A comprehensive review of the psychological effects of brainwave entrainment

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CRD summary
The authors concluded that preliminary evidence suggested that brainwave entrainment was an effective therapeutic tool, but further research was required. The evidence presented appeared to justify the recommendation for further research. In view of the lack of controlled evidence and problems with methodology and reporting in the review, the authors' conclusions regarding efficacy did not appear reliable.

Authors' objectives
To evaluate the psychological effects of brainwave entrainment (BWE) using auditory or visual stimulation.

Searching
MEDLINE, PsycINFO and Scopus databases were searched. Search terms were reported. Search dates varied, but spanned the years 1806 to 2007. The reference lists of articles retrieved were checked for additional studies. The search was limited to articles in English published in peer-reviewed journals as full-length papers.

Study selection
Controlled or pre/post studies of the effects of BWE using auditory or visual stimulation were eligible for inclusion, provided pulses of light or tone were delivered at frequencies hypothesised to have a beneficial effect or in line with a protocol addressing clinical outcomes. Studies were required to report clinical or psychological outcomes (measured using standard methods or as deemed appropriate by peer review) and to report statistical analysis. Studies of outcomes such as electroencephalogram (EEG) response or neurotransmitter levels were not eligible. Case studies were excluded.

Participants in the included studies were children and adults, either healthy or with conditions such as learning disabilities, attention deficit hyperactivity disorder, migraine, stress, anxiety and myofascial pain. Interventions included single, alternating, ascending or descending frequencies of photic or auditory stimulation or audiovisual entrainment selected either by the participant or by the investigator. Nearly half the studies used single sessions and the rest used multiple sessions ranging from nine to 100. Length of session varied from 0.5 seconds to 60 minutes. Frequency of session varied from twice daily to weekly. Outcomes reported in the review included cognition (including verbal skills, performance skills, attention, memory and overall intelligence/achievement), short- and long-term stress, pain, headache/migraine, mood, behavioural problems and premenstrual syndrome (PMS).

The authors stated neither how the papers were selected for the review nor how many reviewers performed the selection.

Assessment of study quality
The authors did not state that they assessed validity.

Data extraction
Results were classified by outcome. For each study, the proportion of measured outcomes that provided significant benefit was reported. The authors state neither how the data were extracted for the review nor how many reviewers performed the data extraction

Methods of synthesis
The studies were combined in a narrative synthesis organised by outcome. Findings were also grouped by type of intervention (frequency or pattern of frequency stimulation).

Results of the review
Twenty studies were included (n=608, range four to 108): three randomised controlled trials (RCTs) (n=152); two controlled trials (n=49); and 15 pre/post studies. Two RCTs and one CT were blinded.
Cognition (nine studies, n=251)
A crossover RCT of a single session of theta stimulation in four healthy adults reported no significant improvement in verbal fluency or attention associated with the intervention and a reduction in immediate recall. Controlled comparisons reported significant benefit from the intervention in all three outcomes measured. Six pre/post studies reported significant benefit from the intervention for 19 of 28 cognitive outcomes.

Stress (seven studies, n=212)
One RCT (n=108) showed significant reduction in anxiety from a single session of alpha/delta therapy for day surgery patients. A crossover RCT of a single session of theta stimulation in four healthy adults reported significant improvement from the intervention in one of five measures. Five pre/post studies reported significant benefit from the intervention for 16 of 27 outcomes.

Pain (two studies, n=59)
One RCT (n=40) reported significantly reduced pain among patients who had photic stimulation during surgery. One pre/post study reported significant benefit from the intervention for 23 of 24 outcomes.

Headache and migraine (three pre/post studies, n=90)
Photic stimulation was effective for treating or preventing migraine in two studies and for treating muscle pain in two studies. One study found it ineffective for migraine or sinusitis.

Mood (three studies, n=41)
A crossover RCT of a single session of theta stimulation in four healthy adults reported no significant effect from the intervention. One controlled comparison and one pre/post study reported no benefit from the intervention in any of 15 outcomes.

Behaviour (two pre/post studies, n=57)
Two pre/post studies of children with behaviour problems found significant benefit from the intervention for 16 of 39 outcomes.

PMS (One pre/post study, n=50)
Photic stimulation was associated with significant relief of PMS symptoms.

A summary of findings for specific brainwave entrainment frequencies was also reported.

Authors' conclusions
Preliminary evidence suggested that BWE is an effective therapeutic tool. Further research was required.

CRD commentary
The objectives and inclusion criteria of the review were clear. Relevant sources were searched for studies, although the restriction to published studies in English meant that the review was prone to publication and language biases. The authors did not state whether steps were taken to minimise the risk of bias and error in the processes of study selection and data extraction (for example, by having more than one reviewer independently make decisions). The authors mentioned which studies were blinded, but it did not appear that study validity was systematically assessed, which made it difficult to judge the reliability of the review findings. The decision to combine studies by narrative synthesis appeared appropriate given the strong clinical heterogeneity between the studies, but the authors failed to quantify the size or statistical significance of the findings reported. The evidence presented appeared to justify the authors’ conclusions that further research was justified, but in view of the dearth of good-quality evidence and problems with methodology and reporting in the review, the conclusions regarding efficacy did not appear reliable.

Implications of the review for practice and research
Practice: the authors stated that BWE was worthy of consideration as a therapeutic tool.

Research: the authors stated that qualitative electroencephalogram signatures needed to be developed for different disorders and tested using standard validated methods of psychological assessment. Larger RCTs were needed with clear inclusion criteria for participants. The RCTs should measure qualitative EEG, hormone levels and the time of day.
of the intervention. Interventions protocols should be clearly defined and the relationship between session frequency/duration and outcomes should be explored. More studies of auditory stimulation were needed, as well as studies comparing different types of stimulation, monaural, binaural and isochronic beats and use of white noise versus music.

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