

Infra-Slow EEG Neurofeedback for Insomnia: Individual Response Trajectories in Primary Care

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Introduction

Insomnia is a prevalent and burdensome condition associated with impaired daytime functioning, reduced quality of life, and increased risk of adverse health outcomes. Although cognitive behavioural therapy for insomnia is recommended as first-line treatment, many patients continue to experience persistent sleep difficulties. Infra-Slow Neurofeedback (ISF-NF) has been proposed as a promising intervention targeting slow state-dependent fluctuations in neural activity, yet empirical evidence remains limited, particularly within primary care settings.

Single-case experimental designs may be particularly useful for evaluating individualized interventions such as ISF-NF, as they allow detailed examination of response trajectories over time. The present study examined the feasibility, acceptability, and preliminary effects of ISF-NF for insomnia in Swedish primary care.

Methods

Ten adults with insomnia and related comorbidities, including stress-related exhaustion, anxiety, and migraine, were recruited from primary care. Participants completed a 14-day baseline phase followed by approximately 12 weekly sessions of individualized ISF neurofeedback. Nine participants completed the intervention and eight provided sufficient daily data for quantitative analyses.

Subjective sleep quality was assessed daily using the Brief Self-Reported Sleep Quality Assessment (BSRSQA). Secondary outcomes included the Pittsburgh Sleep Quality Index (PSQI),

Patient Health Questionnaire-9 (PHQ-9), and Generalized Anxiety Disorder-7 (GAD-7), administered at baseline, post-intervention, and three-month follow-up. Fitbit Inspire 3 devices were used to continuously collect wearable-derived sleep metrics. Treatment effects were evaluated using visual analysis and Tau-U statistics.

Results

Daily subjective sleep ratings indicated improvements in perceived sleep quality for several participants across the intervention phase. Five of eight participants demonstrated statistically significant Tau-U effects, one participant showed a positive trend, and two participants showed no statistically significant improvement. Group-level analyses further indicated reductions in sleep difficulties and depressive symptoms from baseline to post-intervention, with some attenuation at follow-up.

Visual analyses revealed considerable interindividual variability in treatment response. While some participants showed relatively rapid improvements, others exhibited more gradual or delayed response trajectories over the course of treatment. Several participants demonstrated improvements following individualized adjustment of the ISF temporal integration parameter.

Wearable-derived sleep metrics demonstrated greater variability than subjective outcomes and showed limited convergence with total sleep time. However, descriptive analyses suggested improvements in sleep consolidation and sleep timing in several participants, often occurring alongside subjective improvements in sleep quality.

Treatment adherence was high, therapeutic alliance ratings were favourable, and few adverse effects were reported, supporting the feasibility and acceptability of the intervention.

Conclusions

ISF neurofeedback was feasible and well tolerated within a primary care setting and was associated with improvements in subjective sleep quality for a subset of participants. Daily measurements revealed highly individualized response trajectories, suggesting that treatment-related changes may emerge gradually and differ substantially between individuals.

The combination of dense longitudinal self-report data and continuous wearable monitoring may provide a useful framework for studying adaptation processes and potential learning effects during neurofeedback interventions. Future controlled studies are needed to determine efficacy, identify predictors of treatment response, and investigate the neurophysiological mechanisms underlying observed clinical improvements.