

Data Analytics for Immersive Environments - Pair Project

Virtual Reality(VR) Interventions: Evaluating Efficacy in the Treatment of Generalized Anxiety Disorder(GAD)

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Learning Outcomes

To practice the following:

- Formulation of an experiment hypothesis.
- Application of appropriate statistical tests.
- Descriptive and inferential analysis of data.
- Generation of descriptive statistics.
- Report generation in R Markdown and R Notebook.
- Use of R language and R Studio.

Introduction

As of 2019, according to the World Health Organization, approximately 301 million people worldwide suffer from anxiety disorders. Anxiety disorders are a group of mental disorders characterized by feelings of anxiety and fear. These feelings may cause physical symptoms such as a racing heart and shakiness. Anxiety is a natural response to stress, but for individuals with an anxiety disorder, the fear or nervousness does not go away and can get worse over time, affecting daily activities such as job performance, school-work, and relationships.

Triggers for anxiety disorders can range from environmental factors, genetics, brain chemistry, medical factors, to a combination of these. There are several types of anxiety disorders, including generalized anxiety disorder, panic disorder, specific phobias, agoraphobia, social anxiety disorder, and separation anxiety disorder. Treatment options for these disorders include a combination of psychotherapy, behavioral therapy, and medications.

Virtual Reality has emerged as a transformative tool in the treatment of anxiety disorders, offering immersive therapeutic experiences that can simulate real-world scenarios in a controlled environment. By exposing patients to stimuli or situations that trigger anxiety, VR allows for gradual habituation and desensitization, making it a potent complement to traditional cognitive-behavioral therapies. For instance, Opris et al. (2012) demonstrated that VR exposure therapy (VRET) significantly reduced post-traumatic stress disorder symptoms in military personnel. Similarly, a study by Maples-Keller et al. (2017) found that VRET can be as

effective as in vivo exposure for the treatment of acrophobia. Furthermore, Lindner et al. (2017) showcased the potential of using VR in treating social anxiety disorders, particularly in enhancing public speaking skills. The continued integration of VR into therapeutic practices showcases its potential to revolutionize the treatment landscape for anxiety disorders.

```
knitr::include_graphics(here::here("images", "vr_exposure.png"))
```

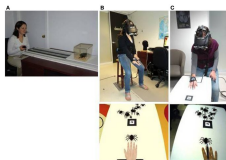


Figure 1: Three types of exposure-based methods(1)

Non-pharmacological therapies for Generalised Anxiety Disorder are normally described under the umbrella term of Cognitive Behavioural Therapy (CBT). The most common approaches are:

- Imaginal Exposure Therapy
- Stress Inoculation Training
- Eye Movement Desensitization and Reprocessing

There are several methods employed to assess GAD severity including structured interviews and self-report questionnaires. In this experiment, the severity of the anxiety disorder was assessed using self-report (i.e., State-Trait Anxiety Inventory (6) and Generalized Anxiety Disorder 7-item scale (7)) mechanisms. Both measurements are scaled to the range of 0 to 10.

Experiment Details

Data from a study are presented that investigated the effect of VR exposure therapy, conducted in a virtual reality environment, on psychotherapy patients undergoing treatment for GAD.

The study consisted of 180 patients (M=96, F=84) in total, divided into the groups listed below. The participants were randomly sampled from the clinic client list and randomly assigned to one of two groups below:

- Control (traditional CBT, no VR) (M=48, F=42)
- Experimental (VR-based therapy) (M=48, F=42)

All patients were adults in the age range of 18 - 40 years. Information on the exact age of participants was not recorded. Gender information was recorded. All groups were of equal size. The two groups underwent 12 weeks of treatment for 50 minutes per week with a therapist. During that time the patients either underwent traditional CBT or used the VR app. GAD measurements for all groups were measured using the two self-report mechanisms outlined above. Measurements were taken at the start and end of the study.

Requirements

The data gathered will be made available to each student group via Moodle. Each group will receive a different subset of the results the study participants. As part of this assignment, you are required to perform statistical analysis on these data. This will involve the completion of the following steps:

1. Determine whether the data provided are appropriate for the test(s) available and whether any data cleaning is required.
2. Formulate a **single** hypothesis test to be used to compare the effectiveness of the approaches used during the experiment.
3. Determine if the data meet the assumptions required by any statistical test.
4. Provide descriptive statistics (graphs and tables) for any assumptions made.
5. Analyse the data to provide the hypothesis testing conclusion.

6. Determine the 95% confidence interval for the population mean of a **single** group.

Lab Report Structure

These steps will result in the generation of a single R Notebook file containing the R source code. This R Notebook file must be configured to generate a HTML document (**1200 words excluding plots or tables with a maximum of 5 plots/tables allowed**).

The R Notebook **must** have the following structure:

1. Title (including participant full names)
2. Table of Contents
3. Abstract (**2.5 marks**)
 - Aim and rationale
 - Participants and setting
 - Experiment design
 - Results gathering
 - Findings/implications
4. Introduction (**15 marks**)
 - Topic and context
 - ~~Theoretical framework~~
 - ~~Summary of previous work~~
 - Rationale
 - Hypothesis
5. Method (**20 marks**)
 - Participants
 - Design
 - Materials
 - Procedure
6. Results (**40 marks**)
 - Descriptive statistics
 - Inferential statistics
 - Statistical tests
 - Magnitude and direction of results
7. Discussion (**10 marks**)
 - Outline findings and relation to the hypothesis
 - ~~Compare results to background work reported earlier~~
 - Limitations (if confounding variables are clearly identified by your group)
8. References (**2.5 marks**)

Structure, Presentation & Quality

Your R Notebook source code should output **both the code and any data/plot/table** to the rendered HTML document.

A total of **2.5 marks** will be awarded for the clear commenting of any (non-trivial) line of R code and a clear description of any novel processing and/or user-defined functions.

Next, **2.5 marks** will be awarded if all included graphs/tables are formatted to maximise readability (i.e. main heading, labs, tick spacing and frequency, plot character, and caption).

You will be awarded a maximum of **5 marks** based on the clarity, coherence, and quality of your written expression. This corresponds to a report that is clear in its expression, logical in its presentation of the steps followed, and free from grammatical and typographic errors.

Only a single R Notebook file should be submitted. Submission of multiple R Notebook files will result in the grading of only the first (alphabetically listed) R Notebook file.

Version Control Requirements

You must use a recognised online code repository (e.g., GitHub) and make regular well-named commits to your private repository. A link to your code repo must be included in a README as part of the final submission and you must add your lecturer as a developer to the repository. The repository must be named *2023_DAIE_GCA_StudentInitials1_StudentInitials2*.

Your grade for this component will depend directly upon the **regularity** of your commits. A development project of this size should consist of a minimum of **5+ distinct commit messages** spread over the lifetime of the development. Committing all your code in one commit, before the deadline, will be interpreted negatively.

Any submission made which does not include a repository link will not be graded.

Submission Requirements

1. A **README** file containing a link to your R source code repository. Ensure that **no** changes are made to the repository following the submission deadline. You should create a separate fork for this submission and leave it unchanged after the deadline. Ask your lecturer for details on fork creation.
2. The assignment must be entirely the work of each student group. Students are **not** permitted to share any pseudocode or source code from their solution with any other group in the class.
3. Students may **not** distribute the source code of their solution to any other student, in any format (i.e., electronic, verbal, or hardcopy transmission).
4. Plagiarised assignments will receive a mark of **zero**. This also applies to the individual/group allowing their work to be plagiarised. Any plagiarism will be reported to the Head of Department and a report will be added to your permanent academic record.
5. Late assignments will **only** be accepted if accompanied by the appropriate medical note. This documentation must be received within 10 working days of the project deadline. The Institute standard penalties for late submission will apply.
6. Each student group **must** complete and **sign** a single assignment cover sheet. Please submit the signed cover sheet before 5 pm on the Friday of the week of the deadline.
7. Online individual video interviews for this project will be scheduled in the **first week** following the deadline. You will need both audio and video in this interview so please ensure that you have both setups beforehand and adequate connection speed to support the video session (i.e., download/upload speeds $\geq 1.2\text{Mbps}$). The interview will not take place in the absence of video and audio from your side of the connection.
8. Failure to attend the **interview** will result in a 0% grade. Both students in a group will be required to answer **several questions** on your submission to demonstrate understanding of the submitted project. Your **individual grade** for this component will be contingent on your **knowledge** of the work you submit.

References

1. Baus, Oliver & Bouchard, Stéphane. (2014). Moving from Virtual Reality Exposure-Based Therapy to Augmented Reality Exposure-Based Therapy: A Review. *Frontiers in human neuroscience*. 8. 112. 10.3389/fnhum.2014.00112. (Accessed: 3 October 2023)
2. Anxiety disorders (no date) World Health Organization (Accessed: 4 October 2023)
3. Opris, D., Pinte, S., García-Palacios, A., Botella, C., Szamosközi, S., & David, D. (2012). Virtual reality exposure therapy in anxiety disorders: a quantitative meta-analysis. *Depression and Anxiety*, 29(2), 85-93. (Accessed: 4 October 2023)
4. Maples-Keller, J. L., Bunnell, B. E., Kim, S. J., & Rothbaum, B. O. (2017). The Use of Virtual Reality Technology in the Treatment of Anxiety and Other Psychiatry Disorders. *Harvard Review of Psychiatry*, 25(3), 103-113. (Accessed: 4 October 2023)
5. Lindner, P., Miloff, A., Hamilton, W., Reuterskiöld, L., Andersson, G., Powers, M. B., & Carlbring, P. (2017). Creating state of the art, next-generation Virtual Reality exposure therapies for anxiety disorders using consumer hardware platforms: design considerations and future directions. *Cognitive Behaviour Therapy*, 46(5), 404-420. (Accessed: 5 October 2023)

6. State-Trait Anxiety Inventory (STAI) (Accessed: 4 October 2023)
7. Generalized Anxiety Disorder 7-item scale (GAD-7) (Accessed: 4 October 2023)
8. Freeman, D. et al. (2017) Virtual reality in the assessment, understanding, and treatment of mental health disorders: Psychological medicine, Cambridge Core (Accessed: 6 October 2023)

Additional Resources

The resources below are provided as a mixture of **optional background reading**, technical reference, and useful tools.

- DkIT - Writing in the sciences...: Lab Reports
- Writing Up Research - Discovering Statistics
- Recommended Text - OpenIntro Statistics Videos & Slides
- How to Test for Normality in R
- 7 Types of Statistical Analysis: Definition and Explanation
- PTSD Symptom Scale-Interview Version
- YouTube - Riffomonas Project - R Language Tutorials
- Mendeley - Manage and share research papers
- Microsoft OneNote - Note taking and web page snipping
- R Markdown Cookbook
- R Markdown Cheatsheet
- Understanding YAML headers
- R Markdown Themes
- Harvard referencing quick guide: Citing and referencing material

Formal Harvard referencing guidelines have **not** been strictly followed in this document.