As is the case with multiple testing, there is always a greater likelihood of chance findings; therefore, caution is warranted in the interpretation.

Despite these limitations, study strengths include the use of a multimodal quantitative sensory testing battery to assess pain sensitivity. There was also a low drop-out rate (N = 4) after randomization, with the majority discontinuing in the EDU group (N = 3), thus speaking to the feasibility and credibility of the Hope intervention. Moreover, intervention development was adapted from a traditional psychotherapy protocol with real-world applications, and the techniques in the Hope intervention were based on a theoretical model of hope.[31,32] This model also aligns with Fredrickson's broaden-and-build theory,[10] signifying that positive emotions such as hope can fortify personal resources to improve health and function. Importantly, exploratory analysis revealed that hope is a possible working mechanism underlying treatment efficacy. However, given that the intervention targeted various psychological facets, other factors may play a mediating role in treatment outcomes. For example, hope therapy may facilitate goal-directed behavior through an upregulation of positive emotions and self-efficacy, thereby cultivating adaptive pain-coping methods. Although this is speculative, these data encourage testable hypotheses regarding potential mediators by which hope therapy exerts its effects.

Given the adaptive benefits of positive psychological factors on pain, there has been a growing interest in interventions that optimize resilient functioning. Our findings prompt further evaluation of hope and other resilience-based interventions, including their putative mechanisms. Whether these interventions can serve as stand-alone treatments or integrated into existing therapies has yet to be determined. It is also recognized that numerous psychosocial and behavioral factors work synergistically to shape the process of resilience. Thus, targeting multisystem resiliency through the harnessing of multiple protective factors may yield more robust treatment gains for chronic pain. A current study is underway that addresses this important question. Pursuing these directives will also require the development of a more unified theoretical model of resilience that captures various systems of analysis. Extending current conceptualizations of resilience or integrating existing theories may improve our present-day therapies and clarify the processes that underlie adaptive functioning in chronic pain.

Disclosures

Acknowledgements

References

[1] Barlow JH, Wright CC. Dimensions of the Center of Epidemiological Studies-Depression Scale for people with arthritis from the UK. Psychol Rep 1998;83(3 pt 1):915–19.

[2] Bartley EJ, Palit S, Staud R. Predictors of osteoarthritis pain: the importance of resilience. Curr Rheumatol Rep 2017;19:57.

[3] Berg CJ, Snyder CR, Hamilton N. The effectiveness of a hope intervention in coping with cold pressor pain. J Health Psychol 2008;13:804–9.

[4] Brister H, Turner JA, Aaron LA, Mancl L. Self-efficacy is associated with pain, functioning, and coping in patients with chronic temporomandibular disorder pain. J Orofac Pain 2006;20:115–24.

[5] Costello NL, Bragdon EE, Light KC, Sigurdsson A, Bunting S, Grewen K, Maixner W. Temporomandibular disorder and optimism: relationships to ischemic pain sensitivity and interleukin-6. PAIN 2002;100:99–110.

[6] Doran GT. There's a S.M.A.R.T. way to write management's goals and objectives. Manag Rev 1981;70:35–6.

[7] Edwards RR, Dworkin RH, Sullivan MD, Turk DC, Wasan AD. The role of psychosocial processes in the development and maintenance of chronic pain. J Pain 2016;17(9 suppl):T70–92.

[8] Fillingim RB, Ohrbach R, Greenspan JD, Knott C, Dubner R, Bair E, Baraian C, Slade GD, Maixner W. Potential psychosocial risk factors for chronic TMD: descriptive data and empirically identified domains from the OPPERA case-control study. J Pain 2011;12(11 suppl):T46–60.

[9] Flink IK, Smeets E, Bergbom S, Peters ML. Happy despite pain: pilot study of a positive psychology intervention for patients with chronic pain. Scand J Pain 2015;7:71–9.

[10] Fredrickson BL. The role of positive emotions in positive psychology: the broaden-and-build theory of positive emotions. Am Psychol 2001;56: 218–26.

[11] Goubert L, Trompetter H. Towards a science and practice of resilience in the face of pain. Eur J Pain 2017;21:1301–15.

[12] Guillory J, Chang P, Henderson CR Jr, Shengelia R, Lama S, Warmington M, Jowza M, Waldman S, Gay G, Reid MC. Piloting a text message-based social support intervention for patients with chronic pain: establishing feasibility and preliminary efficacy. Clin J Pain 2015;31: 548–56.

[13] Hanssen MM, Peters ML, Vlaeyen JW, Meevissen YM, Vancleef LM. Optimism lowers pain: evidence of the causal status and underlying mechanisms. PAIN 2013;154:53–8.

[14] Hassett AL, Finan PH. The role of resilience in the clinical management of chronic pain. Curr Pain Headache Rep 2016;20:39.

[15] Hausmann LM, Youk A, Kwoh C, Gallagher RM, Weiner DK, Vina ER, Obrosky DS, Mauro GT, McInnes S, Ibrahim SA. Effect of a positive psychological intervention on pain and functional difficulty among adults with osteoarthritis: a randomized clinical trial. JAMA Netw Open 2018;1: e182533.

[16] Hausmann LRM, Parks A, Youk AO, Kwoh CK. Reduction of bodily pain in response to an online positive activities intervention. J Pain 2014;15: 560–7.

[17] Hausmann LRM, Youk A, Kwoh CK, Ibrahim SA, Hannon MJ, Weiner DK, Gallagher RM, Parks A. Testing a positive psychological intervention for osteoarthritis. Pain Med 2017;18:1908–20.

[18] Howell AJ, Jacobson RM, Larsen DJ. Enhanced psychological health among chronic pain clients engaged in hope-focused group counseling. Couns Psychol 2014;43:586–613.

[19] Larsen DJ, King RL, Stege R, Egeli NA. Hope in a strengths-based group activity for individuals with chronic pain. Counsell Psychol Q 2015;28: 175–99.

[20] McCracken LM. Toward understanding acceptance and psychological flexibility in chronic pain. PAIN 2010;149:420–1.

[21] McCracken LM, Vowles KE, Eccleston C. Acceptance of chronic pain: component analysis and a revised assessment method. PAIN 2004;107: 159–66.

[22] Meints SM, Edwards RR. Evaluating psychosocial contributions to chronic pain outcomes. Prog Neuropsychopharmacol Biol Psychiatry 2018;87(pt B):168–82.

[23] Muller R, Gertz KJ, Molton IR, Terrill AL, Bombardier CH, Ehde DM, Jensen MP. Effects of a tailored positive psychology intervention on well-being and pain in individuals with chronic pain and a physical disability: a feasibility trial. Clin J Pain 2016;32:32–44.

[24] Nicholas MK. The pain self-efficacy questionnaire: taking pain into account. Eur J Pain 2007;11:153–63.

[25] Peters ML, Smeets E, Feijge M, van Breukelen G, Andersson G, Buhrman M, Linton SJ. Happy despite pain: a randomized controlled trial of an 8-week internet-delivered positive psychology intervention for enhancing well-being in patients with chronic pain. Clin J Pain 2017;33:962–75.

[26] Rollman GB, Gillespie JM. The role of psychosocial factors in temporomandibular disorders. Curr Rev Pain 2000;4:71–81.

[27] Schiffman E, Ohrbach R, Truelove E, Look J, Anderson G, Goulet JP, List T, Svensson P, Gonzalez Y, Lobbezoo F, Michelotti A, Brooks SL, Ceusters W, Drangsholt M, Ettlin D, Gaul C, Goldberg LJ, Haythornthwaite JA, Hollender L, Jensen R, John MT, De Laat A, de Leeuw R, Maixner W, van der Meulen M, Murray GM, Nixdorf DR, Palla S, Petersson A, Pionchon P, Smith B, Visscher CM, Zakrzewska J, Dworkin SF. Diagnostic criteria for temporomandibular disorders (DC/TMD) for clinical and research applications: recommendations of the International RDC/TMD Consortium Network and Orofacial Pain Special Interest Group. J Oral Facial Pain Headache 2014;28:6–27.

[28] Sherman JJ, Turk DC. Nonpharmacologic approaches to the management of myofascial temporomandibular disorders. Curr Pain Headache Rep 2001;5:421–31.

[29] Silvestrini N, Piguet V, Cedraschi C, Zentner MR. Music and auditory distraction reduce pain: emotional or attentional effects? Music Med 2011;3:264–70.

[30] Sipila K, Ylostalo PV, Ek E, Zitting P, Knuuttila ML. Association between optimism and self-reported facial pain. Acta Odontol Scand 2006;64: 177–82.

[31] Snyder CR. Hope theory: rainbows in the mind. Psychol Inq 2002;13: 249–75.

[32] Snyder CR, Harris C, Anderson JR, Holleran SA, Irving LM, Sigmon ST, Yoshinobu L, Gibb J, Langelle C, Harney P. The will and the ways: development and validation of an individual-differences measure of hope. J Pers Soc Psychol 1991;60:570–85.

[33] Snyder CR, Sympson SC, Ybasco FC, Borders TF, Babyak MA, Higgins RL. Development and validation of the State Hope Scale. J Pers Soc Psychol 1996;70:321–35.

[34] Sturgeon JA, Zautra AJ. Resilience: a new paradigm for adaptation to chronic pain. Curr Pain Headache Rep 2010;14:105–12.

[35] Sturgeon JA, Zautra AJ. Psychological resilience, pain catastrophizing, and positive emotions: perspectives on comprehensive modeling of individual pain adaptation. Curr Pain Headache Rep 2013;17:317.

[36] Sullivan MJL, Bishop SR, Pivik J. The Pain Catastrophizing Scale: development and validation. Psychol Assess 1995;7:524–32.

[37] Tse MM, Lo AP, Cheng TL, Chan EK, Chan AH, Chung HS. Humor therapy: relieving chronic pain and enhancing happiness for older adults. J Aging Res 2010;2010:343574.

[38] Von Korff M, Ormel J, Keefe FJ, Dworkin SF. Grading the severity of chronic pain. PAIN 1992;50:133–49.

[39] Watson D, Clark LA, Tellegen A. Development and validation of brief measures of positive and negative affect: the PANAS scales. J Pers Soc Psychol 1988;54:1063–70.