

# **Research methods in Cognitive Neuroscience**

Carlos González

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# Welcome

This text is aimed to serve as your guide for the first half of the course “Methodology in Cognitive Neuroscience: Basic and Applied Research” in the Master’s Program in Cognitive and Behavioral Neuroscience at the University of Granada.

In this section, we will explore the foundations of experimental research in cognitive neuroscience and develop practical skills in experiment programming. We’ll begin by introducing key concepts in research methods and experimental thinking, providing you with a solid theoretical foundation. Then, we’ll dive into hands-on training using [E-Prime](#) and [OpenSesame](#), two powerful pieces of software for creating psychology experiments.

By the end of this module, you will be able to:

- Understand and apply principles of experimental design in cognitive neuroscience
- Think critically about research methodology and experimental control
- Design and program your own experiments using E-Prime and OpenSesame
- Troubleshoot common issues in experiment programming

This guide is designed to be both theoretical and practical. Most of the chapters include conceptual discussions followed by hands-on exercises to help you apply what you’ve learned. Remember, mastering these skills requires practice, creativity, and persistence!

## Relevant links

[Course guide](#)

## Disclaimer

This material has been elaborated for the use of the Cognitive Neuroscience master students of the Universidad de Granada, years 2023-25.

The resources listed here are Open Educational Resources (OER) that are free to use, share, copy, and edit, with attribution, following the terms of the specified license.

Please contact [Carlos González](#) for any inquiry.

# 1 Required Software

Check PRADO for instructions on how to install **E-Prime**.

**OpenSesame** (download latest version from [here](#)).

It should run in any more or less recent computer. If you have any issue installing it, please let me know as soon as possible!

## 1.1 Resources and recommended readings

### Note

Note: these are just extra readings in case you want to learn more. They are encouraged but not required to follow or pass the course.

- Barbosa, J., Stein, H., Zorowitz, S., Niv, Y., Summerfield, C., Soto-Faraco, S., & Hyafil, A. (2023). A practical guide for studying human behavior in the lab. *Behavior Research Methods*, 55(1), 58-76.
- Frank, M. C., Braginsky, M., Cachia, J., Coles, N.A., Hardwicke, T.E., Hawkins, R.E., Mathur, M.B., and Williams, R. 2024. *Experimentology: An Open Science Approach to Experimental Psychology Methods*. MIT Press. <https://doi.org/10.7551/mitpress/14810.001.0001>.
- Mathôt, S., Schreij, D., & Theeuwes, J. (2012). OpenSesame: An open-source, graphical experiment builder for the social sciences. *Behavior Research Methods*, 44, 314-324.
- Myers, J. L., Well, A. D., & Lorch Jr, R. F. (2013). *Research design and statistical analysis*. Routledge.

## 1.2 Assessment

This course is divided in two parts:

- 1) Programming of experiments (50% of the final grade)
- 2) Statistical analyses (50% of the final grade)

**⚠ Important!**

A minimum of 25% in each phase is required to pass the course.

In my part of the course (*Part 1*), your final grade will depend on:

Activity	Contribution to final grade
Participation and in-class assignments	30%
Individual programming assignments	30%
Final project	40%

## 1.3 Course Policies

### 1.3.1 Attendance and Participation

Attendance is strongly encouraged for this course due to its eminently practical nature. Please note:

- Many in-class activities and hands-on exercises might not be easily replicated outside of class.
- Regular attendance will significantly enhance your learning experience and ability to complete assignments successfully.
- If you must miss a class, it is your responsibility to catch up on missed material and assignments.
- Consistent participation in class discussions and activities will positively impact your learning and final grade.

### 1.3.2 Late Work and Extensions

- Assignments are due on the dates specified in the course schedule.
- Late submissions will incur a 20% penalty
- If you anticipate difficulty meeting a deadline, please contact me as soon as possible to discuss potential extensions.
- Extensions may be granted for documented emergencies or extenuating circumstances at the instructor's discretion.

### **1.3.3 Academic Integrity**

- All work submitted must be your own.
- When using external sources (including generative AI tools), proper citation is required.
- Collaboration on assignments is encouraged, but each student must submit their own original work.

### **1.3.4 Communication**

- Email (cgonzalez at ugr dot es) is the primary mode of communication outside of class.
- You can also use PRADO if you prefer.

## **1.4 Office Hours**

Mondays from 8:30 to 11, but feel free to send me an email anytime or just ask me after class.

## 2 From Research Questions to Data

The essence of cognitive neuroscience experiments is to examine relationships between manipulations (independent variables) and their effects on measurable outcomes (dependent variables). Remember there are various experimental designs, such as:

- **Between-participants design:** Each participant experiences only one level of a factor.
- **Within-participants design:** Participants experience multiple levels of a factor, allowing for within-subject comparisons.
- **Mixed designs:** Combining elements of both between- and within-participant designs.

There are also techniques like **counterbalancing** to mitigate order effects and ensure reliable, replicable results.

### 2.1 Tools for Experimental Design

During the programming phase, you'll become familiar with two key software tools:

#### 2.1.1 E-Prime

- Widely used at CIMCYC
- Great for users with little coding experience
- Only available on Windows (License required; check PRADO)

#### 2.1.2 OpenSesame

- Python-based and open source
- Cross-platform and free
- Requires basic coding knowledge, but has a large online community

If you need help accessing these tools or have a non-Windows computer, feel free to reach out!

### Relevant readings

For more reading, check out the following resources:

- [Myers, Well, & Lorch \(2013\). Research Design and Statistical Analysis](#)
- [Experimentology](#)
- [Barbosa \(2022\)](#)

Below, you can find the slides from this session: