

40Hz Auditory Stimulation and Naturalistic Soundscapes for the Treatment and Management of Alzheimer's Disease

Claire Rogers¹, Divyanshi Singh¹, Rebecca Main¹, Ruth Mckirdy¹, Ronan Breslin², Mario A. Parra¹, Jessica Argo², Shuzo Sakata³, William J. McGeown¹
1. School of Psychological Sciences and Health, University of Strathclyde
2. The Glasgow School of Art
3. Strathclyde Institute of Pharmacy and Biomedical Sciences, University of Strathclyde

INTRODUCTION

Alzheimer's Disease (AD) is a progressive neurodegenerative disorder, associated with memory loss, behaviour changes and physical impacts (Whitewell, 2018). It is the most common form of dementia. Reliable treatments to slow its progression are in high demand and 40Hz sensory stimulation may offer a solution.

Humans with AD and mouse models of the disease exhibit lower gamma oscillations which are important for multiple areas of cognition (McDermott et al., 2018). Studies show that auditory and visual 40Hz stimulation elicit greater gamma oscillations in mice with AD pathology and alleviates symptoms (Martorell et al., 2019; Olsen, 2021; Traikapi & Konstantinou, 2021).

In humans, pilot studies have shown 40Hz sound stimulation to improve cognitive deficits (Figure 1) in mild to moderate AD patients (Clements-Cortes et al., 2016).

Studies indicate that greater volumes elicit greater gamma oscillations compared to lower (Schadow et al., 2007).

Immersive soundscapes such as forest and beach sounds present calming and therapeutic effects in and out of care homes (Cheng & Sabran, 2022; Houben et al., 2019; Voisin et al., 2021).

Combining soundscapes and 40Hz sound stimulation may be beneficial to AD management as studies show sounds and music can help patients remember long-term memories and balance the sound stimulation.

Literature Gap

There is limited research on the effects of stimulation volume and on including 40Hz sound in combination with soundscapes and how this can be effective in the treatment and management of AD. Early investigation and optimisation of different stimulation protocols on gamma oscillations and on participant perceptions can be carried out in healthy older adults, prior to their administration to people with AD.

AIMS AND HYPOTHESIS

Aim: To assess the feasibility of integrating natural soundscapes and different volumes of 40Hz sound stimulation on eliciting gamma oscillations in a healthy population, to investigate their effects on participant perceptions.

Hypothesis 1: Higher volume levels of 40Hz sound stimulation will elicit greater gamma oscillations, compared to lower volume levels.

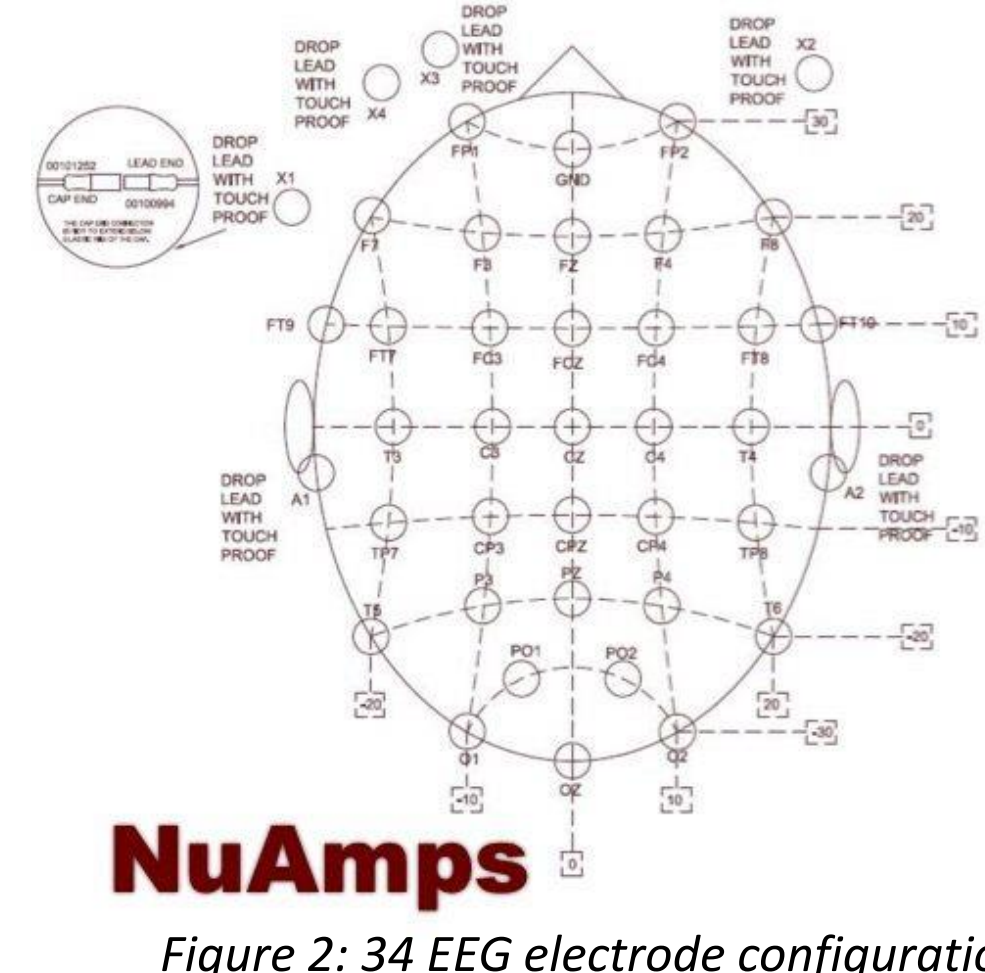
Hypothesis 2: 40Hz sound stimulation combined with the natural soundscapes will be more tolerable and will be perceived as more pleasant by participants.

METHODOLOGY

Participants: Aiming to recruit 40 participants, inclusion criteria includes those aged 18-30 years with fluent or good understanding of English. Those with psychiatric or neurological diagnoses are excluded.

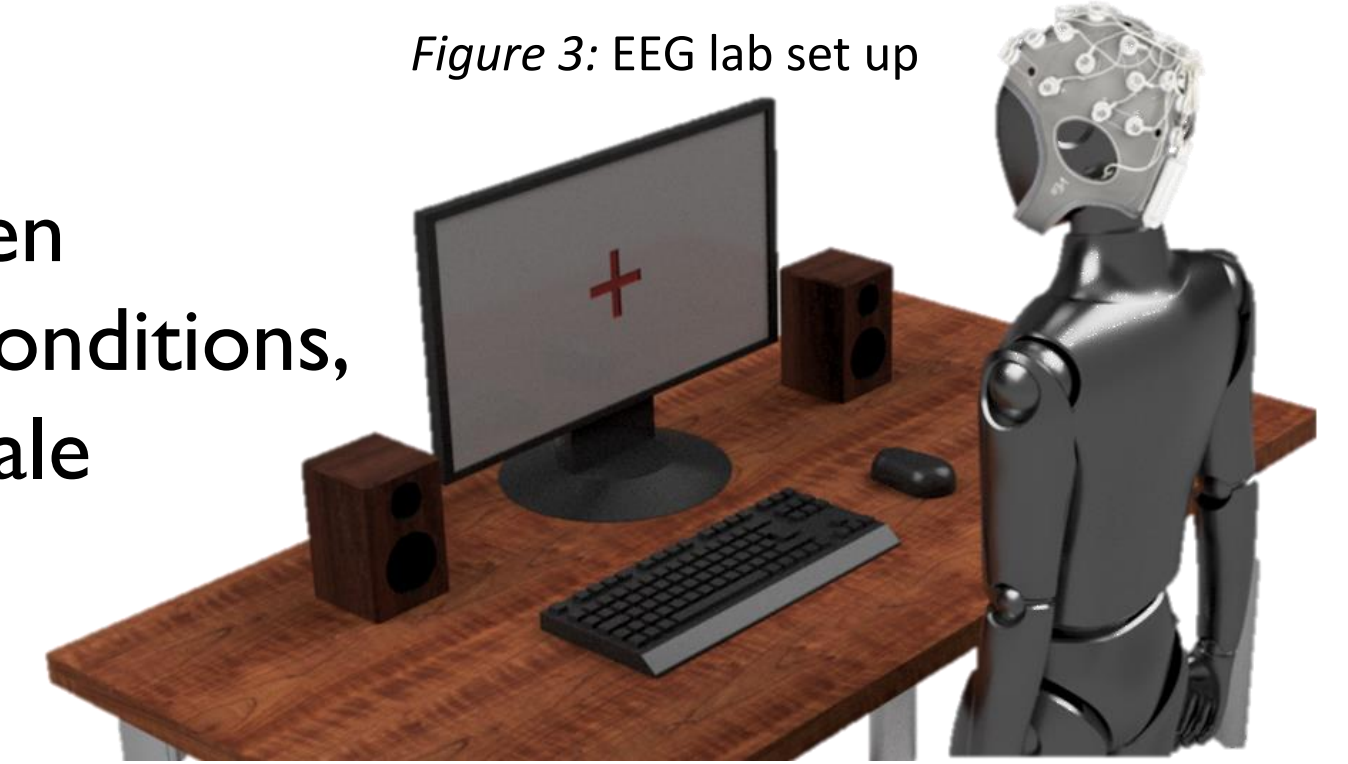
Materials and Procedure: Participants were evaluated using an electroencephalogram (EEG) - NuAmps 40 channel amplifier and Quik-cap (Figure 2).

The experiment was carried out using E-Prime and then participants underwent a 5 minute semi-structured interview to evaluate their perceptions.



METHODOLOGY

Sitting facing a computer (Figure 3), participants rested for 3 mins and were then administered the remaining 9 stimulation conditions, after each one, answering 5-point Likert scale questions about the pleasantness, relaxation, and nostalgia of the sound.



Design: Mixed-method repeated measures design. The 40Hz sound stimulation is presented as a click train, 1-ms long, 40 times per second (Martorell et al., 2019).

Combination of these variables resulted in 10 conditions (Table 1).

Table 1: Experimental Conditions

Rest (baseline)	No sound stimulation (baseline)
Beach soundscape only	Forest soundscape only
40Hz stimulation only (low volume)	40Hz stimulation only (medium volume)
Beach soundscape with 40Hz sound stimulation at low volume	Forest soundscape with 40Hz sound stimulation at low volume
Beach soundscape with 40Hz sound stimulation at medium volume	Forest soundscape with 40Hz sound stimulation at medium volume

Semi-Structured Interview: 8 Questions (5 minutes):

Participants asked to elaborate more on their perceptions of the experiment, including any pleasant, nostalgic and relaxing experiences.

Example:

Can you tell me about any nostalgic thoughts and feelings you experienced during this task?

PROPOSED ANALYSIS

Quantitative Analysis

Data will be analysed using MATLAB with the EEGLAB toolbox extension. EEG gamma spectral power will be calculated for the resting-state periods for each of the conditions. To test the hypotheses, ANOVA will be used to test the differences between conditions on gamma oscillations, and the Likert scale responses will be compared.

Qualitative Analysis

An inductive thematic analysis will be used to identify key themes within the interview transcripts. This will provide insight into personal experiences to identify the optimum combination of volume and soundscape, for future research.

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