Meta-analysis of EEG biofeedback in treating epilepsy

CRD summary
EEG biofeedback significantly reduced seizure frequency in patients who had seizures that could not be controlled medically. Given the unclear quality of included studies, the small sample sizes and the possibility of publication bias, the authors’ conclusions should be treated with caution.

Authors' objectives
To evaluate the effectiveness of electroencephalograph (EEG) biofeedback in treating epilepsy.

Searching
MEDLINE, PsycLIT and PsycINFO were searched between 1970 and 2005. Search terms were reported.

Study selection
Prospective, peer reviewed, published studies that evaluated sensorimotor rhythm (SMR) uptraining or slow cortical potentials (SCP) training in participants with epilepsy were eligible for inclusion. Studies needed to report individual pre- and post-intervention seizure rates to be included for the review. Studies were excluded if they were preliminary or the first in a series of studies.

Included studies were of sensorimotor rhythm with frequency ranges of 12-15Hz, 12-16 Hz, 6-12Hz combined with 12-14Hz and 9-14Hz. Three studies inhibited theta band frequency. One study used slow cortical potentials. Some studies included a sham condition. The duration of intervention ranged from five weeks to 18 months. Included participants had a wide range of seizure types. All participants had seizures that could not be controlled medically. Participant ages ranged from six years to 55 years. Some participants had learning difficulties. Studies dates ranged from 1974 to 2001.

Two authors selected the studies for review.

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

Data extraction
The number of seizures before and after intervention were extracted for each individual patient and were calculated as log(post/pre). Where post-intervention seizures reduced to 0, the minimum value of log for other participants in that study was substituted. The mean and standard deviation were extracted and used to calculate the effect size for each study. Authors were contacted for individual patient data, where this was not reported in the original study. The authors did not state how many reviewers performed the data extraction.

Methods of synthesis
The results were pooled using Hedge's $g$ and reported the standard error (SE) using both fixed-effect and random-effects models. Statistical heterogeneity was assessed using the Q-statistic. Publication bias was assessed with funnel plots to determine whether individual studies might explain any pattern of difference among standardised effect sizes. Publication bias was assessed by calculating Hedge's $g$ separately for groups with large and small standard errors and testing for difference between these using the $\chi^2$ test.

Results of the review
Ten studies were included for review (n=87). Nine studies were within-subjects design (n=53); six of these studies used combinations of AB, ABA, ABAB and ABCA study designs (A for baseline condition, B for treatment and C for an optional additional treatment). One study had a mixed within-subjects and between-subjects design (n=34); only the within-subject data was used in the meta-analysis. Sample sizes ranged from three to 34. All but one study had a
sample size of less than 10. Nine studies had no dropouts and one study had two dropouts from a total of 34 participants.

SMR and slow cortical potentials training significantly reduced the number of seizures post-intervention compared to pre-intervention levels (Hedges g -0.20, SE 0.04; 10 studies, n=87). Removing the largest study did not significantly alter the results (Hedges g -0.19, SE = 0.04; nine studies, n=53). There was no evidence of significant statistical heterogeneity. The results reported were for fixed-effects models; use of a random-effects model did not significantly alter the results.

Inspection of the funnel plot and testing for difference between the effect sizes of studies with small and large standard errors suggested the possibility of publication bias (p=0.06).

Authors' conclusions
EEG biofeedback significantly reduced seizure frequency in patients who had seizures that could not be controlled medically.

CRD commentary
The review addressed a clear question with well-defined inclusion criteria. Several relevant databases were searched. However, unpublished data were excluded and an assessment found some evidence of publication bias. It is unclear whether language restrictions were applied to the search, therefore the possibility of language bias cannot be ruled out. Two reviewers selected studies for review, but it was unclear whether this was independent. It was unclear whether steps were taken in the data extraction process to minimise reviewer error and bias. Therefore, the possibility of reviewer error and bias could not be ruled out. It appeared that no validity assessment was carried out and so it was not possible to ascertain the quality of included studies. The reliability of the findings was undermined by the very small number of participants in the included studies. Appropriate methods were used to combine the studies, statistical heterogeneity was assessed and ruled out. Given the unclear quality of included studies, the small sample sizes and the possibility of publication bias, the authors' conclusions should be treated with caution.

Implications of the review for practice and research
Practice: The authors did not state any implications for practice.

Research: Further randomised controlled trials were needed with feasible alternative comparison conditions. Seizure type and focus should be clearly documented and functional outcomes should also be assessed. Research should investigate the efficacy of EEG biofeedback techniques in participants whose epilepsy responded to medication.

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