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Version 4.0 - December 2019.

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BrainTap Technologies Literature Review. Version 4.0 - December 2019.

1. Disclaimer

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2. Data acquisition and study selection

Studies using the keywords listed on table 1 were collected in this review.

Publications for potential inclusion were retrieved via a systematic search of PubMed and the CochraneLibrary.

Citations were limited to English, Portuguese, Spanish, Italian, French and German language. The literature search was completed on NOV 10, 2019.

3. Results

3.1. Number of publications retrieved

The number of retrieved publications that met the selection criteria according to each term or combination of terms is listed below:

Keywords	Number of Publications	Publications of Relevance
Terms related to Audio-visual Brain Entrainment		
Audio-Visual Entrainment	11	0
Audio-Visual Stimulation	459	5
Auditory Beat Stimulation	277	13
Binaural Beats	96	39
Brain Entrainment	309	4
Brainwave Entrainment	171	11
Isochronic Tones	2	0
Meditative Binaural Music	1	1
Neuro-Sensory Algorithms	1	0
TOTAL	**1327**	**73 (57)***
Terms related to Auriculotherapy + "LASER" OR "light" OR “low level" OR "LLLT" OR "Diode"		
Auricular Therapy	199	1
Auriculotherapy	34	5
Ear Acupuncture	71	3
TOTAL	**304**	**9 (7)***

Table 1: Search keywords.
*Some publications were retrieved with more than one set of keywords. The number in parenthesis are total single publications retrieved.

3.2. Summary of the publications retrieved

3.2.1. For the keywords: “Audio-Visual Stimulation”

1. 2016 Grasso et al. [Clinical trial, n=10]. Audio-visual multisensory stimulation promote long-term plastic changes in hemianopics (patients suffering from blindness over half the field of vision), resulting in stable and long-lasting ameliorations in behavioral and electrophysiological measures.
2. 2015 Tang et al. [Review]. Open-Loop Audio-Visual Stimulation (AVS) can potentially improve sleep and reduce pain.
3. 2015 Tinelli et al. [?]. Audiovisual training can induce activation of visual responsiveness of the oculomotor system also in children and adolescents with acquired lesions.
4. 2016 Tang et al. [Pilot study, n=8]. 30-min audio-visual stimulation (AVS) program significantly improved insomnia symptoms (ISI, $p = 0.002$) and sleep quality (PSQI, $p = 0.004$); with moderate to large effect sizes.
5. 2014 Tang et al. [Pilot study, n=13]. Audio-visual stimulation (AVS) may be efficacious in decreasing both insomnia and pain symptoms.

3.2.2. For the keywords: “Auditory Beat Stimulation”

1. 2019 Garcia-Argibay et al. A meta-analysis study that adds to the growing evidence that binaural-beat exposure is an effective way to affect cognition over and above reducing anxiety levels and the perception of pain without prior training, and that the direction and the magnitude of the effect depends upon the frequency used, time under exposure, and the moment in which the exposure takes place.
2. 2017 Jirakittayakorn & Wongsawat. [Clinical trial, n=47] Encephalic frontal, temporal, and central regions were activated within 15min of 40-Hz binaural beat. Recalled words were increase in the working memory portion of the list (in the word list recall task) with accompanying changes in emotional states (Brunel Mood Scale Questionnaire).
3. 2017 Chaieb et al. [Randomized, double-blinded, placebo-controlled trial, n=25]. Monaural beat stimulation was found to reduce state anxiety.
4. 2017 Beauchene et al. [Randomized trial, n=34]. Listening to 15 Hz binaural beats during an N-Back working memory task increased the individual participant's

accuracy, modulated the cortical frequency response, and changed the cortical network connection strengths during the task. Only the 15 Hz binaural beats produced significant change in relative accuracy compared to the None condition.

5. 2016 Beauchene et al. [Randomized trial, n=28]. Listening to 15Hz binaural beats during a visuospatial working memory task not only increased the response accuracy, but also modified the strengths of the cortical networks during the task. The three auditory control conditions and the 5Hz and 10Hz binaural beats all decreased accuracy. Based on graphical network analyses, the cortical activity during 15Hz binaural beats produced networks characteristic of high information transfer with consistent connection strengths throughout the visuospatial working memory task.
6. 2017 Ecsy et al. [Randomized trial, n=64]. This study suggests that a short presentation of auditory and visual stimuli, oscillating in the alpha range, have an analgesic effect on acute laser pain, with the largest effect following the 10-Hz visual stimulation. Pain reductions following stimulation in the alpha range are independent of sleepiness, anxiety, and negative moods. This study provides new behavioural evidence showing that visual and auditory entrainment of frequencies in the alpha-wave range can influence the perception of acute pain in humans.
7. 2015 Chaieb et al. [Review]. Auditory beat stimulation positively affect cognition and mood States.
8. 2015 Becher et al. [Randomized, double-blinded, placebo-controlled, cross-over trial, n=xx]. Monaural and binaural beat stimulation offer a non-invasive approach for the modulation of intracranial electroencephalography (EEG) characteristics.
9. 2014 de Castro et al. [Randomized trial, n=11]. Musical auditory stimulation attenuates the cardiac autonomic responses to postural change maneuver (PCM).
10. 2013 Reedijk et al. [Randomized, placebo-controlled, cross-over trial, n=22]. Binaural beats, regardless of the presented frequency, can affect divergent but not convergent thinking. Individuals with low EBRs mostly benefitted from alpha binaural beat stimulation, while individuals with high EBRs were unaffected or even impaired by both alpha and gamma binaural beats. This suggests that binaural beats, and possibly other forms of cognitive entrainment, are not suited for a one-size-fits-all approach, and that individual cognitive-control systems need to be taken into account when studying cognitive enhancement methods.
11. 2010 Kennel et al. [Randomized, placebo-controlled trial, n=20]. The results from this study indicate that binaural auditory beat stimulation did not significantly

reduce the symptom of inattention in children and adolescents with attention-deficit/hyperactivity disorder. However, parents and adolescents stated that homework problems due to inattention improved during the 3-week study. Parents and participants stated that the modality was easy to use and helpful.

12. 2005 Hori et al. [Clinical trial, n=12]. Acoustic and visual stimuli influence Heart Rate Variability.
13. 1998 Lane et al. [Randomized, double-blinded, placebo-controlled trial, n=29]. Binaural auditory beats can affect psychomotor performance and mood.

3.2.3. For the keywords: “Binaural Beats"

1. 2019 Munro & Searchfield. [Placebo-controlled, cross-over trial, n=20]. Small improvements in tinnitus rating scores occurred with binaural beats at 8 Hz. Some individuals showed more improvement with the binaural beats than ocean waves sound alone (control group).
2. 2019 Garcia-Argibay et al. [Meta-analysis, n=22 studies]. The results showed an overall medium, significant, consistent effect size (g = 0.45). Meta-regression results indicated that it does not seem to be necessary to mask binaural beats with white noise or pink noise in terms of effectiveness, obtaining similar effects with unmasked binaural beats. Moreover, the findings suggest that binaural-beat exposure before, and before and during the task produces superior results than exposure during the task. Time under exposure contributed significantly to the model indicating that longer periods are advisable to ensure maximum effectiveness. Binaural-beat exposure is an effective way to affect cognition over and above reducing anxiety levels and the perception of pain without prior training, and that the direction and the magnitude of the effect depends upon the frequency used, time under exposure, and the moment in which the exposure takes place.
3. 2018 Sewak & Spielholz. [Randomized, double-blinded, placebo-controlled trial, n=116]. Binaural beats (sound intervention) significantly reduced the probability of relapse in recently-detoxified subjects during the 90-days of this study.

4. 2018 Lim et al. [Clinical trial, n=25]. Brain massage (mechanical massage and binaural beats) are effective in reducing mental fatigue and improving the cognitive function.
5. 2018 Lee-Harris et al. [Clinical trial, n=30]. Meditative Binaural Music (MBM) may effectively contribute to relaxation with more pronounced effects on younger age group.
6. 2018 Gálvez et al. [Randomized, double-blinded, controlled trial, n=14]. Binaural-rhythmic sound may be a co-assistant tool in the treatment of Parkinson's Disease (PD) resulting in normalization of EEG power (altered in PD), normalization of brain FC (also altered in PD) and working memory improvement (a normalizing effect).
7. 2018 Derner et al. [Controlled, cross-over trial, n=15]. Binaural vs. monaural 5Hz stimulation increases vs. decreases long-term memory performance. These behavioral effects appear to be related to reverse phase shifts within rhinal cortex.
8. 2018 Carrick et al. [Randomized, placebo-controlle trial, n=84]. A short 12 week course of neurofeedback (including Binaural beats) using the Mente Autism device can lead to significant changes in brain activity (qEEG), sensorimotor behavior (posturography), and behavior (standardized questionnaires) in Children affected by autism spectrum disorder.
9. 2017 Phneah & Nisar. [Clinical trail, n=37]. EEG-based alpha neurofeedback training increased alpha power and decreased physiological measures (although not statistically significant when compared to placebo).
10. 2017 Jirakittayakorn & Wongsawat. [Placebo-controlled trial, n=28]. Results show reduction of tension and increased theta activity in the entire cortex within 10 min of exposure to 6-Hz binaural beat on a 250 Hz carrier tone.
11. 2017 Isik et al. [Randomized, controlled trial, n=60]. Binaural beats significantly reduced preoperative anxiety in dentistry (impacted third molars removed).
12. 2017 Garcia-Argibay et al. [Randomized, double-blinded, cross-over trial, n=32]. Binaural auditory beats can affect long-term memory both positively and negatively, depending on the frequency used.

13. 2017 Colzato et al. [Randomized, placebo-controlled, cross-over trial, n=18]. High-frequency binaural beats bias the individual attentional processing style towards a reduced spotlight of attention (more attentional focusing through binaural beats).
14. 2017 Colzato et al. [Randomized, double-blinded, placebo-controlled trial, n=30]. Gamma-frequency (40 Hz) binaural beats enhance selectivity in updating episodic memory traces and further strengthen the hypothesis that neural activity in the gamma band is critically associated with the control of feature binding (the integration of different stimulus properties).
15. 2017 Chaieb et al. [Randomized, double-blinded, placebo-controlled trial, n=25]. Monaural beat stimulation modulates anxiety state and are in line with previous studies reporting anxiety-reducing effects of auditory beat stimulation
16. 2017 Calomeni et al. [Clinical trial, n=75]. Brain Stimulation by Light and Binaural Beats had different effects on Alpha and SMR brain waves of the patients [elderly without dementia diagnosis (n=15), diagnosed with Parkinson's disease (n=15), diagnosed with Alzheimer's disease (n=15); children with Autism (n=10), with Intellectual Impairment (n=10) with normal cognitive development (n=10)]. Treatment induced gains in memory functions, for both, children and elderlies.
17. 2017 Beauchene et al. [Randomized trial, n=34]. Listening to 15 Hz binaural beats during an N-Back working memory task increased the individual participant's accuracy, modulated the cortical frequency response, and changed the cortical network connection strengths during the task. Only the 15 Hz binaural beats produced significant change in relative accuracy compared to the None condition.
18. 2016 Zampi. [Randomized, blinded, placebo-controlled, cross-over trial, n=36]. Theta Binaural Beats in an external audio protocol was effective in reducing perceived pain severity in Chronic Pain participants.
19. 2016 Hommel et al. [Randomized, controlled trial, n=32]. High-Frequency Binaural Beats Increase Cognitive Flexibility.
20. 2016 Beauchene et al. [Randomized trial, n=28]. Listening to 15Hz binaural beats during a visuospatial working memory task not only increased the response

accuracy, but also modified the strengths of the cortical networks during the task. The three auditory control conditions and the 5Hz and 10Hz binaural beats all decreased accuracy. Based on graphical network analyses, the cortical activity during 15Hz binaural beats produced networks characteristic of high information transfer with consistent connection strengths throughout the visuospatial working memory task.

21. 2015 Reedijk et al. [Clinical trial, n=22]. High-frequency binaural beats enhance attentional control.
22. 2015 Palaniappan et al. [Pilot trial, n=5]. Binaural brain entrainment induces lower heart rate variability.
23. 2015 Friedrich et al. [Clinical trial, n=58]. Stimulation through binaural beats (sound frequency) at 40 Hz (gamma) gamma enhances long term memory capacity.
24. 2015 Chaieb et al. [Review]. Auditory beat stimulation and its effects on cognition and mood States.
25. 2015 Becher et al. [Randomized, double-blinded, placebo-controlled, cross-over trial, n=xx]. Monaural and binaural beat stimulation offer a non-invasive approach for the modulation of intracranial electroencephalography (EEG) characteristics.
26. 2014 Cocoana et al. [Randomized controlled trial, n=47]. Binaural beats reduced pain perception in young adults (aged between 21 and 48 years old) following painful stimulus applied with a hemostat.
27. 2014 McConnell et al. [Randomized, double-blinded, placebo-controlled trial, n= 21]. Listening to theta-frequency binaural beats post-exercise increases parasympathetic activation and sympathetic withdrawal.
28. 2014 Gao et al. [Pilot trial, n=13]. Relative Power (RP) increase in theta and alpha bands and decrease in beta band during delta and alpha binaural beats (BB) stimulations. RP decreased in beta band during theta BB, while RP decreased in theta band during beta BB. Observation supports the hypothesis that BBs could affect functional brain connectivity.

29. 2014 Abeln et al. [Clinical trial, n= 15]. Eight weeks of auditory stimulation with binaural beats improved perceived sleep quality and the post-sleep state of athletes, whereas the effect on physical level is assumed to occur in a time-delayed fashion.
30. 2013 Reedijk et al. [Randomized, placebo-controlled, cross-over trial, n=22]. Binaural beats, regardless of the presented frequency, can affect divergent but not convergent thinking. Individuals with low EBRs mostly benefitted from alpha binaural beat stimulation, while individuals with high EBRs were unaffected or even impaired by both alpha and gamma binaural beats. This suggests that binaural beats, and possibly other forms of cognitive entrainment, are not suited for a one-size-fits-all approach, and that individual cognitive-control systems need to be taken into account when studying cognitive enhancement methods.
31. 2011 Weiland et al. [Randomized, placebo-controlled trial, n= 169]. In moderately anxious ED patients, state anxiety was reduced by 10%-15% following exposure to purpose-designed sound interventions including audio field recordings with embedded bianaural beats.
32. 2010 Kennel et al. [Randomized, placebo-controlled trial, n=20]. The results from this study indicate that binaural auditory beat stimulation did not significantly reduce the symptom of inattention in children and adolescents with attention-deficit/hyperactivity disorder. However, parents and adolescents stated that homework problems due to inattention improved during the 3-week study. Parents and participants stated that the modality was easy to use and helpful.
33. 2007b Wahbeh et al. [Pilot study, n=?]. Binaural beat technology may exhibit positive effect on self-reported psychologic measures, especially anxiety.
34. 2005 Padmanabhan et al. [Randomized, double-blinded, placebo-controlled trial, n=108]. Binaural beat audio decreased acute pre-operative anxiety (measured by the State-Trait Anxiety Inventory questionnaire).

35. 2001 Le Scouarnec et al. [Clinical trial, n=15]. Listening to binaural beat tapes in the delta/theta electroencephalogram range may be beneficial in reducing mild anxiety.
36. 1998 Lane et al. [Randomized, double-blinded, placebo-controlled trial, n=29]. Binaural auditory beats can affect psychomotor performance and mood.
37. NEGATIVE RESULTS - 2017 López-Caballero & Escera. [Randomized, blinded, placebo-controlled trial, n=14]. results do not support binaural-beat stimulation as a potential tool for the enhancement of EEG oscillatory activity, nor to induce changes in emotional arousal.
38. NEGATIVE RESULTS - 2008 Carter. [Placebo-controlled, cross-over trial, n=12]. Binaural beats did not affect the 12 participant's blood pressure or pulse ($p > 0.05$). One reason for this may be that the sounds were not played long enough for the brain to either perceive and/or resonate to the frequency. Another reason why the sounds did not affect blood pressure and pulse may be due to the participant's age since older brains may not perceive the binaural beats as well as younger brains.
39. NEGATIVE RESULTS - 2007a Wahbeh et al. [Randomized, double-blinded, placebo-controlled, cross-over trial, n=4]. We did not find support for steady-state entrainment of the scalp-recorded EEG while listening to 7-Hz binaural beats.

3.2.4. For the keywords: “Brain Entrainment”

1. 2019 Hanslmayr yet al. [Review]. Studies using different techniques of entrainment lend support to the idea that brain oscillations can modulate human memory, and suggest that oscil- lations are causally relevant for memory processes
2. 2018 Gálvez et al. [Randomized, double-blinded, controlled trial, n=14]. Binaural-rhythmic sound may be a co-assistant tool in the treatment of Parkinson's Disease (PD) resulting in normalization of EEG power (altered in PD), normalization of brain FC (also altered in PD) and working memory improvement (a normalizing effect).
3. 2014 Abeln et al. [Clinical trial, n= 15]. Eight weeks of auditory stimulation with binaural beats improved perceived sleep quality and the post-sleep state of

athletes, whereas the effect on physical level is assumed to occur in a time-delayed fashion.

4. 2011 Lavallee et al. [Clinical trial, n= 8]. This study evaluated the effects of hindering (15 Hz) and facilitative (7 Hz) binaural beats on the meditative process. Novice meditators were not able to maintain certain levels of θ power in the occipital regions when hindering binaural beats were presented, whereas when the facilitative binaural beats were presented, the experienced meditators displayed increased θ power in the left temporal lobe. These results suggest that the experienced meditators have developed techniques over the course of their meditation practice to counter hindering environmental stimuli, whereas the novice meditators have not yet developed those techniques.

3.2.5. For the keywords: “Brainwave Entrainment"

1. 2018 Roberts et al. [Randomized trial, n=90]. Rhythmic auditory and visual stimulation in Theta selectively increased source memory performance. Targeted manipulation of theta activity could be a promising new approach to enhance theta activity and memory performance in healthy individuals and in patients with memory disorders.
2. 2018 Gálvez et al. [Randomized, double-blinded, controlled trial, n=14]. Binaural-rhythmic sound may be a co-assistant tool in the treatment of Parkinson's Disease (PD) resulting in normalization of EEG power (altered in PD), normalization of brain FC (also altered in PD) and working memory improvement (a normalizing effect).
3. 2018 Ecsy et al. [Randomized trial, n=32]. Experimental induction of increased alpha power suppresses the cortical processing of acute pain. While it is known that visual stimulation can increase the brain's oscillatory alpha rhythms, this study shows that this increase in alpha power occurs alongside reduced cortical processing of nociception, as measured with EEG. This establishes an objective marker of alpha entrainment-based analgesia that may be useful in the development of neuromodulatory treatments for clinical pain.
4. 2017 Albouy et al. [Randomized trial, n=17]. Selective entrainment of theta oscillations enhances auditory working memory performance. Driving brain oscillations with rhythmic stimulation can specifically improve auditory working memory performance and modulate brain activity and connectivity patterns.

5. 2017 Ecsy et al. [Randomized trial, n=64]. This study suggests that a short presentation of auditory and visual stimuli, oscillating in the alpha range, have an analgesic effect on acute laser pain, with the largest effect following the 10-Hz visual stimulation. Pain reductions following stimulation in the alpha range are independent of sleepiness, anxiety, and negative moods. This study provides new behavioural evidence showing that visual and auditory entrainment of frequencies in the alpha-wave range can influence the perception of acute pain in humans.
6. 2016 Gao et al. [Randomized trial, n=11]. Chaotic activities of the brain and the heart became more coordinated during Mindfulness-Based Stress Reduction training, suggesting that mindfulness training may increase the entrainment between mind and body.
7. 2016 Laccarino et al. [Pre-clinical trial]. Gamma rhythms in recruiting both neuronal and glial responses to attenuate Alzheimer's-disease-associated pathology.
8. 2015 Tang et al. [Review]. Open-Loop Audio-Visual Stimulation (AVS) can potentially improve sleep and reduce pain.
9. 2014 Abeln et al. [Clinical trial, n= 15]. Eight weeks of auditory stimulation with binaural beats improved perceived sleep quality and the post-sleep state of athletes, whereas the effect on physical level is assumed to occur in a time-delayed fashion.
10. 2008 Huang & Charyton. [Review]. Brainwave entrainment (BWE) is an effective therapeutic tool. People suffering from cognitive functioning deficits, stress, pain, headache/migraines, PMS, and behavioral problems benefited from BWE. However, more controlled trials are needed to test additional protocols with outcomes.
11. NEGATIVE RESULTS - 2017 López-Caballero & Escera. [Randomized, blinded, placebo-controlled trial, n=14]. Results do not support binaural-beat stimulation as a potential tool for the enhancement of EEG oscillatory activity, nor to induce changes in emotional arousal.

3.2.6. For the keywords: “Meditative Binaural Music"

1. 2018 Lee-Harris et al. [n=30]. Meditative Binaural Music (MBM) may effectively contribute to relaxation with more pronounced effects on younger age group.

3.2.7. For the keywords: “Auricular Therapy”

1. 2018 Lim. [Clinical trial, n=175]. Low-level laser Auricular Therapy not only helps smokers stop smoking but also restores their homeostasis and good health.

3.2.8. For the keywords: “Auriculotherapy”

1. 2019 Rodrigues et al. [Randomized, blinded, prospective, n=40]. Low-power laser auriculotherapy improved the physical and emotional symptoms of patients with temporomandibular disorders (TMDs).
2. 2018 Mercante et al. [Review]. Auricular Neuromodulation through transcutaneous vagus and trigeminal nerve stimulation are scientifically validated non-invasive bottom-up brain modulation techniques, easily implemented from the outer ear.
3. 2016 Suen et al. [Double-blinded, randomised, feasibility study n=43]. Laser auriculotherapy for osteoarthritic knee among elders is feasible and could be applied in future larger-scale study.
4. 2011 Bergamaschi et al. [Preliminary clinical trial, n=34]. Laser acupuncture and auriculopuncture stimulations reduce nociceptive interference and thus improve postural control.
5. 1990 King et al. [Pilot clinical trial, n=9]. Laser auriculotherapy can induce analgesia and suggest a possible alternative for patients intolerant of transcutaneous electrical nerve stimulation.

3.2.9. For the keywords: “Ear acupuncture”

1. 2011 Bergamaschi et al. [Preliminary clinical trial, n=34]. Laser acupuncture and auriculopuncture stimulations reduce nociceptive interference and thus improve postural control.
2. 1998 Yu et al. [Clinical trial, n=101]. Photo-acupuncture is a safe, painless, nontraumatic and effective method for treatment of simple obesity, and it is easy to be accepted by children.
3. 1990 King et al. [Pilot clinical trial, n=9]. Laser auriculotherapy can induce analgesia and suggest a possible alternative for patients intolerant of transcutaneous electrical nerve stimulation.

4. Conclusions

A higher number of publications of interest was retrieved when using the search words “Binaural Beats”, with 39 publications; followed by "Auditory Beat Stimulation", with 13 publications. The search term “Auriculotherapy"+ the terms "LASER" OR "light" OR “low level" OR "LLLT" OR “Diode”, yielded references.

These data may indicate the importance or interest, at least of the scientific community, of the terms, which should be considered for the claim set and/or marketing.

Although many of the studies presented in this review do not meet the highest standards of scientific research (randomized, double-blinded, placebo-controlled, large sample size), many were well-designed and reached statistically significant results stating to the benefits of Audio-Visual Brain Entrainment. For a summary of evidence-based outcomes see the table below (Table 2 - Main outcomes).

Terms related to Audio-visual Brain Entrainment	
Keywords	**Main Outcomes**
Audio-Visual Stimulation	• Induced stable and long-lasting ameliorations in hemianopics (Grasso et al., 2016), and activation of visual responsiveness in patients with ocular lesions (Tinelli et al., 2015). • Improved sleep quality, decreased insomnia symptoms, and reduced pain (Tang et al., 2014, 2015, 2016).

Auditory Beat Stimulation	• Affected cognition and mood states, reducing anxiety (Garcia-Argibay et al., 2019; Chaieb et al., 2015; Chaieb et al., 2017), and the perception of pain (Garcia-Argibay et al., 2019; Ecsy et al., 2017). • Increased working memory and accuracy (Beauchene et al., 2017), modified the strengths of the cortical networks during memory tasks (Beauchene et al., 2016), with accompanying changes in emotional states (Jirakittayakorn & Wongsawat, 2017). • Attenuated the cardiac autonomic responses to postural change maneuver (de Castro et al., 2014). • Decreased homework problems due to inattention in children and adolescents with attention- deficit/hyperactivity disorder (Kennel et al., 2010). • Influence Heart Rate Variability (Hori et al., 2005). • Affect psychomotor performance and mood (Lane et al., 1998).

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Binaural Beats	• Induced small improvements in tinnitus rating scores (Munro & Searchfield, 2019). • Affected cognition (Derner et al., 2018; Colzato et al., 2017; Hommel et al., 2016; Chaieb et al., 2015; Reedijk et al., 2013), reducing anxiety levels (Garcia-Argibay et al., 2019; Chaieb et al., 2017; Weiland et al., 2011; Wahbeh et al., 2007b; Padmanabhan et al., 2005; Le Scouarnec et al., 2001) and the perception of pain (Garcia-Argibay et al., 2019; Cocoana et al., 2014). • Significantly reduced the probability of relapse in recently-detoxified subjects (Sewak & Spielholz, 2018). • Reduced mental fatigue and improved the cognitive function (Lim et al., 2018; Colzato et al., 2017). • Effectively contributed to relaxation (Lee-Harris et al., 2018). • Significantly changed brain activity, sensorimotor behavior, and behavior in Children with autism (Carrick et al., 2018). • Reduced preoperative anxiety in dentistry (Isik et al., 2017). • Affected long-term (Garcia-Argibay et al., 2017; Friedrich et al., 2015) and working memory (Beauchene et al., 2017). • Positively affected brain waves and induced gains in memory functions of patients [healthy elderly; elderly diagnosed with Parkinson's or Alzheimer's disease; children with Autism; children with Intellectual Impairment; as well as children with normal cognitive development) (Calomeni et al., 2017). • Reduced perceived pain severity in Chronic Pain participants (Zampi, 2016). • Enhanced attentional control (Reedijk et al., 2015). • Increases parasympathetic activation and sympathetic withdrawal post-exercise (McConnell et al., 2014). • Affected functional brain connectivity (Gao et al., 2014). • Improved perceived sleep quality and the post-sleep state of athletes, as well as physical level (Abeln et al., 2014). • Decreased homework problems due to inattention in children and adolescents with attention- deficit/hyperactivity disorder (Kennel et al., 2010). • Affected psychomotor performance and mood (Lane et al., 1998)

Brain Entrainment	• Modulated human memory (Hanslmayr yet al., 2019). • Co-assisted in the treatment of Parkinson's Disease (a normalizing effect and working memory improvement) (Gálvez et al., 2018). • Improved perceived sleep quality and physical level (Abeln et al., 2014). • Selectively Hindered (15Hz) or facilitated (7Hz) meditative processes (Lavallee et al., 2011).
Brainwave Entrainment	• Increased source memory performance (Roberts et al., 2018). • Co-assisted in the treatment of Parkinson's Disease (a normalizing effect and working memory improvement) (Gálvez et al., 2018). • Enhanced auditory working memory performance and modulate brain activity and connectivity patterns (Albouy et al., 2017). • Helped chaotic activities of the brain and the heart to became more coordinated during Mindfulness-Based Stress Reduction training (Gao et al., 2016). • Recruited both neuronal and glial responses to attenuate Alzheimer's-disease-associated pathology (Laccarino et al., 2016) [Pre-clinical trial]. • Improved sleep (Tang et al., 2015; (Abeln et al., 2014)) and Induced analgesia (Ecsy et al., 2018; Ecsy et al., 2017; Tang et al., 2015). • Improved cognitive functioning deficits, stress, pain, headache/ migraines, PMS, and behavioral problems (Huang & Charyton, 2008).
Meditative Binaural Music	• Induces relaxation (Lee-Harris et al., 2018).
Terms related to Auriculotherapy + "LASER" OR "light" OR “low level" OR "LLLT" OR "Diode"	
Auricular Therapy	• LASER auriculotherapy helped smokers stop smoking but also restores their homeostasis and good health (Lim et al., 2018).
Auriculotherapy	• LASER auriculotherapy: Improved the physical and emotional symptoms of patients with temporomandibular disorders (Rodrigues et al., 2019); decreased osteoarthritic knee among elders (Suen et al., 2016); reduced pain (Bergamaschi et al., 2011; King, 1990) and improved postural control (Bergamaschi et al., 2011).

Ear acupuncture	• LASER auriculotherapy reduced pain (Bergamaschi et al., 2011; King, 1990) and improved postural control (Bergamaschi et al., 2011).

Table 2: Main outcomes.

5. Limitations

A number of limitations may exist in the present literature review.

Primarily, only a few keywords and two databases were consulted for this review, i.e., Pubmed and the CochraneLibrary. Future updated versions will encompass a revised and extended list of keywords and search terms; and will search additional databases, e.g., Directory of Open Access Journals, Goole Scholar, and Embase Database.

Secondly, although publications in any languages were retrieved, in the results only citations in English, Portuguese, Spanish, Italian, French and German were considered in this review, thus, additional data may exist on this topic that may have been overlooked.

6. References

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