


Eye Movement Desensitization and Reprocessing as a Treatment for Tinnitus

John S. Phillips, PhD, FRCS(ORL-HNS) ; Sally Erskine, MD, MRCS(ENT); Tal Moore, BA, MSc, ClinPsyD;
Ian Nunney, MSc; Catherine Wright, RGN

Objectives/Hypothesis: To determine the effectiveness of eye movement desensitization and reprocessing (EMDR) as a treatment for tinnitus.

Study Design: Single-site prospective interventional clinical trial at a university hospital in the United Kingdom.

Methods: Participants were provided with tEMDR. This is a bespoke EMDR protocol that was developed specifically to treat individuals with tinnitus. Participants received a maximum of 10 sessions of tEMDR. Outcome measures including tinnitus questionnaires and mood questionnaires were recorded at baseline, discharge, and at 6 months postdischarge.

Results: Tinnitus Handicap Inventory and Beck Depression Inventory scores demonstrated a statistically significant improvement at discharge after EMDR intervention ($P = .0005$ and $P = .0098$, respectively); this improvement was maintained at 6 months postdischarge. There was also a moderate but not significant ($P = .0625$) improvement in Beck Anxiety Inventory scores.

Conclusions: This study has demonstrated that the provision of tEMDR has resulted in a clinically and statistically significant improvement in tinnitus symptoms in the majority of those participants who took part. Furthermore, the treatment effect was maintained at 6 months after treatment ceased. This study is of particular interest, as the study protocol was designed to be purposefully inclusive of a diverse range of tinnitus patients. However, as a small uncontrolled study, these results do not consider the significant effects of placebo and therapist interaction. Larger high-quality studies are essential for the verification of these preliminary results.

Key Words: Tinnitus, eye movement desensitization and reprocessing, neurotology, quality of life.

Level of Evidence: 4

Laryngoscope, 00:1-7, 2019

INTRODUCTION

Tinnitus is a common, yet poorly understood condition,^{1,2} with a prevalence of about 10% in the United Kingdom.³ Despite the high worldwide prevalence of tinnitus and the large number of proposed therapies available, there is a distinct paucity of well controlled trials in the literature to support an effective treatment.⁴ Eye movement desensitization and reprocessing (EMDR) is an integrative psychotherapy that involves bilateral stimulation, such as rapid movements of the eyes from side to side. EMDR is gaining popularity as an effective treatment for an increasing number and broad range of conditions. Since its introduction in 1989, numerous controlled studies have been conducted to evaluate EMDR's utility as a treatment for various forms of

trauma-related complaints, particularly posttraumatic stress disorder (PTSD).⁵

EMDR therapy is an eight-phase treatment composed of standardized protocols and procedures. These phases follow a process of history taking, preparation of the patient, assessment, desensitization, installation, body scanning, closure and reassessment. During a typical EMDR therapy session patients divide their attention between recalling traumatic memories and engaging in a bilateral cue. To enable bilateral stimulation, the original EMDR protocol involved the patient sitting across from the therapist and following the therapist's hand repeatedly moving from right to left. As EMDR expanded, other forms of bilateral stimulation evolved. Rather than relying on eyes tracking a visual stimuli alone, auditory and/or tactile forms of bilateral stimulation were introduced in addition to the eye movements or on their own. Shapiro states that "Like CBT with a trauma focus, EMDR therapy aims to reduce subjective distress and strengthen adaptive cognitions related to the traumatic event. Unlike CBT with a trauma focus, EMDR does not involve a) detailed descriptions of the event, b) direct challenging of beliefs, c) extended exposure, or d) homework."⁶

There are a number of common features that promote EMDR as a potentially viable mode of treatment for individuals with tinnitus. Tinnitus may be considered as a form of phantom auditory perception, parallels have been drawn between individuals with chronic tinnitus and individuals

From the Norfolk and Norwich University Hospital National Health Service Foundation Trust (J.S.P., S.E., T.M., C.W.), Norwich, United Kingdom; and the Norwich Clinical Trials Unit (I.N.), Norwich Medical School, University of East Anglia, Norwich, United Kingdom.

Editor's Note: This Manuscript was accepted for publication on January 7, 2019.

J.S.P. has paid consultancies with Otonomy.

This work was funded by a research award from the British Tinnitus Association.

The authors have no other funding, financial relationships, or conflicts of interest to disclose.

Send correspondence to John S. Phillips, Department of Otolaryngology, Norfolk and Norwich University Hospital, Colney Lane, Norwich, Norfolk NR4 7UY, United Kingdom. E-mail: john.phillips@mac.com

DOI: 10.1002/lary.27841

with chronic pain,^{7,8} and traumatic personal experiences can influence the maintenance of chronic tinnitus.⁹⁻¹² There has been recent interest in the use of eye movement therapies to treat patients with phantom sensations such as phantom limb pain.^{13,14} EMDR is used as a treatment for chronic pain,¹⁵ and the utilization of EMDR for trauma-related conditions is widely reported.¹⁶ In view of these encouraging features, together with emerging evidence from earlier proof of concept work,¹⁷ the authors of this article embarked on a feasibility study to determine whether a bespoke form of EMDR could be considered to be an effective treatment for individuals with tinnitus.

MATERIALS AND METHODS

The ethical issues regarding this study were presented to the United Kingdom National Health Service (NHS) National Research Ethics Service for approval before acquiring local approvals from the Research and Development department of the Norfolk and Norwich University Hospital NHS Foundation Trust.

Participants

Patients being treated at Norfolk and Norwich University Hospital NHS Foundation Trust were offered the opportunity to participate in this study. Inclusion criteria were: 1) adults aged 18 years old and above with the capacity to consent; 2) subjective idiopathic tinnitus, specifically chronic decompensated tinnitus, with a Tinnitus Handicap Inventory (THI) score of 38 to 100; 3) tinnitus for greater than 6 months duration; and 4) willing to commit to a full course of EMDR therapy. Exclusion criteria were: 1) severe mental health problems (current treatment from secondary care mental health services) and 2) difficulty communicating in English.

Treatment Protocol

Study participants received EMDR therapy according to a bespoke protocol that was developed specifically for patients experiencing tinnitus (tEMDR). This protocol drew on the work of Shapiro's original adult-based EMDR protocol¹⁸ and Grant's 2009 EMDR protocol for the treatment of chronic pain.¹⁹ Each participant underwent a maximum number of 10 sessions of tEMDR therapy lasting 60 minutes each. tEMDR therapy sessions occurred regularly with a frequency of once every 1 to 2 weeks. The tEMDR was administered by a single clinical psychologist, accredited as an EMDR practitioner, at the Norfolk and Norwich University Hospitals NHS Foundation Trust.

An EMDR therapy session is an individual therapy session with a trained EMDR therapist. Prior to the initial EMDR session, each study participant was provided with a verbal and written explanation of the rationale behind the use of EMDR therapy for their tinnitus. EMDR was provided according to the standard eight-phase protocol comprising 1) history and treatment planning, 2) client preparation, 3) assessment, 4) desensitization, 5) installation, 6) body scan, 7) closure, and 8) reevaluation. Each study participant worked with the therapist to collect a relevant history and current information about the study participant's experiences of his/her tinnitus, which provided the basis for an individually tailored formulation. If the participant experienced historical trauma that was psychologically linked to the tinnitus, the traumatic event(s) was initially processed using the standard EMDR protocol. Once the past tinnitus-related trauma was processed, and for those participants who did not have past trauma related to their tinnitus, the tEMDR protocol followed. In the

tEMDR protocol, the study participant is then asked to create a description of their tinnitus that included: 1) an image or a felt sense that represents the study participant's tinnitus experiences, 2) negative belief(s) in relationship to the tinnitus experiences, 3) a preferred belief in relation to the experiences, 4) the (usually negative/undesirable) emotions associated with the experiences, and 5) the physical sensations associated with the experiences. Subjective ratings of disturbance (SUDS) (ranging from 0 = neutral/no distress to 10 = bad/most distressing) and the study participant's subjective validity of the positive beliefs/cognitions (ranging from 0 = perceiving the belief as completely false to 7 = seeing the belief as completely true) were recorded to monitor progress during each session.

After this protocol was established, the desensitization phase began with one of two forms of bilateral stimulation: bilateral eye movements or pulsators for bilateral tactile stimulation; this was subject to the study participant's preference. The pulsators option had two pulsators held in each hand that provided alternating bilateral tactile stimulation. The pulsators were connected to a battery-operated control box held by the therapist. When turned on, the pulsators provided alternating gentle vibrations, which could be altered in speed and length.

Each study participant progressed through the process of bilateral stimulation sets, pausing and reporting on inner observations and experienced change between each set. Assuming that the study participant's thoughts, feelings, images, and physical sensations became less distressing, the therapist asked them to reconsider how true the positive belief seemed now, and this was strengthened with short sets of bilateral stimulation. Finally, participants were invited to create a positive statement about their changed experience of their tinnitus, and bilateral stimulation was employed to help the participant begin to embed this new way of thinking about themselves.

Each study participant was provided with a maximum number of 10 tEMDR sessions, exclusive of the initial history-taking session. However, 10 sessions were not required for all participants. Discontinuation of tEMDR sessions took place when a participant had completed processing all of their negative tinnitus-related beliefs and either of the following levels had been attained: 1) a SUDS level of less than 3 or 2) a THI score of less than 18.

Outcome Measurements

The primary outcome measure was the THI score. Secondary outcome measures were the Beck Depression Inventory (BDI),²⁰ and the Beck Anxiety Inventory (BAI).²¹ Each participant took part in the study for a maximum of 10 weeks. Outcome measures were administered by a research nurse. Measures were recorded at the preintervention assessment (T0), and then further assessments were made at discharge (T1) and 6 months postdischarge (T2). The THI questionnaire was completed prior to every contact session with the clinician. In total, the THI questionnaire was completed at consent (T0), before the first EMDR session (on the day of the EMDR session), and then before every subsequent EMDR session began (on the day of the EMDR session) for up to a maximum of 10 EMDR sessions, at discharge (T1), and then at 6 months postdischarge (T2). This provided a maximum of 13 data points.

Adverse Events

Adverse events were reviewed at every study visit.

TABLE I.
Characteristics of Study Participants.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Age, yr	67	44	60	50	64	66	73	58	57	49	32	70	67	39
Sex	M	M	F	M	F	M	F	F	M	F	M	M	F	F
Location of tinnitus	Bilateral	Bilateral	Left	Bilateral	Left	Bilateral	Central	Left	Left	Central	Left	Bilateral	Bilateral	Left
Duration of tinnitus, yr	6	1	0.5	5	1	20	5	2	1	5	10	12	3	3
Etiology of tinnitus	Noise	Not known	Not known	Not known	Otitis media	Stress	Not known	Not known	Stress	Not known	Not known	Not known	Noise	Ear surgery
Hearing status*	BiModHi hearing loss	BiMod hearing loss	BiModHi hearing loss	BiSev hearing loss	UniMidHi hearing loss	BiMidHi hearing loss	BiModHi hearing loss	BiMidHi hearing loss	UniSevMidHi hearing loss	BiModMidHi hearing loss	BiMidHi hearing loss	UniMod hearing loss	BiModHi hearing loss	UniSevMidHi hearing loss
No. of EMDR sessions	3	7	10	7	7	10	8	9	10	10	9	10	6	9
Baseline THI score	72	47	55	84	56	65	43	60	74	67	69	54	39	86

*Hearing status has been reported according to the British Society of Audiology recommendations (mild hearing loss: 20-40 dB HL; moderate hearing loss: 41-70 dB HL; severe hearing loss: 71-95 dB HL; profound hearing loss: >95 dB HL).
 BiModHi = bilateral mild high frequency; BiMod = bilateral moderate (across all frequencies); BiMidHi = bilateral moderate mid and high frequency; BiSev = bilateral severe (across all frequencies); EMDR = eye movement desensitization and reprocessing; TH = Tinnitus Handicap Inventory; UniMidHi = unilateral mild high frequency; UniMod = unilateral moderate (across all frequencies); UniSevMidHi = unilateral severe mid and high frequency.

Statistical Analysis

Descriptive statistics were reported for all variables at baseline. For the primary and secondary outcome variables, descriptive statistics were reported for the change from baseline for their respective recorded time points. A Wilcoxon signed rank test was also performed to test for differences in the changes from baseline. All analyses were carried out using SAS statistical software version 9.4 (SAS Institute, Cary, NC).

RESULTS

Seventeen individuals with tinnitus were recruited to take part in this study. Of those, three participants withdrew before completion of their tEMDR therapy. One withdrawal was due to work commitments interfering with session attendance. For another participant it was the increased awareness that the tinnitus was associated with painful childhood experiences but not feeling in a position to explore this. For the third participant that withdrew, no explanation was provided as contact with them was lost. Of the fourteen participants who completed this study, 50% of the participants were male, and the average age was 57 years (standard deviation = 12.4). The median duration of tinnitus symptoms was 4 years (interquartile range [IQR] = 1-9 years). The median number of EMDR sessions undertaken by the participants was nine sessions (IQR = 7-10 sessions). Table I summarizes key characteristics of the study participants. Table II reports the overall trial results. Figure 1 illustrates the improvements in THI for individual study participants. Figure 2 illustrates the overall improvements in THI for all study participants. No adverse events were reported.

At discharge (T1), the median improvement in THI score was 20 (IQR = 16-35), which was a statistically significant improvement ($P = .0005$). Eight (57.1%) of the 14 subjects had an improvement greater than 20 points. The BDI scores also improved from baseline, with a median improvement of seven points (IQR = 0-11; $P = .0098$). For both THI

TABLE II.
Overall Trial Results.

Outcome	Median (IQR)	Decrease From T0	P Value*	Percentage > 20-Point Decrease
THI				
T0	62.5 (54-72)			
T1	37.5 (34-49)	20 (16-35)	.0005	8 (57.1%), 17% to 71%
T6	38.5 (32-46)	24 (11-30)	.0009	9 (64.3%), 11% to 61%
BDI				
T0	13.5 (7.5-18.5)			
T1	6.5 (1.0-11.0)	7.0 (0-11)	.0098	
T6	6.0 (1.0-13.0)	6.5 (0-10)	.0054	
BAI				
T0	6 (2-12)			
T1	5 (2-8)	3.5 (2-5)	.0625	
T6	5.5 (3.0-8.0)	1.5 (0-4)	.3125	

*Wilcoxon signed rank test.
 BAI = Beck Anxiety Inventory; BDI = Beck Depression Inventory; IQR = interquartile range; THI = Tinnitus Handicap Inventory; T0 = preintervention assessment; T1 = discharge; T2 = 6 months postdischarge.

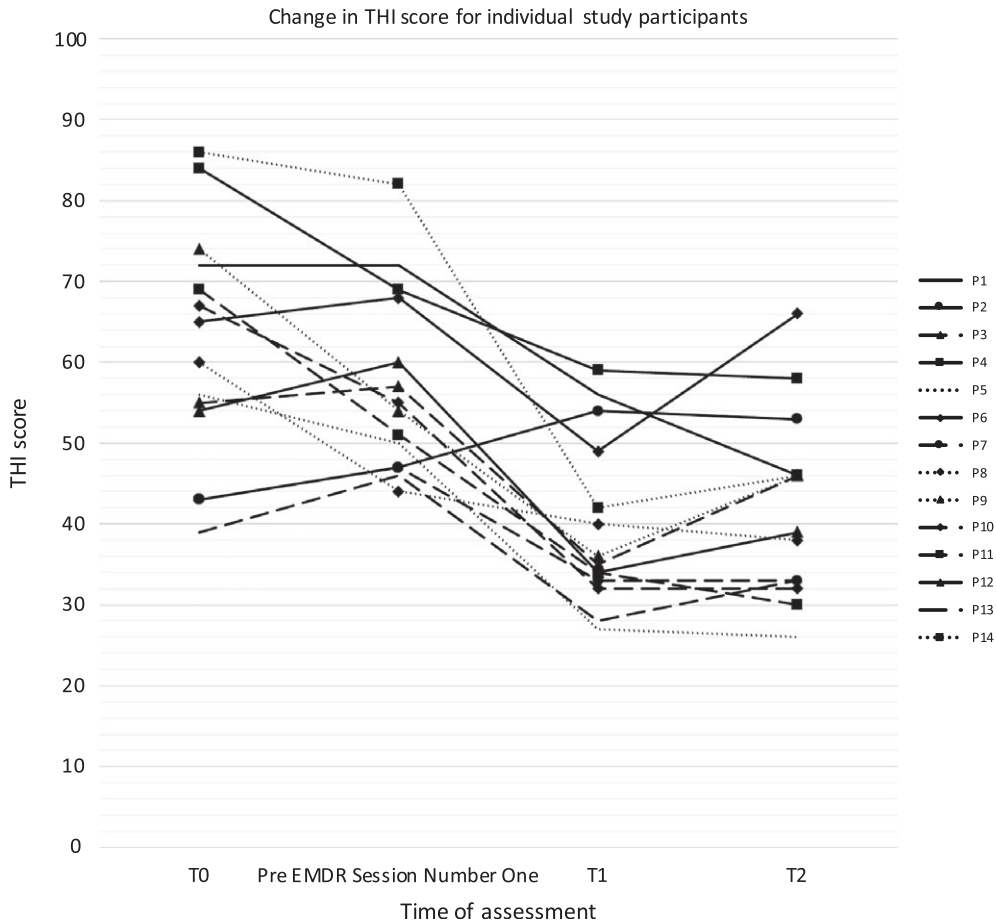


Fig. 1. Change in Tinnitus Handicap Inventory (THI) score for individual study participants. EMDR = eye movement desensitization and reprocessing.

and BDI, the improvement was also maintained at the 6-month follow-up (T2). THI scores improved by a median of 24 points (IQR = 11–30; $P = .0009$) with nine (64.3%) of

the 14 subjects having an improvement greater than 20 points. The BAI scores had a statistically nonsignificant improvement at both discharge and at the 6-month follow-

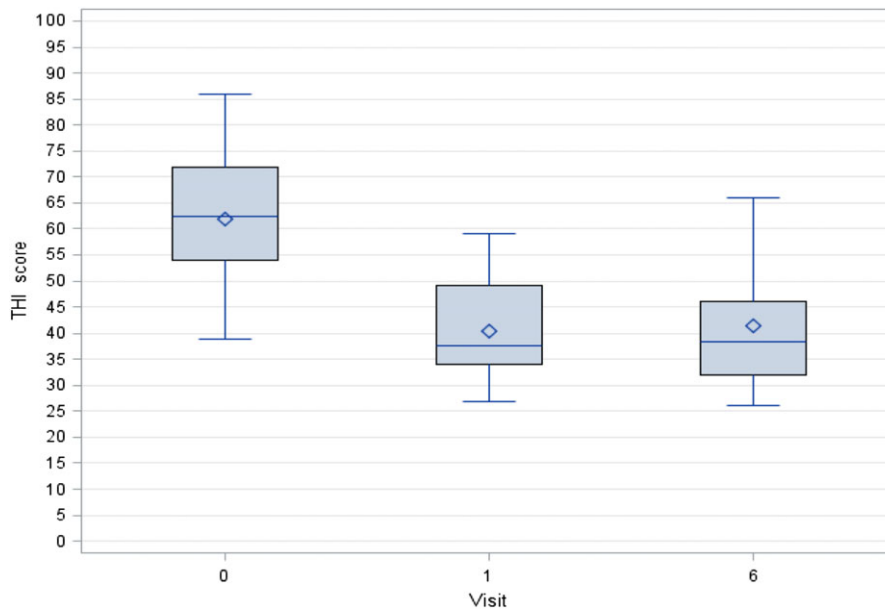


Fig. 2. Improvements in Tinnitus Handicap Inventory (THI) for study participants. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

up. This was expected, as the baseline median anxiety score of 6 (IQR = 2–12) was considered to be a low median score. The median improvement in BAI scores at discharge was 3.5 (IQR = 2–5; $P = .0625$), and at 6 months it was 1.5 (IQR = 0 to 4; $P = .3125$).

DISCUSSION

EMDR was first described by Shapiro in 1989.²² Its application has been particularly documented in the context of PTSD.¹⁶ EMDR has been described as an integrative psychotherapy,²³ due to its assimilation of various elements from diverse psychotherapies. A number of models have been proposed to account for the role of eye movements in EMDR, including Shapiro's adaptive information processing model,¹⁸ Dyck's conditioning model,²⁴ attentional processing accounts,²⁵ and theories of reverse learning.²⁶ A recurrent mechanism in a number of these accounts is that of the orientating reflex. MacCollock and Feldman argue that lateral eye movements trigger an investigatory component of this reflex to assess safety with regard to potential external threats.²⁷ Where threats are positively identified, a fight or flight response is initiated; in situations where no danger is identified, a functional reduction in arousal takes place. Support for this reassurance response in nonclinical patients has been demonstrated using auditory stimuli.²⁸ Overlap between these concepts and theories related to the perception of tinnitus bode well, especially when one considers the neurophysiological model proposed by Jastreboff.²⁹ Recent evidence from the neuroscience literature provides further insight regarding the mechanisms by which the tracking of lateral eye movements can alter the retention of emotional memories and reduce learned fear responses. Brain imaging data suggest that engagement with a bilateral stimulus alone activates prefrontal brain pathways, which in turn deactivate (due to resource competition) the amygdala, the brain's emotional threat center.³⁰ This competition for neural resource has also been shown to lessen the experience of fear related to a stimulus.³⁰ Similarly, previous studies that tasked working memory reported a reduction in emotionality and vividness of autobiographical memories and in the experience of intrusive memories.^{31–33}

The positive results from numerous clinical trials has established EMDR as an effective trauma treatment and have prompted numerous professional organizations to recognize its efficacy, beginning with the American Psychological Association's (APA) Division 12 Task Force on Psychological Interventions³⁴ in 1998. Since then, the NHS,³⁵ the International Society for Traumatic Stress Studies,³⁶ the Israeli National Council for Mental Health,³⁷ and the Northern Ireland Department of Health³⁸ have also supported EMDR. Most recently, the US Department of Defense and Department Veterans Affairs³⁹ stated that EMDR was an effective treatment of trauma, as did the American Psychiatric Association.⁴⁰ It has also been found to be helpful in medically unexplained symptoms and somatoform disorders.⁴¹

Cognitive science has provided neural networks that model tinnitus.⁴² These neural network models were inspired by theoretical models that described possible

neural mechanisms mediating tinnitus.^{29,43,44} The majority of these models rely on the lateral-inhibition network to simulate tinnitus^{45–48} and focus on the role of central auditory processing regions as possible anatomical locations of the physiological abnormalities that cause tinnitus. Recent work has identified a number of regions responsible for the generation and modulation of tinnitus including limbic, somatosensory, and motor areas.⁴⁹ There has been some encouraging work described in the German literature regarding the effectiveness of EMDR for the treatment of tinnitus.⁵⁰ Further benefit has been identified during earlier trials performed in Vancouver, Canada on a small number of participants.¹⁷ A recent small pilot study from the Netherlands has further contributed to the literature regarding the use of EMDR in individuals with tinnitus.⁵¹ This study has taken a different approach to our study, in as much as a more trauma-focused approach has been employed. Our study has taken in account parallels between chronic tinnitus and chronic pain, and as such, we were keen to provide a more bespoke approach to the creation of EMDR protocol that would specifically meet the requirements of individuals with tinnitus (tEMDR). For this reason, the tEMDR protocol has a present-oriented focus on the experience of the tinnitus that meets the needs of the majority of tinnitus sufferers seen in our trial for whom there was no trauma history related to the tinnitus. The Dutch study has been well designed and has produced encouraging results, but as a pilot study, it reports the same shortcomings as our preliminary study. The solution to understanding the outcomes of emerging therapies for difficult-to-treat conditions is often cited as to perform well-controlled randomized clinical trials; however, any future trial would need to strongly consider the influence of placebo and the fact that a distressed individual is receiving interaction with an interested and motivated therapist. It is not possible to propose at this stage where on the spectrum (from trauma-focused EMDR therapy to pain-focused EMDR therapy) EMDR for tinnitus patients should lie, but the determination of this balance is likely to be specific to the individual needs of the individual tinnitus patient receiving therapy.

The purpose of the study was to determine whether our bespoke protocol for providing EMDR therapy (tEMDR) was effective for a small diverse group of individuals with tinnitus. With this respect, we have found this to be true, with the provision of tEMDR resulting in clinically and statistically significant improvement in tinnitus symptoms for the majority of participants. Furthermore, the treatment effect was sustained at 6 months after treatment ceased.

Many contemporary clinical trials for tinnitus treatments are restricted with respect to their inclusion criteria, and this can pose an issue regarding the generalizability of their results. Recent examples include drug trials that require the participants to have had experienced a recent onset of tinnitus due to a known insult to the inner ear. As an early exploratory clinical trial, this study has benefited from a study protocol that was designed to be purposefully inclusive of a diverse range of tinnitus patients; there was no restriction with respect to tinnitus onset, tinnitus etiology, or associated hearing loss for the individuals who participated in our study. This means that the potential benefit

of tEMDR could be considered for a better representation of the tinnitus patient population at large.

Limitations of the Study

This study is limited as it is a small study, but despite the small numbers of participants taking part, the results are of significance both clinically and statistically. As emphasized above, a placebo effect is particularly prevalent in tinnitus studies,⁵² so these results do have to be reviewed with caution. Only well-designed randomized controlled clinical trials can truly demonstrate benefit of tEMDR in comparison to an appropriate control group. However, the degree of improvement in symptoms in a group of individuals, some of whom suffering from tinnitus for a very long time, should not be overlooked.

Implications for the Future

The success of this small clinical trial provides data to support the design and execution of a larger, formal, randomized controlled clinical trial. The data acquired from this study will allow appropriate estimates to be made regarding sample sizes. Evolutions in the methods employed to measure tinnitus will also be considered.⁵³ For future evolutions of this current trial, great caution would need to be heeded regarding the use of a fair control group. A multitude of trial design options exist, all requiring a balanced consideration of scientific merit and ethical issues. A trial that avoids a control group that involves interaction with a clinician or therapist should be strongly considered.

Interest in applying EMDR for a variety of new indications is increasing. This current study builds on a foundation of scientific evidence that is evolving. From a pathophysiological perspective, if EMDR is ultimately found to be an effective treatment for tinnitus, this will further our understanding of the pathways that initiate, propagate, and maintain tinnitus perception, stimulating further research to explore these pathways in more detail.

CONCLUSION

This small study has demonstrated that the provision of tEMDR has resulted in a clinically and statistically significant improvement in tinnitus symptoms in the majority of those participants who took part. Furthermore, the treatment effect was sustained at 6 months after treatment ceased. This study is of particular interest, as the study protocol was designed to be purposefully inclusive of a diverse range of tinnitus patients. However, as this is an uncontrolled study, these results do not consider the effects that might have been due to placebo and/or the therapist interaction. Larger high-quality studies are essential for the verification of these preliminary results.

BIBLIOGRAPHY

1. Lockwood AH, Salvi RJ, Burkard RF. Tinnitus. *N Engl J Med* 2002;347:904–910.

2. Noell CA, Meyerhoff WL. Tinnitus. Diagnosis and treatment of this elusive symptom. *Geriatrics* 2003;58:28–34.
3. Davis A, El Rafaie A. Epidemiology of tinnitus. In: Tyler RS, ed. *Tinnitus Handbook*. San Diego, CA: Singular; 2000:1–23.
4. McFerran D, Phillips JS. Tinnitus and hyperacusis. In: Watkinson J, Clarke R, eds. *Scott-Brown's Otorhinolaryngology and Head and Neck Surgery*. 8th ed. Boca Raton, FL: CRC Press; 2018.
5. Oren E, Solomon R. EMDR therapy: an overview of its development and mechanisms of action. *Eur Rev Appl Psychol* 2012;62:197–203.
6. Shapiro F. The role of eye movement desensitization and reprocessing (EMDR) therapy in medicine: addressing the psychological and physical symptoms stemming from adverse life experiences. *Perm J* 2014;18:71–77.
7. Sedley W, Friston KJ, Gander PE, Kumar S, Griffiths TD. An integrative tinnitus model based on sensory precision. *Trends Neurosci* 2016;39:799–812.
8. Eggermont JJ, Roberts LE. Tinnitus: animal models and findings in humans. *Cell Tissue Res* 2014;361:311–336.
9. Fagelson MA. The association between tinnitus and posttraumatic stress disorder. *Am J Audiol* 2007;16:107–117.
10. Fagelson MA, Smith SL. Tinnitus self-efficacy and other tinnitus self-report variables in patients with and without post-traumatic stress disorder. *Ear Hear* 2016;37:541–546.
11. Gupta MA. Review of somatic symptoms in post-traumatic stress disorder. *Int Rev Psychiatry* 2013;25:86–99.
12. Carpenter-Thompson JR, Akrofi K, Schmidt SA, Dolcos F, Husain FT. Alterations of the emotional processing system may underlie preserved rapid reaction time in tinnitus. *Brain Res* 2014;1567:28–41.
13. Wilensky M. Eye movement and desensitization and reprocessing (EMDR) as treatment for phantom limb pain. *J Brief Ther* 2006;54:31–44.
14. Schneider J, Hofmann A, Rost C, Shapiro F. EMDR in the treatment of chronic phantom limb pain. *Pain Med* 2008;9:76–82.
15. Tesarz J, Leisner S, Gerhardt A, et al. Effects of eye movement desensitization and reprocessing (EMDR) treatment in chronic pain patients: a systematic review. *Pain Med* 2014;15:247–263.
16. Bisson J, Andrew M. Psychological treatment of post-traumatic stress disorder (PTSD). *Cochrane Database Syst Rev* 2007;(3):CD003388.
17. Phillips JS. EMDR for tinnitus. Paper presented at: 29th Politzer Society Meeting; 2013; Antalya, Turkey.
18. Shapiro F. *Eye Movement Desensitization and Reprocessing (EMDR): Basic Principles, Protocols, and Procedures*. 2nd ed. New York City, NY: Guilford Press; 2001.
19. Grant M. *Pain Control with EMDR: Treatment Manual*. 5th ed. Scotts Valley, CA: CreateSpace; 2009.
20. Beck AT, Steer RA, Brown GK. *The Beck Depression Inventory*. 2nd ed. San Antonio, TX: Psychological Corp.; 1996.
21. Beck AT, Epstein N, Brown G, Steer RA. An inventory for measuring clinical anxiety: psychometric properties. *J Consult Clin Psychol* 1988;56:893–897.
22. Shapiro F. Efficacy of the eye movement desensitization procedure in the treatment of traumatic memories. *J Trauma Stress* 1989;2:199–223.
23. Shapiro F. Paradigms, processing, and personality development. In: Shapiro F, ed. *EMDR as an Integrative Psychotherapy Approach: Experts of Diverse Orientations Explore the Paradigm Prism*. Washington, DC: American Psychological Association Press; 2002.
24. Dyck M. A proposal for a conditioning model of eye movement desensitization treatment for posttraumatic stress disorder. *J Behav Ther Exp Psychiatry* 1993;24:201–210.
25. Kuiken D, Bears M, Miall D, Smith L. Eye movement desensitization reprocessing facilitates attentional orienting. *Imagin Cogn Pers* 2002;21:3–20.
26. Hassard A. Reverse learning and the physiological basis of eye movement desensitization. *Med Hypotheses* 1996;47:277–282.
27. MacCulloch MJ, Feldman P. Eye movement desensitization treatment utilizes the positive visceral element of the investigatory reflex to inhibit the memories of post-traumatic stress disorder: a theoretical analysis. *Br J Psychiatry* 1996;169:571–579.
28. Barrowcliff AL, Gray NS, MacCulloch S, Freeman TC, MacCulloch MJ. Horizontal rhythmic eye movements consistently diminish the arousal provoked by auditory stimuli. *Br J Clin Psychol* 2003;42(pt 3):289–302.
29. Jastreboff PJ. Phantom auditory perception (tinnitus): mechanisms of generation and perception. *Neurosci Res* 1990;8:221–254.
30. de Voogd LD, Kanen JW, Neville DA, Roelofs K, Fernández G, Hermans EJ. Eye-movement intervention enhances extinction via amygdala deactivation. *J Neurosci* 2018;38:8694–8706.
31. Holmes EA, James EL, Coode-Bate T, Deerprou C. Can playing the computer game "Tetris" reduce the build-up of flashbacks for trauma? A proposal from cognitive science. *PLoS One* 2009;4:e4153.
32. Engelhard IM, van Uijen SL, van den Hout MA. The impact of taxing working memory on negative and positive memories. *Eur J Psychotraumatol* 2010;1:5623.
33. James EL, Bonsall MB, Hoppitt L, et al. Computer Game play reduces intrusive memories of experimental trauma via reconsolidation-update mechanisms. *Psychol Sci* 2015;26:1201–1215.
34. Chambless DL, Baker MJ, Baucom DH, et al. Update on empirically validated therapies. II. *Clin Psychol* 1998;51:3–16.
35. National Collaborating Centre for Mental Health. National Institute for Clinical Excellence. *Post traumatic stress disorder (PTSD): the management of adults and children in primary and secondary care*. Leicester, United Kingdom: Gaskell; 2005.
36. Chemtob CM, Tolin DF, van der Kolk BA, Pitman RK. Eye movement desensitization and reprocessing. In Foa EB, Keane TM, Friedman MJ,

- eds. *Effective treatments for PTSD: practice guidelines from the International Society for Traumatic Stress Studies*. New York, NY: Guilford Press; 2000:139–155, 333–335.
37. Bleich A, Kotler M, Kutz E, Shaley A. A position paper of the (Israeli) National Council for Mental Health: Guidelines for the assessment and professional intervention with terror victims in the hospital and in the community. Jerusalem, Israel: Israeli National Council for Mental Health; 2002.
 38. Clinical Resource Efficiency Support Team. *The Management of Post Traumatic Stress Disorder in Adults*. Belfast, Northern Ireland: Northern Ireland Department of Health; 2003.
 39. Department of Veterans Affairs and Department of Defense. VA/DoD clinical practice guideline for the management of post-traumatic stress. 2004. Available at: <https://www.healthquality.va.gov/guidelines/mh/ptsd/>. Accessed January 23, 2019.
 40. American Psychiatric Association. *Practice guideline for the treatment of patients with acute stress disorder and posttraumatic stress disorder*. Arlington, VA: American Psychiatric Association Practice Guidelines; 2004.
 41. van Rood YR, C de Roos. EMDR in the treatment of medically unexplained symptoms: a systematic review. *J EMDR Pract Res* 2009;3:248–263.
 42. Husain FT. Neural network models of tinnitus. *Prog Brain Res* 2007;166:125–140.
 43. Moller AR. Pathophysiology of tinnitus. *Ann Otol Rhinol Laryngol* 1984;93:39–44.
 44. Moller AR. Pathophysiology of tinnitus. In: Vernon JA, Moller AR, eds. *Mechanisms of Tinnitus*. Boston, MA: Allyn and Bacon; 1995:207–217.
 45. Gerken GM. Central tinnitus and lateral inhibition: an auditory brainstem model. *Hear Res* 1996;97:75–83.
 46. Kral A, Majernik V. On lateral inhibition in the auditory system. *Gen Physiol Biophys* 1996;15:109–127.
 47. Bruce I, Bajaj H, Ko J. Lateral-inhibitory-network model of tinnitus. In: *5th IFAC Symposium on Modelling and Control in Biomedical Systems*. Amsterdam, the Netherlands: Elsevier; 2003:359–363.
 48. Dominguez M, Becker S, Bruce I, Read H. A spiking neuron model of cortical correlates of sensorineural hearing loss: spontaneous firing synchrony, and tinnitus. *Neural Comput* 2006;18:2942–2958.
 49. Bauer CA. Mechanisms of tinnitus generation. *Curr Opin Otolaryngol Head Neck Surg* 2004;12:413–417.
 50. Zengin F. Treatment of acute hearing loss and tinnitus with EMDR therapy. In: Plassmann R. *At Your Own Pace: The EMDR Treatment of Eating Disorders, Attachment Disorders, Allergies, Pain, Anxiety Disorders, Tinnitus and Addictions (Research Psychosocial)*. Giessen Germany: Psychosozial Verlag; 2008.
 51. Rikkert M, van Rood Y, de Roos C, Ratter J, van den Hout M. A trauma-focused approach for patients with tinnitus: the effectiveness of eye movement desensitization and reprocessing - a multicentre pilot trial. *Eur J Psychotraumatol* 2018;9(1):1512248.
 52. Phillips JS, McFerran DJ, Hall DA, Hoare DJ. The natural history of subjective tinnitus in adults: a systematic review and meta-analysis of no-intervention periods in controlled trials. *Laryngoscope* 2018;128:217–227.
 53. Hall DA, Smith H, Heffernan E, Fackrell K; Core Outcome Measures in Tinnitus International Delphi (COMiTID) Research Steering Group. Recruiting and retaining participants in e-Delphi surveys for core outcome set development: evaluating the COMiTID study. *PLoS One* 2018;13:e0201378.