Received: 29 November 2023 | Revised: 30 April 2024 | Accepted: 6 May 2024

DOI: 10.1111/joor.13740

JOURNAL OF ORAL REHABILITATION WILEY

ORIGINAL ARTICLE

Does combining oro-facial manual therapy with bruxism neuroscience education affect pain and function in cases of awake bruxism? A pilot study

Harry von Piekartz[1] | Sonja Bleiss[1] | Sebastian Herzer[1] | Toby Hall[2] | Nicolaus Ballenberger[1]

[1]Department Movement and Rehabilitation Science, Faculty of Business, Management and Social Science, Osnabruck, Germany

[2]Curtin School of Allied Health, Curtin University, Perth, Western Australia, Australia

Correspondence
Harry von Piekartz, Department Movement and Rehabilitation Science, Faculty of Business, Management and Social Science, Caprivistrasse 30a, 49076 Osnabruck Germany.
Email: h.von-piekartz@hs-osnabrueck.de

Abstract

Background: Although awake bruxism is associated with temporomandibular disorder (TMD) as well as head and neck pain, the effects of physical therapy and bruxism education to address these factors have not been investigated.

Objective: The aim of this study was to evaluate the effects of oro-facial manual therapy and bruxism neuroscience education (BNE) on awake bruxism over a 3-week period with an open-ended follow-up questionnaire after 3 months.

Methods: Subjects ($n = 28$) were randomly allocated to one of two groups, an intervention group and a control group. Data regarding disability, function and pain were collected pre- and post-assessment, with all measures administered in a single-blind fashion. Participants in both groups received six treatment sessions during this period. In addition to manual therapy, participants were provided with information on the neurophysiological mechanisms of bruxism and contributing factors. Individual behavioural guidelines and daily exercises were determined in consultation with the therapist. An introduction to a bruxism specific app (Brux.App) was also provided, which all participants used as an adjunct to their treatment.

Results: The intervention group demonstrated notable improvement as indicated by their scores in the Neck Disability Index (NDI) ($p = .008$), Pain Disability Index (PDI) ($p = .007$) and Jaw Disability List (JDL) ($p = .03$). Furthermore, clinical assessments of the temporomandibular joint (TMJ) revealed a significant progress in terms of mouth opening ($p = .03$) and lateral jaw movement (laterotrusion) ($p = .03$). The mechanical pain threshold (PTT) of both the masseter ($p = .02$) and temporalis muscle ($p = .05$) also showed significant improvement. At 3-month follow-up, the questionnaire revealed that the majority of the intervention group (13/15, 87%) reported a benefit from the treatment.

Conclusion: The reduction in pain and disability together with improvement in function and increased coping suggest a potential modification of awake bruxism through specialised musculoskeletal intervention and BNE tailored to the individual patient.

KEYWORDS
awake bruxism, physical therapy, pilot study

1 | INTRODUCTION

Bruxism is a term encompassing atypical oral habitual behaviours.[1,2] It is defined as the repetitive grinding, gnashing or clenching of teeth accompanied by heightened jaw-muscle activity.[2,3] Bruxism manifests in two primary forms, occurring either during sleep (sleep bruxism) or while awake (awake bruxism).[2,4] Sleep bruxism is predominantly subconscious which involves grinding and clenching of the jaw and has been the subject of extensive investigation.[5] On the other hand, awake bruxism centres on dental compression during waking hours.[6,7] It is imperative to differentiate between these forms as sleep and awake bruxism exhibit distinct implications and origins.[8]

Although the aetiology of bruxism remains unclear, possible factors include genetics, malocclusion, central nervous system influences, sleep disorders, reflux and psycho-emotional causes such as stress.[9] There is no difference in prevalence between men and women, but it appears to be more common in children than in older adults.[10] Diagnosis relies primarily on self-reports, partner reports and questionnaires, although tools such as electromyography (EMG) and polysomnography (PSG) provide additional diagnostic support.[11]

Current treatment strategies often rely on dental approaches such as occlusal splints, pharmacotherapy or occlusal adjustments[12] However, physical therapy (PT), a discipline that focuses on maximising functional movement without movement limitation and pain, has not yet emerged as a prominent treatment approach for awake bruxism.[13]

In a recent systematic review examining the effectiveness of PT interventions for both awake and sleep bruxism, the combination of muscle stretching, massage therapy and PT exercises showed only low-quality evidence due to study poor methodological quality.[14] It should be noted that the intervention was focused on a prescription treatment rather than an individualised clinically reasoned approach encompassing neuroscience education (NE).

Pain neuroscience education (PNE) is a method focused on educating individuals about the neurobiological underpinnings of pain. This approach aims to empower people to manage and cope with their pain more effectively. The effectiveness of PNE has been shown to vary, perhaps influenced by the mix of interventions used and the characteristics of the study population.[15–18] These effects include a significant reduction in pain as well as improved functional outcomes. However, this approach has not yet been integrated in the treatment and management of patients with bruxism. This study attempts to fill the gap regarding the effects of PT interventions for awake bruxism.

Female volunteers with awake bruxism participated in a 3-week multidimensional treatment approach comprising individualised musculoskeletal PT, BNE and a smartphone app-based behavioural training programme and were compared to a control group.

The results will form a basis for a larger trial. The study aims are to gain insight into the effects of the intervention on various outcomes. Additionally, the feasibility, compliance and acceptance of the intervention will be evaluated in patients with awake bruxism. To the best of the authors' knowledge, this study represents the first study assessing a comprehensive PT strategy that integrates both direct ('hands on') and indirect ('hands off') treatments for awake bruxism, aimed at alleviating pain and enhancing oro-facial/cervical function.

2 | METHOD

A randomised controlled pilot trial was used to evaluate the short-term effects of a 3-week multidimensional PT treatment approach. The present study was planned and conducted in accordance with the CONSORT extension to pilot and feasibility trials.[19]

2.1 | Participants

Eligibility criteria were female volunteers ($n=42$) aged 18–40 with mean age 29.8 (±SD 9.2) diagnosed with awake bruxism by a dentist familiar with a bruxism classification system.[2,20] Participants were excluded if they exhibited systemic inflammatory, degenerative, cardiorespiratory, central nervous system or rheumatic conditions, as well as any eye issues impacting visual function.

To eliminate the presence of dysfunctional chronic pain, the German Graded Chronic Pain Status (GCPS) was employed. This psychometric instrument comprises a set of seven questionnaires aimed at discerning and classifying individuals into four distinct subgroups according to their pain-related circumstances. Grades I and II denote minor complaints, indicative of functional chronic pain, whereas grades III and IV signify notable complaints, suggestive of dysfunctional chronic pain.[21,22] Participants with Grade I and II were included. The study content and procedures were explained to the participants, and consent obtained. The study was conducted in accordance with the Helsinki guidelines and approved by the local ethics committee of the University of Applied Sciences Osnabrück (key WISO_MS-MT _HP-WS-21/22-03).

2.2 | Procedure

All enrolled participants underwent an evaluation conducted by the first assessor, which involved the administration of questionnaires

and a physical examination in accordance with the Axis I DC/TMD criteria. The study was conducted in two physical therapy practices in Western Germany. The first assessor was a physical therapists with over 6 years of experience, who had also undergone a 4-hour training session on temporomandibular joint (TMJ) examination conducted by a clinical expert (HP). This assessor performed the baseline measurements of all participants. The second assessor was a physical therapist with over 10 years of experience and specialisation in treating oro-facial pain. This assessor randomly allocated participants to one of two groups. Utilising a digital random number generator, they assigned individuals to either the control group (CP) or the intervention group (IC). Participants in the CP were placed on a waiting list for 3 weeks before receiving their initial treatment.

2.3 | Outcomes

2.3.1 | Questionnaires

The Pain Disability Index (*PDI*) is a validated measure of the subjective perception of functional limitations due to pain-related problems in daily life.[23,24] It measures the complex interactions of pain and the influence of biopsychosocial factors and is independent of the degree of injury (Gatchel et al. 2006). The questionnaire consists of seven items covering the following domains: 1. family and household responsibilities, 2. recreation, 3. social activities, 4. occupation, 5. sexual life, 6. self-care and 7. essential activities. Using an 11-point scale ranging from 0 (no impairment) to 10 (complete impairment), the participant indicates for each item the impact of his or her pain on various activities of daily living, due to complex interactions of biopsychosocial factors and is independent of the degree of injury.[23]

The Neck Disability Index (*NDI*) appraises neck-related disability and comprises a self-assessment questionnaire encompassing 10 items that cover daily activities, concentration and pain intensity. This scale is rated on a range from 0 (indicating an absence of pain and disability) to 50 (representing significant pain and disability). Extensive research has demonstrated its robust psychometric attributes, ranging from good to excellent.[25]

The Jaw Disability List (*JDL*) is a screening tool of 12 closed-ended questions ('no') to assess oro-facial factors based on both physical and psychological aspects and can be used in subjects classified with Axis I and II.[26,27]

2.3.2 | Physical measurements

Physiological movements included mouth opening (measured for both range and deviation), laterotrusion to either side and active mandible propulsion and repulsion quantified using a 10 cm ruler conforming with the DC/TMD guidelines.[28]

Mechanical pressure pain threshold (*PPT*); the assessment of mechanosensitivity across the Masseter and Temporalis Anterior muscles involved the utilisation of a pressure algometer (Wagner instruments, Force dial FDK 10) to quantify the PPT. The evaluation of PPT was measured at specific anatomical points: 1 cm above the masseter tuberosity (P1), 1 cm below the zygomatic arch (P2) for the masseter and 1 cm lateral to the eye angle for the anterior temporal muscle (P3). Pressure was applied steadily at an approximate rate of 1 $kg/cm^2/s$ until subjects indicated the transition from pressure to pain. Two measurements were taken at each site and muscle, and these values were averaged for subsequent analysis. The validity and reliability of this method for assessing mechanosensitivity have been demonstrated in previous studies.[29,30]

The feasibility and acceptance of the intervention was evaluated by the rate of compliance and adherence to the treatment sessions. Furthermore, the adherences to a special app, the BruxApp which is a smartphone application designed to manage various aspects of awake bruxism, including its diagnosis, management, prevention and scientific research was assessed.[13] An online questionnaire retrieved further information through an open-ended questionnaire after 3 months of the intervention (see Appendix A). Additionally, the intervention group was asked about the self-reported and perceived effect of the treatment.

2.4 | Interventions

The treatment provided by the two specialised musculoskeletal therapists comprised of 3 sections:

2.4.1 | Oro-facial manual therapy (OFMT)

OFMT i*ncludes* passive mobilisation of the TMJ, stretching and trigger point techniques of the masticatory muscles, eccentric muscle techniques, as well as passive mobilisation and manual techniques to reduce tension in the craniocervical muscles.

2.4.2 | Motor control and behavioural exercises

A set of eight motor control tests, demonstrating a single underlying factor for structural validity, excellent internal consistency (0.90) and reliable agreement between different raters, served as the foundational framework for the motor control exercises.[31]

2.4.3 | Habitual reversal training (HRT)

The concept of HRT, initially introduced by psychologists Azrin and Nunn in 1973,[32] was subsequently adapted by von Piekartz in 2007.[33] This approach focuses on cultivating self-awareness and disrupting parafunctional behaviours of the jaw, such as thrusting, bracing and pressing, through the practice of alternative movement

patterns in situations where these behaviours are triggered. An illustrative example is the implementation of isometric antagonistic movements, like static resistance in the direction of mouth closing while opening the mouth (Figure 1A).

2.4.4 | The brace relaxation technique (BRT)

The brace relaxation technique (BRT), colloquially known as the wobble technique, is a method of relaxation designed to be incorporated into patients daily routines. Firstly, the techniques performed by the therapist involve a keen awareness of the tension-relaxation dynamics of the mandible, as illustrated in Figure 1B. If the patient detects heightened tension in their jaw muscles, the recommended approach involves assuming an upright seated posture, releasing the lower jaw, holding the head with one hand and gripping the entire lower jaw with the other. In this stance, the patient is encouraged to execute subtle oscillatory movements in the direction of lateral shifting, alternating between right and left. Simultaneously, the patient engages in a cognitive task focused on achieving a state of 'relaxation'.[34]

2.4.5 | Tongue-teeth breathing swallowing exercise (TTBS)

Characteristics are a rhythmic nose–mouth breathing, in which the rhythmic movement of the tongue towards the palate (inhalation) and towards the floor of the mouth (exhalation) is performed without dental contact, thus avoiding parafunctions. This action is followed by a controlled swallow (with peripheral contact), followed by nasal mouth breathing.[33,35]

2.4.6 | Smartphone application based on ecological momentary assessment and intervention (EMA) principles

The Brux.App® (developed by the Brux.App Team in Pontedera, Italy) has the purpose of changing behaviour by encouraging exercise, such as HRT, BRT and TTBS, by emitting random alert sounds throughout the day via a smartphone. Users are required to promptly respond by tapping the corresponding display icon that represents the present state of their jaw muscles or teeth positioning. These states encompass relaxed jaw muscles, tooth contact, tooth clenching, tooth grinding and jaw clenching (excluding tooth contact, known as mandible bracing). The selection of these behaviours is rooted in their association with the awake bruxism spectrum. The data collected can be used for behavioural therapy through push messaging and has demonstrated positive results.[36] Further details of the App have been published.[13,37] During this study, the subjects were educated about the Brux.App during the first session and received a hand-out to take home. The decision to use the Brux.App was made jointly by the patient and the therapist.

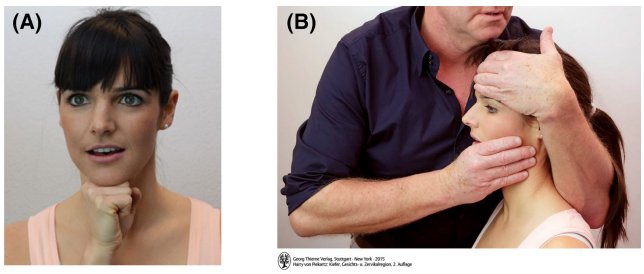

FIGURE 1 (A) Starting position of the habitual reversal technique (HRT). (B) The brace relaxation technique (BRT) executed by the therapist.

2.4.7 | Habit formation exercise

Red Dots may have been chosen by the therapist as a reminder technique where the participants place red dots in visible areas as cues to perform specific tasks such as the exercises mentioned above. These dots served as visual triggers, reminding the person to engage in a predetermined activity each time they saw a dot.[38,39] In this study, participants were permitted to use up to five dots, specifically in situations where the participant had been informed about their relevance to managing awake bruxism.

2.4.8 | Bruxism neuroscience education (BNE)

BNE is a modification of PNE which is a methodical strategy used to educate patients about the patho-biological mechanisms that underlie persistent pain.[40,41] PNE is a well-defined cognitive-behavioural intervention, aimed at adults dealing with chronic pain, and functions by reshaping unhelpful illness-related beliefs and consequently modifying behaviours.[15] BNE encompasses identical principles but focuses on the atypical masticatory (motor) behavioural patterns that could give rise to bruxism and associated complaints, as outlined in the existing literature. An outline of the subjects covered is provided in Table 1 for reference.

Intervention decisions were based on the therapist's (Assessor 2) clinical expertise and individual judgement. This was in collaboration with the participant, where they decided what was the most appropriate individual treatment (collaborative reasoning). BNE was obligatory and the treatment lasted 20–30 min and was delivered four to six times over a 3-week period. Between Days 21 and 27, the first blinded assessor performed the second assessment (M2) (Figure 2). Following this initial awake bruxism treatment period, participants were subsequently administered a digital open-ended survey 3 months later. This survey assessed both Brux.App adherence and treatment satisfaction, with the evaluation being presented in percentage terms (Appendix A).

TABLE 1 Outline of the subjects covered.

Information/ progression	Subject	Explanation
1.	Somatomotor Reflex	• The somatomotor reflex is a rapid communication between sensory neurons and motor neurons leading to coordinated muscle contractions or movements with(out) conscious control • Examples of oro-facial activities such as speaking, eating, biting, swallowing, but it is also responsible for abnormal activities such as involuntary grinding or clenching of teeth
2.	Nociceptor (warning signals)	• Sensors in the teeth, TMJ and masticatory muscles can send alarm signals to the brain. These sensors may inform the brain and may cause a pain experience and can increase motor activity of the chewing muscles
3.	Centralised mechanism	• Trigeminal cervical convergence. The upper neck, facial and temporomandibular regions have interconnectedness through the trigeminal complex, allowing for reciprocal influence among them. • Brain: warning signals may influence the neural connections in the brain which can lead for example to a pain experience, increased motor activity or mood changes and sleep disturbances
4.	Memory for motor functions	• Motor neurons in the central nervous system have a memory and can be subtly activated by different events such as: a thought and/or emotion, visual and olfactory events, day/night rhythm, workload and people in your environment. • Your own uncontrolled motor inhibition system. Somatic, cognitive-emotional, contextual individual motor control may be the cause of the trigger. The triggers should be inventoried and systematically reduced and or controlled
5.	Your own (un)controlled motor inhibition system	• The uncontrolled motor activity of the chewing system influenced by possibly increased alarm signals in the oro-facial region, thoughts, beliefs, daily activity, sleep hygiene or stress
6.	Management of motion control	• For this, there are numerous treatment options that can reduce the sensitivity of the nervous system and thereby positively affect the chewing muscles and your quality of life. In PT, if necessary, we treat oral and facial regions with manual therapy, offer exercises and educate you about your abnormal muscle activity

Note: During BNE and subsequent treatment, an effort was made to minimise the use of the term 'bruxism' and related terms such as 'grinding, clenching, bracing and thrusting'. The terminology used was adapted based on the basic understanding of the participants.

2.5 | Statistical analysis

Baseline characteristics and demographic data between the two groups were compared by Chi-squared tests and independent *t* tests for categorical and interval data respectively. In case of non-normally distributed data Mann–Whitney's *U*-test was applied. Outcomes after the intervention period were analysed by linear regression with adjustment for baseline values. Hence, mean differences between both groups are given as both unadjusted and adjusted values. Bilateral measurements (e.g., PPT of temporalis muscle) were averaged as these were not significantly different between sides. The data of the questionnaire were analysed descriptively.

3 | RESULTS

Out of the initially eligible participants, dentists excluded 42 due to the lack of symptoms of Awake Bruxism (AB). Additionally, 14 participants were excluded for various reasons: 6 because their score on the Graded Chronic Pain Scale (GCPS) was classified in Grade III or IV, 3 due to a systematic disease, and 5 because they could not commit enough time for six treatments. A total of 28 participants qualified based on the study's inclusion criteria and were chosen for randomisation, which was conducted using the IOS app 'Random'. During the 3-week treatment period, no dropouts were observed, providing a final group of 28 participants who completed the entire study.

During baseline measurement, no significant distinctions were observed in biometric data, questionnaire or clinical test results between the two groups (Table 2). Adhering to the DC/TMD guidelines, out of the 28 participants, 14 (60%) presented with temporomandibular disorders (TMD). Among them, six people (40%) exhibited myogenous TMD, while one person (7%) displayed arthrogenous TMD, and a further two people (13%) demonstrated mixed TMD.

Table 3 shows the results for both groups after the intervention phase with and without adjustment for baseline values. Regarding physiological movements, mouth opening and laterotrusion were significantly greater in the intervention group. All other movements were not significantly different.

The assessment of mechanosensitivity shows significantly higher mechanical PPT at all muscle sites in the intervention group after adjustment for baseline. Furthermore, the scores of NDI, PDI and JDL are significantly greater in the intervention group after the intervention (Table 4).

4 | DISCUSSION

The main purpose of our study was to identify whether a 3-week period of specialised PT affects the pain experience and function of the oro-facial/cervical region in subjects with awake bruxism. We used data from three valid questionnaires assessing pain (JFL and

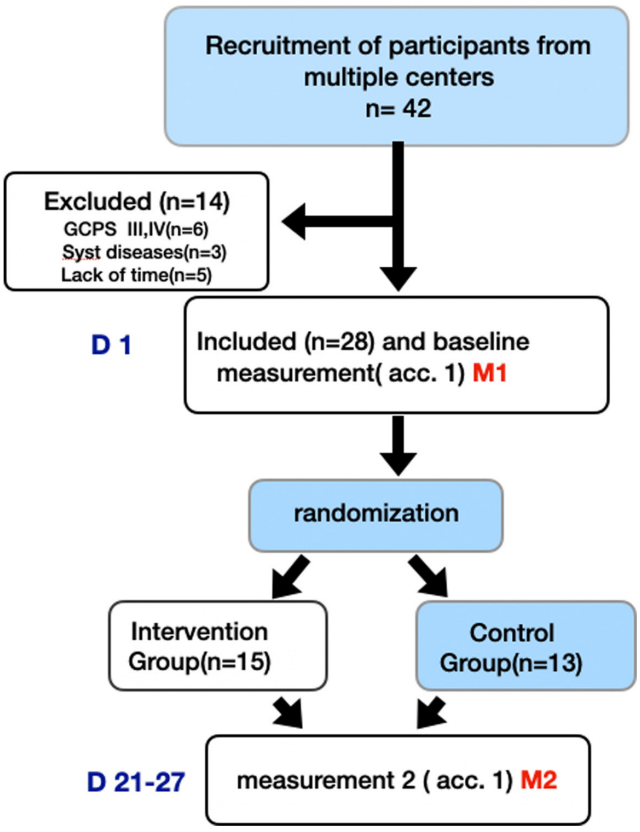

FIGURE 2 Flow chart of the study in which the participants were enrolled. Assessor(Acc).1 refers to the two investigators at both centres who were blinded. Acc.2 refers to the two therapists who were responsible for randomising and administering treatments to participants.

NDI), as well as oro-facial and neck function (JFL and NDI). In all three questionnaires there was a significant improvement following the intervention suggesting that the patients experienced a significant reduction in pain and improved function.

In this pilot study, a majority of participants reported high satisfaction with the physiotherapeutic intervention (87%) and an improved ability to manage their symptoms related to awake bruxism (87%). However, there was lower compliance observed in using the Brux.App (60%) and the habit formation exercises (red dots) (40%). One reason for this reduced compliance is that the use of the Brux. App was not mandatory. Additionally, during the intervention phase, we did not record the frequency and duration of participants' exercise compliance throughout the day. In future studies, it may be beneficial to consider using Brux.App 2.0 to assess the daily behaviours of individuals with bruxism and their associated complaints, which could serve as a basis for determining exercise duration and frequency.

We chose these three questionnaires because of their excellent validity and direct relation to the primary outcome of the study; pain and function. Also, these questionnaires are easy and quick to apply in daily practice. Concerning assessment of pain, the numerical rating scale was considered, but the PDI measures pain related to function and activities. We also considered the Craniofacial Pain Disability Index (CF-PDI) which measure the domains pain, function and quality of life. However this questionnaire is more intended for oro-facial -TMD complaints. Life-quality questionnaire such as the Patient Health Questionnaire-4 (PHQ-4) or the Short Form questionnaire (SF-12) could indeed still be considered in future studies and its absence here a limitation of this study. Partly the consideration of

TABLE 2 Participants characteristics of the bruxism and non-bruxism group.

	Intervention ($n=13$)	Control ($n=15$)	p-Value
Age in years (mean ± SD)	31.30 (11.16)	28.50 (10.33)	.8
Weight in kg (mean ± SD)	64.4 (10.4)	66.80 ± 6.68	.87
Height in cm (mean ± SD)	165.08 ± 10.71	168.53 ± 7.40	.52
Questionnaires			
NDI (mean±SD)	21.69 (10.48)	24.4 (8.46)	.3
PDI	10.54 (10.36)	15.07 (8.39)	.4
JPL	2.38 (2.69)	3.07 (2.63)	.93
Physiological movements	(mm)		
Mouth opening	46.54 (5.87)	45.33 (8.43)	.49
Laterotrusion Left	11.38 (3.33)	10.67 (3.66)	.92
Laterotrusion right	11.15 (2.61)	10 (2.95)	.68
Propulsion	5.08 (2.57)	4.53 (1.55)	.69
Repulsion	3.69 (1.65)	3.4 (1.77)	.89
Pain pressure threshold	PTT (kg^2/cm) (±SD)		
Masseter P1 left	1.1 (0.36)	1.17 (0.31)	.43
Masseter P1 left	1.16 (0.45)	1.28 (0.48)	.24
Temporalis P3 left	1.26 (0.4)	1.37 (0.46)	.9
Masseter P1 right	0.89 (0.3)	1.09 (0.39)	.37
Masseter P2 right	1.04 (0.32)	1.18 (0.43)	.6
Temporalis P3 right	1.61 (0.59)	1.20 (0.5)	.55
DC/TMD Axis I	*N* (%)		
Myogenic	5 (40%)	5 (33%)	
Arthrogenic	1 (7%)	2 (13%)	
Mixed	2 (13%)	1 (7%)	
Non	5 (40%)	7 (47%)	

Abbreviations: DC/TMD, diagnostic criteria temporomandibular dysfunction; JPL, Jaw Disability List; NDI, Neck Disability Index; PDI, Pain disability index.

TABLE 3 Outcomes after the intervention period for both groups.

Intervention group		Control group		Not adjusted for baseline			Adjusted for baseline	
Variable	Mean	SD	Mean	SD	Mean difference	*p*-Value	Mean difference	*p*-Value
Mouth opening	48.46	6.06	43.07	8.74	−5.39	.07	−4.44	**.03**
Propulsion	5.58	2.60	5.47	1.55	−0.12	.88	0.08	.92
Retropulsion	3.58	1.90	3.53	1.85	−0.05	.94	0.05	.94
Laterotrusion	11.98	1.98	9.80	2.90	−2.18	**.03**	−1.68	**.04**
Temporalis	1.66	0.58	1.38	0.49	−0.27	.18	−0.31	**.05**
MasseterP1	1.54	0.78	1.16	0.42	−0.37	.12	−0.50	**.02**
MasseterP2	1.77	0.82	1.26	0.45	−0.51	**.05**	−0.59	**.02**
NDI	14.15	6.71	23.80	9.41	9.65	**.00**	8.32	**.00**
PDI	5.92	5.33	15.33	10.15	9.41	**.01**	6.41	**.01**
JDL	1.31	1.55	3.40	3.00	2.09	**.03**	1.63	**.02**

Note: Mean differences are given as both unadjusted and adjusted values for baseline scores. Bold values means 'significant'.
Abbreviations: JPL, Jaw Disability List; NDI, Neck Disability Index; PDI, Pain disability index.

TABLE 4 Findings from the open-ended questionnaire pertaining to the Brux.App, Red Dot method, the benefit level of individual physiotherapeutic intervention, and coping for managing awake bruxism.

	Satisfactory/benefit-level				
Application	*N* (%)	High *N* (%)	Moderate *N* (%)	Minimal *N* (%)	None *N* (%)
Brux App *n*. %	9/15 (60%)	8/9 (89%)	1/9 (11%)	0	0
Red Dot Method	6/15 (40%)	3/3 (100%)	0	0	0
Brux App and Red Dot.	5/15 (33%)	4/5 (80%)	1/5 (20%)	0	0
No use of application	3/15 (20%)				
Physiotherapeutic intervention	13/15 (87%)	10/13 (77%)	3/13 (23%)	0	0
Coping with bruxism	13/15 (87%)	11/13 (85%)	0	2/13 (15%)	

life-quality is addressed in the open-ended questionnaire, with 87% reporting a reduction in their symptoms and increased coping together with satisfaction with treatment.

The effect of treatment may be attributable to individually chosen oro-facial manual treatment in combination with the individual BNE. Current evidence supports the use of PNE in combination with musculoskeletal therapy reducing pain, improving function and lowering disability.[15] BNE as used in this study is based on PNE principals but is focused on masticatory motor control during parafunction rather than pain and is supported by the current knowledge and evidence about parafunctional activities into comprehensible language for the bruxism patient (see Table 1). Unfortunately, in this study it cannot be concluded what the specific effect is of BNE as we chose a combination of both interventions (oro-facial manual therapy, motor control training, exercise and BNE) based on a patient–therapist collaborative reasoning approach.[42]

To the best of the authors' knowledge and in consideration of the existing literature, current PT interventions frequently incorporate combinations of treatments, including occlusal splints, acupuncture and TENS, which are often described as standardised treatments. Thus, this study stands out notably from prior research. What distinguishes this study is the involvement of a specialised physiotherapist who evaluated the most suitable intervention for each individual patient and supplemented that with BNE to tailor the approach to the specific bruxism mechanisms for the individual patient. This can be seen in the absence of participant dropouts and the high level of satisfaction reported at the 3-month mark. While it is evident that additional evaluations can be incorporated over an extended duration, it is important to note that this study serves as an initial 'pilot', and future research can be further honed based on the insights gained from this study.

4.1 | Strengths and weakness

This study represents the first to evaluate a combined approach guided by clinical reasoning involving oro-facial manual therapy and BNE for the treatment of awake bruxism. While the findings appear promising, it is important to acknowledge several potential limitations. Firstly, the study comprised a small sample, and a formal sample size calculation was not conducted. Secondly, additional assessments measuring various domains, such as anxiety (e.g., Generalised Anxiety Disorder 7—GAD-7) or general health (e.g., Patient Health Questionnaire-4—PHQ-4, or Short Form-12—SF-12), could be considered. Additionally, this study does not establish whether BNE or oro-facial physical therapy, when applied independently, yields comparable or superior outcome. Furthermore, it would be useful

to examine long-term effects within a larger sample size and explore differences among different demographic groups including monitoring the occurrence of relapses and adverse effects. Consequently, based on the results of this pilot study, a larger sample over an extended period is warranted. The introduction of a measure, such as the Brux.App, for an extended duration holds promise and may be integrated into future research.[43]

5 | CONCLUSION

The findings from this initial pilot study endorse the effectiveness of specialised physiotherapists in alleviating awake bruxism-related complaints. The integration of tailored oro-facial manual therapy, combined with education on the neurophysiological mechanisms of bruxism, has the potential to impact pain reduction, improve function and enhance overall satisfaction with care. Further research should be designed with larger participant cohorts, longer study durations, comparisons with other types of interventions, and the inclusion of additional measures to assess contributing factors such as anxiety and quality of life.

AUTHOR CONTRIBUTIONS

Conceptualization: HP. Design: HP, TH and NB. Data collection: SB, SH and HP. Interpretation: HP, SB, TH and NB. Logistic: HP, SB and SH. Statistics: NB and HP. Writing end manuscript: HP and TH. All authors discussed the results and contributed to the manuscript.

ACKNOWLEDGEMENTS

Thanks are given to the volunteers contributing to this study. The research was carried out without funding. Open Access funding enabled and organized by Projekt DEAL.

CONFLICT OF INTEREST STATEMENT

The authors have stated that there are no conflict of interest in connection with this article.

PEER REVIEW

The peer review history for this article is available at https://www.webofscience.com/api/gateway/wos/peer-review/10.1111/joor.13740.

DATA AVAILABILITY STATEMENT

Data supporting this study are not publicly available due to client confidentiality. Please contact our-research-group H.von-Piekartz@hs-osnabrueck.de for further information.

ETHICAL APPROVAL

The study was approved by the Research Ethics Commission of the University of Applied Science Osnabrück (key WISO_MS-MT_HP-WS-21/22-03).

ORCID

Harry von Piekartz https://orcid.org/0000-0002-4509-929X

REFERENCES

1. Lobbezoo F, Koyano K, Paesani DA, Manfredini D. Sleep bruxism: diagnostic considerations. In: *Principles and Practice of Sleep Medicine*. Elsevier; 2017:1427-1434.
2. Lobbezoo F, Ahlberg J, Raphael KG, et al. International consensus on the assessment of bruxism: report of a work in progress. *J Oral Rehabil*. 2018;45(11):837-844.
3. Turner JA, Dworkin SF, Mancl L, Huggins KH, Truelove EL. The roles of beliefs, catastrophizing, and coping in the functioning of patients with temporomandibular disorders. *Pain*. 2001;92(1–2):41-51.
4. Van Selms M, Lobbezoo F, Wicks DJ, et al. Craniomandibular pain, oral parafunctions, and psychological stress in a longitudinal case study. *J Oral Rehabil*. 2004;31(8):738-745.
5. Manfredini D, Winocur E, Guarda-Nardini L, Paesani D, Lobbezoo F. Epidemiology of bruxism in adults: a systematic review of the literature. *J Orofac Pain*. 2013;27(2):99-110.
6. Lavigne GJ, Kato T, Kolta A, Sessle BJ. Neurobiological mechanisms involved in sleep bruxism. *Crit Rev Oral Biol Med*. 2003;14(1):30-46.
7. Lavigne GJ, Khoury S, Abe S, Yamaguchi T, Raphael K. Bruxism physiology and pathology: an overview for clinicians. *J Oral Rehabil*. 2008;35(7):476-494.
8. Fernandes G, Franco AL, Gonçalves DA, Speciali JG, Bigal ME, Camparis CM. Temporomandibular disorders, sleep bruxism, and primary headaches are mutually associated. *J Orofac Pain*. 2013;27(1):14-20.
9. Feu D, Catharino F, Quintão CCA, Almeida MADO. A systematic review of etiological and risk factors associated with bruxism. *J Orthod*. 2013;40(2):163-171.
10. Bulanda S, Ilczuk-Rypuła D, Nitecka-Buchta A, Nowak Z, Baron S, Postek-Stefańska L. Sleep bruxism in children: etiology, diagnosis, and treatment—a literature review. *Int J Environ Res Public Health*. 2021;18(18):9544.
11. Manfredini D, Ahlberg J, Aarab G, et al. The development of the standardised tool for the assessment of bruxism (STAB): an international road map. *J Oral Rehabil*. 2022;51:15-28.
12. Gholampour S, Gholampour H, Khanmohammadi H. Finite element analysis of occlusal splint therapy in patients with bruxism. *BMC Oral Health*. 2019;19:1-9.
13. Manfredini D, Bracci A, Djukic G. BruxApp: the ecological momentary assessment of awake bruxism. *Minerva Stomatol*. 2016;65(4):252-255.
14. Amorim CS, Santo ASE, Sommer M, Marques AP. Effect of physical therapy in bruxism treatment: a systematic review. *J Manipulative Physiol Ther*. 2018;41(5):389-404.
15. Louw A, Zimney K, Puentedura EJ, Diener I. The efficacy of pain neuroscience education on musculoskeletal pain: a systematic review of the literature. *Physiother Theory Pract*. 2016;32(5):332-355.
16. Bonatesta L, Ruiz-Cardenas JD, Fernandez-Azorin L, Rodriguez-Juan JJ. Pain science education plus exercise therapy in chronic nonspecific spinal pain: a systematic review and meta-analyses of randomized clinical trials. *J Pain*. 2022;23(4):535-546.
17. Gorji SM, Mohammadi Nia Samakosh H, Watt P, Henrique Marchetti P, Oliveira R. Pain neuroscience education and motor control exercises versus core stability exercises on pain, disability, and balance in women with chronic low back pain. *Int J Environ Res Public Health*. 2022;19(5):2964.
18. Ferreira GE, Zadro JR, Traeger AC, et al. Adding brief pain science or ergonomics messages to guideline advice did not increase feelings of reassurance in people with acute low back pain: a randomised experiment. *J Orthop Sports Phys Ther*. 2023;0(ja):1-19.
19. Eldridge SM, Chan CL, Campbell MJ, et al. CONSORT 2010 statement: extension to randomised pilot and feasibility trials. *BMJ*. 2016;355:i5239.
20. Manfredini D, Ahlberg J, Aarab G, et al. Towards a standardized tool for the assessment of bruxism (STAB)—overview and general

remarks of a multidimensional bruxism evaluation system. *J Oral Rehabil*. 2020;47(5):549-556.
21. Sharma S, Kallen MA, Ohrbach R. Graded chronic pain scale: validation of 1-month reference frame. *Clin J Pain*. 2022;38(2):119-131.
22. Von Korff M, DeBar LL, Krebs EE, et al. Graded chronic pain scale revised: mild, bothersome, and high impact chronic pain. *Pain*. 2020;161(3):651-661.
23. Tait RC, Pollard CA, Margolis RB, Duckro PN, Krause SJ. The pain disability index: psychometric and validity data. *Arch Phys Med Rehabil*. 1987;68(7):438-441.
24. Jerome A, Gross RT. Pain disability index: construct and discriminant validity. *Arch Phys Med Rehabil*. 1991;72(11):920-922.
25. Cramer H, Lauche R, Langhorst J, Dobos GJ, Michalsen A. Validation of the German version of the neck disability index (NDI). *BMC Musculoskelet Disord*. 2014;15(1):1-7.
26. Ahmad M, Hollender L, Anderson Q, et al. Research diagnostic criteria for temporomandibular disorders (RDC/TMD): development of image analysis criteria and examiner reliability for image analysis. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2009;107(6):844-860. doi:10.1016/j.tripleo.2009.02.023
27. Schiffman E, Ohrbach R, Truelove E, et al. 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(1):6-27.
28. Walker N, Bohannon RW, Cameron D. Discriminant validity of temporomandibular joint range of motion measurements obtained with a ruler. *J Orthop Sports Phys Ther*. 2000;30(8):484-492.
29. Nussbaum EL, Downes L. Reliability of clinical pressure- pain algometric measurements obtained on consecutive days. *Phys Ther*. 1998;78:160-169.
30. Persson AL, Brogardh C, Sjolund BH. Tender or not tender: test-retest repeatability of pressure pain thresholds in the trapezius and deltoid muscles of healthy women. *J Rehabil Med*. 2004;36:17-27.
31. Von Piekartz H, Stotz E, Both A, et al. Psychometric evaluation of a motor control test battery of the craniofacial region. *J Oral Rehabil*. 2017;44(12):964-973.
32. Azrin NH, Nunn RG. Habit-reversal: a method of eliminating nervous habits and tics. *Behav Res Ther*. 1973;11(4):619-628.
33. Von Piekartz H. Craniomandibular region: Clinical patterns and management. In: Piekartz H, ed. *Craniofacial Pain*. Elsevier; 2007:215-284.
34. Von Piekartz H. Kiefer, gesichts-und zervikalregion. *Kraniomandibulare Region-klinische Muster und Management*. Thieme Verlag; 2015:168-225.
35. Kraus S. *Cervical Influences on Management of TMD (Temporomandibular Disorders)*. 2nd ed., 324 pp. Churchill Livingstone; 1994.
36. Zani A, Lobbezoo F, Bracci A, Ahlberg J, Manfredini D. Ecological momentary assessment and intervention principles for the study of awake bruxism behaviors, part 1: general principles and preliminary data on healthy young Italian adults. *Front Neurol*. 2019;10:169.
37. Bracci A, Djukic G, Favero L, Salmaso L, Guarda-Nardini L, Manfredini D. Frequency of awake bruxism behaviours in the natural environment: a 7-day, multiple-point observation of real-time report in healthy young adults. *J Oral Rehabil*. 2018;45(6):423-429.
38. Lally P, Gardner B. Promoting habit formation. *Health Psychol Rev*. 2013;7(sup1):S137-S158.
39. Calzolari G, Nardotto M. Effective reminders. *Manag Sci*. 2017;63(9):2915-2932.
40. Moseley GL, Butler DS. Fifteen years of explaining pain: the past, present, and future. *J Pain*. 2015;16(9):807-813.
41. Wijma AJ, van Wilgen CP, Meeus M, et al. Clinical biopsychosocial physiotherapy assessment of patients with chronic pain: The first step in pain neuroscience.
42. Jones MA. Clinical reasoning: fast and slow thinking in musculoskeletal practice. In: Jones MA, Rivett D, eds. *Clinical Reasoning in Musculoskeletal Practice*. Elsevier Health Sciences; 2018:2-31.
43. Stanisic N, Do CT, Skarping S, et al. Smartphone application to report awake bruxism: development and testing of the Swedish version and a pilot study to evaluate family history in young adults and their parents. *J Oral Rehabil*. 2023;51:188-195.

How to cite this article: von Piekartz H, Bleiss S, Herzer S, Hall T, Ballenberger N. Does combining oro-facial manual therapy with bruxism neuroscience education affect pain and function in cases of awake bruxism? A pilot study. *J Oral Rehabil*. 2024;51:1692-1700. doi:10.1111/joor.13740

APPENDIX A

Participant code:

You received physiotherapeutic treatment for your facial, jaw and neck pain. Please respond to the following questions for the three months following your treatment in this study. Select one answer for each question. Many thanks

1. During your treatment period, how satisfied were you with the use the Brux.App:
   a. Very Satisfied (more than 10 times)
   b. Moderately Satisfied (between 5 and 10 times)
   c. Less Satisfied (less than 5 times)
   d. Not Satisfied
2. Did you use the Rot Dot method? If so how satisfied were you:
   a. Very Satisfied (more than 10 times)
   b. Moderately Satisfied (between 5 and 10 times)
   c. Less Satisfied (less than 5 times)
   d. Not Satisfied
3. Did you use both the Brux.App and the Rot Dot method? If so how satisfied were you?:
   a. Very Satisfied (more than 10 times)
   b. Moderately Satisfied (between 5 and 10 times)
   c. Less Satisfied (less than 5 times)
   d. Not Satisfied
4. Did you benefit from the therapy?:
   a. I improved significantly and greatly benefited
   b. I improved somewhat and benefited from it
   c. I improved minimally and gained minimal benefit
   d. I became worse
5. Can you better manage the complaints associated with your bruxism?:
   a. I manage it significantly better
   b. I manage it noticeably better
   c. I manage it slightly better
   d. No change in ability to manage
   e. I manage it worse