Plan Overview

A Data Management Plan created using DMPonline

Title: Evaluating sound treatments for ADHD: attention and memory enhancement through inducing brain synchronization.

Creator: Ester Balbo

Principal Investigator: Ester Maria Balbo, Christian Sumner, Andrew Clouter, Sofia Tsitsopoulou

Data Manager: Ester Maria Balbo, Christian Sumner, Andrew Clouter, Sofia Tsitsopoulou

Project Administrator: Ester Maria Balbo, Christian Sumner, Andrew Clouter, Sofia Tsitsopoulou

Contributor: Christian Sumner, Andrew Clouter, Sofia Tsitsopoulou

Affiliation: Nottingham Trent University

Template: Nottingham Trent University DMP

ORCID iD: 0009-0003-2593-9399

ORCID iD: 0000-0002-2573-7418

ORCID iD: 0000-0002-3039-4018

ORCID iD: 0000-0002-4762-8810

Project abstract:

The project aims to verify, by use of electrophysiology (EEG) and behavioural measures, the effect of exposure to regular repeating sounds as a non-pharmacological treatment for subject with ADHD. Prior research underlined the efficacy of Auditory Beat Stimulation as a method of brainwave entrainment, with detection of increased level of memory and attention after exposure to specific sounds. Some studies have already tried to use this type of stimulation with people with ADHD, but these results are fragmented. Furthermore, auditory stimulation required an high level of specificity, since all components such as exposure, frequency or carrier tone, may vary and have different outcomes. Even tough single variables have been tested and has been proven to be effective, there isn’t unanimity about the entire collection of parameters specification. This work will collect all the statistical data from previous research to optimize parameters and verify their efficacy on memory and attention of people with ADHD.

This research will employ an experimental methodology and will include 3 studies. Data will be collected on NTU buildings, using NTU computers and sound producing equipment. First study will collect behavioural responses from people without ADHD, when exposed to auditory beat stimulation. After a parameter optimization, the second experiment will be conducted with people with ADHD, following the same procedure, with the addition of an Eye Tracker device, to collect more data about physiological change after the stimulation. In the third study, participants with ADHD, will be conducting executive functions tasks where they will deploy their memory and attention. In the third study, they will perform the task while wearing a non-invasive EEG cap on their head which measures electrical brain activity in the brain. Behavioural measures collected will be determined by standardized tests. Experimental materials, including the task, data processing, and analysis, will be processed using MATLAB, Experiment Builder and R, with their corresponding scripts. This research is based in the Perception, Attention, and Memory Group and will be done fully within NTU. This is an NTU centrally fully-funded PhD studentship.

The main researcher is Ester Balbo, supervised by Andrew Clouter (Director of Study), Christian Sumner (Co-Supervisor), Sofia Tsitsopoulou (Co- Supervisor). This is an individual project is based in the Psychology department and funded by an NTU studentship.

This data management plan captures the high-level data management strategy in accordance with NTU institutional guidelines. It will be further developed before ethical review.

ID: 176984

Start date: 05-01-2025

End date: 04-01-2029

Last modified: 03-11-2026

Copyright information:

The above plan creator(s) have agreed that others may use as much of the text of this plan as they would like in their own plans, and customise it as necessary. You do not need to credit the creator(s) as the source of the language used, but using any of the plan's text does not imply that the creator(s) endorse, or have any relationship to, your project or proposal

Evaluating sound treatments for ADHD: attention and memory enhancement through inducing brain synchronization.

Project details

Full name:

Ester Maria Balbo

Unique researcher ID:

0009-0003-2593-9399

Provisional project title:

Evaluating sound treatments for ADHD: attention and memory enhancement through inducing brain synchronization.

Worktribe ID:

n1334395

Project timeframes

05/01/2025 - 04/01/2029

Project context:

The project aims to verify, by use of electrophysiology (EEG) and behavioural measures, the effect of exposure to regular repeating sounds as a non-pharmacological treatment for subject with ADHD. Prior research underlined the efficacy of Auditory Beat Stimulation as a method of brainwave entrainment, with detection of increased level of memory and attention after exposure to specific sounds. Some studies have already tried to use this type of stimulation with people with ADHD, but these results are fragmented. Furthermore, auditory stimulation required an high level of specificity, since all components such as exposure, frequency or carrier tone, may vary and have different outcomes. Even tough single variables have been tested and has been proven to be effective, there isn't unanimity about the entire collection of parameters specification. This work will collect all the statistical data from previous research to optimize parameters and verify their efficacy on memory and attention of people with ADHD.

This research will employ an experimental methodology and will include 3 studies. Data will be collected on NTU buildings, using NTU computers and sound producing equipment. First study will collect behavioural responses from people without ADHD, when exposed to auditory beat stimulation. After a parameter optimization, the second experiment will be conducted with people with ADHD, following the same procedure, with the addition of an Eye Tracker device, to collect more data about physiological change after the stimulation. In the third study, participants with ADHD, will be conducting executive functions tasks where they will deploy their memory and attention. In the third study, they will perform the task while wearing a non-invasive EEG cap on their head which measures electrical brain activity in the brain. Behavioural measures collected will be determined by standardized tests. Experimental materials, including the task, data processing, and analysis, will be processed using MATLAB, Experiment Builder and R, with their corresponding scripts. This research is based in the Perception, Attention, and Memory Group and will be done fully within NTU. This is an NTU centrally fully-funded PhD studentship.

The main researcher is Ester Balbo, supervised by Andrew Clouter (Director of Study), Christian Sumner (Co-Supervisor), Sofia Tsitsopoulou (Co- Supervisor). This is an individual project is based in the Psychology department and funded by an NTU studentship.

This data management plan captures the high-level data management strategy in accordance with NTU institutional guidelines. It will be further developed before ethical review.

1. Defining your data

1a) Describe your data and how they will be processed for this project

Study 1

The data will comprise quantitative test responses, during the exposition to auditory stimulation, collected via Matlab. Additionally, a brief post-listening questionnaire will be administered to assess participants' subjective state following the task, including self-reported levels of tiredness, attentional focus, and anxiety.

All data will be stored on a password protected online experimental platform account at the time of collection and on the secure NTU OneDrive for Business following download for the analysis.

Data for the study variables will be automatically compiled and downloaded from the online platform in CSV format for analysis. Data cleaning and statistical analysis will be undertaken in the R software package.

Demographic data (gender and age) will be collected.

Studies 2

Study 2 will be based on insight from studies 1 and will follow the same procedures, but will include only people with ADHD and additional data will be collected by the use of Eye-Link eyetracker (lab-based). The Eye Tracking data will be used to assess endogenous attention levels in participants. Since the procedure will be the same, the data management strategy is identical to the one described for study 1. Eye tracking data will be treated as any other digital data.

Demographic data (gender and age) will be collected along the participants' ADHD profile, that will be collected using the standardize "Adult ADHD Self-Report Scale (ASRS-v1.1)" and a brief self-report questionnaire. Additionally, a pre-listening questionnaire has been introduced, and participants will be asked to rate their fatigue levels before each test.

Study 3

The data collection will follow the same procedure of study 1 and 2, but additional quantitative EEG data will be recorded. Quantitative electrophysiological data will be collected using electroencephalography (EEG). Live electrical brain signal data, while participants are conducting their experimental task, will be in a form of sine waves on the computer screen. Each sine wave will correspond to each EEG electrodes. Behavioural measures will be collected in the form of reaction time (in milliseconds) and accuracy (correct responses). Task will be created using MATLAB codes and with preexisting test codes. In addition to this, scripts to collect behavioural data, overall data pre-processing (including segmentation, etc.), and data storage will also be created.

Demographic data (gender and age) will be collected along the participants' ADHD profile, that will be collected using the standardize "Adult ADHD Self-Report Scale (ASRS-v1.1)" and a brief self-report questionnaire.

1b) Will you be working with pre-existing data for this project? If yes, provide details below:

No pre-existing data will be used.

1c) Will your project involve the collection or processing of personal and/or special category data?

The study will involve the collection of health and biometrics data defined under UK GDPR.

During study 1 demographic information such as age and gender will be collected.

During study 2, in addition to the previously listed data, participants will be asked to share data related to their ADHD profile to evaluate the efficacy of the treatment. In addition, Eye Tracking data will be collected to assess endogenous attention levels in participants.

During study 3, in addition to the previously listed data, EEG recordings will be performed and biometric data will be collected.

All data collection and processing will comply with relevant data protection regulations, including United Kingdom General Data Protection Regulation (UK GDPR). Secure data storage and access control measures will be implemented to ensure the confidentiality and integrity of the data, and full details of these are outlined throughout this plan.

Confidential and sensitive data related to participants diagnosis will be collected. These data will include medical details regarding subject personal data, such as age and gender, and their ADHD specificity, such as type of ADHD and comorbidities. Details of descriptions on how this data will be kept secure can be found later in this plan.

Considering the target demographic, preliminaries power analysis and previous research using EEG time-frequency analysis, it's expected to collect minimum 20 individuals respectively for study 1, 28 individuals for study 2 and a minimum of 40 individuals for study 3, considering a within subject design.

This data won't be disclosed with third party.

1d) Will your project involve the collection or processing of confidential or sensitive data?

Main software used will be MATLAB in the [.txt] format for the experimental task. Statistical analysis and data visualization will be collected using MATLAB in the [.mlx] format. All data will be analyzed in R, using R studio and relative packages.

Eye-tracking data will be collected using an Eye-Link eyetracker (lab-based). Data acquisition will be recorded in the native EyeLink [.edf] format. Recorded measures will include gaze position, pupil size, blinks, fixations, saccades, and time-locked event markers. Raw eye-tracking files will be exported to [.asc] and/or [.csv] formats for preprocessing and analysis. Processed eye-tracking outputs and derived variables will be stored in [.csv] format.

EEG data will initially be collected in [.bdf] format which will then be converted to a more widely compatible [.edf] format and behavioural will be saved as [.txt].

Fatigue levels will be stored securely in digital format, as numerical values associated only with the test name and the participant's anonymised identifier.

Consent forms, pre and post listening questionnaires, self-report questionnaire about ADHD diagnosis and the Adult ADHD Self-Report Scale responses will be collected in paper format and stored securely in a locked cabinet in the supervisor's office.
Data collected are not anonymous at the point of collection. See section 2 for procedures to keep participants anonymous.
Ownership of the data generated in this study will be fully owned by NTU. However, the research team consisting of myself as the primary researcher along with my supervisory team, will have the rights to use the data for research purposes.

2. Data Security and Safeguarding

2a) What measures need to be put in place to process the data securely, ethically and legally?

I have consulted with the following guidance and policies:

- Data Security- Portable Devices and Media Policy
- NTU Records Retention Policy
- NTU Research Ethics Policy
- NTU Data Storage Guidance

To ensure the secure, ethical, and legal processing of data, the following measures will be implemented:
Obtaining informed consent: Participants will be provided with a participant information form including detailed information about the study, its purpose, data collection methods, and how their data will be used. Informed consent will be obtained through signed consent forms, ensuring participants understand their rights, including the right to withdraw, and the process and deadline for doing so.
Anonymising Data: All participants will will have their own uniquely generated code as their ID to ensure anonymity, by extension, all data will be labelled as such. This will be based on, e.g. first letter of surname, first letter of first name, first letter of mother's surname, last 3 digits of phone number = JDS745. Since the data is not anonymised at the point of collection, this ID will be generated after participants signed the consent form.
Ensuring confidentiality of data: If the participant contacts the researcher to request a right to withdraw, all data related to their unique identifier and withdrawal request correspondence will be destroyed to protect confidentiality.
Access Control: All data obtained in the experiment room (excluding informed consent, questionnaires and demographics) will be collected using MATLAB, Experiment Builder and the EEG software and will kept inside the room's designated computer. Fatigue levels will be stored securely in an Excel file as numerical values, with each number corresponding to a reported fatigue level. Although I will personally collect the anonymised data, other NTU personnel using the room will still be able to access the computer (e.g. staff, lecturer, researcher, etc.). All data will be compiled in a single folder specifically for my personal storage for this particular project. This includes experiment data and scripts. Two weeks after data collection, participants will have a last chance to withdraw from the experiment. If not, the generated ID will be changed to numbered ID, e.g. "JDS745" to "participant1", effectively anonymising the data and disassociating it with the participant. This will also be stated verbally and in writing on the consent form. This version of the anonymised data will be the one stored in the open repository. Data used (electrophysiological, behavioural, and demographic) for the completed and published output/work will be kept long term (at least 10 years) in an online repository.
The full research team and myself will have full access to the data:
Ester Maria Balbo* (PhD Student), Andrew Clouter* (Director of Study), Christian Sumner* (Co-Supervisor), Sofia Tsitsopoulou* (Co-Supervisor)
*School of Social Sciences, Nottingham Trent University, 50 Shakespeare Street, Nottingham NG1 4FG, UK
Additional Measures

A favourable ethical opinion will be sought from the NTU Schools of Business, Law and Social Sciences Research Ethics Committee (BLSS REC) to ensure all research activities comply with ethical standards.
Data minimisation principles will be followed, collecting only the data necessary for the study's objectives.
Regular security assessments will be conducted to identify and mitigate potential vulnerabilities.
A data breach response plan will be in place to address any security incidents promptly and in accordance with legal and institutional guidelines

2b) How will data be stored during this project?

During the project, data will be stored securely to ensure its integrity and confidentiality. The data storage plan includes the following stages:
Initial Data Capture: EEG data, Eye tracking data and behavioural data will be collected trough Matlab, EEG software and Experiment Builder then analysed through R. All platform access will be password protected and accessible to the researcher and

supervisory team only. Fatigue levels will be stored as numeric data on an Excel file.

Active Research Data Storage: After initial capture, data will be transferred to the secure NTU OneDrive for Business for data analysis. The drive will be accessed by the researcher and access granted to the supervisory team. Regular backups will be generated and stored in a secure location.

Expected Data Volume: We anticipate generating approximately Expected size for [.edf] = 200 Mb, [.txt] = 2Kb. 1 participant will have a file size of around 200Mb + 2Kb. I plan to recruit 105 participants. Therefore, the expected collected data size will be around 105 x (200Mb + 2Kb) GB of data during the project. This estimate includes data from all anticipated experiments. Measure will vary.

:) Will this data be disclosed to or shared with a third party? If so, please provide details

The project does not involve sharing data with any third parties.

3. Data Preservation

3a) What data should be kept, or destroyed, after the end of your project?

NTU requires that I keep the data supporting my research outputs at the end of the project and make it openly available with as few restrictions as possible. The project will retain the following information:

Raw data files comprising downloaded information from Matlab and an Eye-Link eyetracker (lab-based).

Cleaned data files comprising the downloaded data from Matlab and Eye-Link eyetracker (lab-based) prepared for and used in the analysis.

R code used in the data analysis.

3b) Where will you archive your data?

Data protection will commence at the point of initial data capture in a secure lab setting and non-networked PCs. Data will then be stored in a designated project folder on the NTU DataStore. When needed, a brief usage of an encrypted portable storage (password- protected and non-identifiable information present) will be used to move data (e.g. electrophysiological/behavioural) from machines to the NTU DataStore. NTU DataStorage automatically backup the data. Data will be removed once data transfer is completed. Consent forms will be stored securely in a locked cabinet in the supervisor's office.

The code will be deposited on Github (https://github.com/) and data will be shared on Open Science Framework (https://osf.io).

3c) When will you archive your data?

Data will be deposited in the repository prior to my output being submitted for publication, peer review and examination.

3d) How long will the data be archived for?

In accordance with the NTU Records Retention Schedule, the research data will be retained for 10 years from the date of deposit.

4. FAIR Data

4a) How will you ensure your research data are Findable?

My data will be made discoverable in several ways:

Open Science Framework, Github and NTU Data Archive is fully searchable and indexed.

NTU Data Archive is fully searchable and indexed (e.g. in Google/ Google Scholar)

Published works will be linked to Github and OSF visa the journal article via data citation and data access statement.

My thesis/ publication will include a data citation and data access statement, so readers will know where and how to access the underlying data.

After depositing my project data in Github and OSF, I will register my data with NTU by submitting a PGR Data Registry Form. A metadata record for my research data will be created in NTU IRep. This record will offer a full description of my data, as well as linking directly to the record of my thesis. The thesis record will also link to the dataset metadata record so that people who locate my thesis will also be directed to its underpinning data. The only data not shared with the public are individual EEG recordings files of each participant.

A DOI will be generated for the dataset.

4b) How will you ensure your data is Accessible?

All data (outlined in section 3a and 3b) will be made available to download, with as few restrictions as possible, once uploaded to OSF and Github under Creative Common License.

Data will be freely accessible under Creative Common License on completion of degree and publication of paper.

4c) How will you ensure your data is interoperable?

To ensure that the data is interoperable, I will implement the following strategies:

Standardised Formats: Data will be saved in widely accepted, open-standard data formats that facilitate easy data sharing and integration, for example, tabular data will be stored in CSV format.

Document Variables: I will provide a codebook/data dictionary that will explain variables, units, and measurements which will be stored alongside data files in OSF.

4d) How will your ensure your data is reusable?

To ensure that the data is reusable, I will implement the following strategies:

Attach an appropriate license to my dataset to promote transparency and ensure proper attribution.

Provide an accompanying 'read me' text document detailing how to access and use the data, details on software needed to open the files, and any related requirements. The file will also specify the dataset’s relationships to other files (e.g., code, datasets, manuscripts).

Structure the project data into 'components' on Github and OSF to organise the overall research and create a hierarchy within the project.

5. Implementing your DMP

5a) How often will this plan be reviewed and updated?

The DMP will be updated once measures for Study 1 and 2 have been agreed and in advance of ethical review.

My supervision team and I will also review this plan at interim, annual and PhD transfer meetings and I will update as required.

5b) What actions have you identified from the rest of this plan?

Share DMP with supervision team and discuss any amendments before submitting it with my research proposal.

Set up a data storage area on NTU OneDrive for Business.

Set up a data repository area for the project on Github and OSF, to coincide with pre-registration of Study 1.

Submit and an Active Research Data Storage Form to the Library Team to set up a NTU Data Store folder.

5c) What support/ information do you need to complete these actions?

I will refer to the following information in completing these actions:

NTU Library RDM webpages

UK Data Service

NTU Library Academic Engagement Team: Open Research at LIBOpenResearch@ntu.ac.uk.