

# How to read a Research Paper

Scientific reading in the age of AI

Marius Klug

he/him

PI Young Investigator Group Intuitive XR  
Chair of Neuroadaptive Human-Computer Interaction  
Brandenburg University of Technology Cottbus-Senftenberg

marius.klug@b-tu.de

# What **not** to do



Do not read a paper like a book or a story!

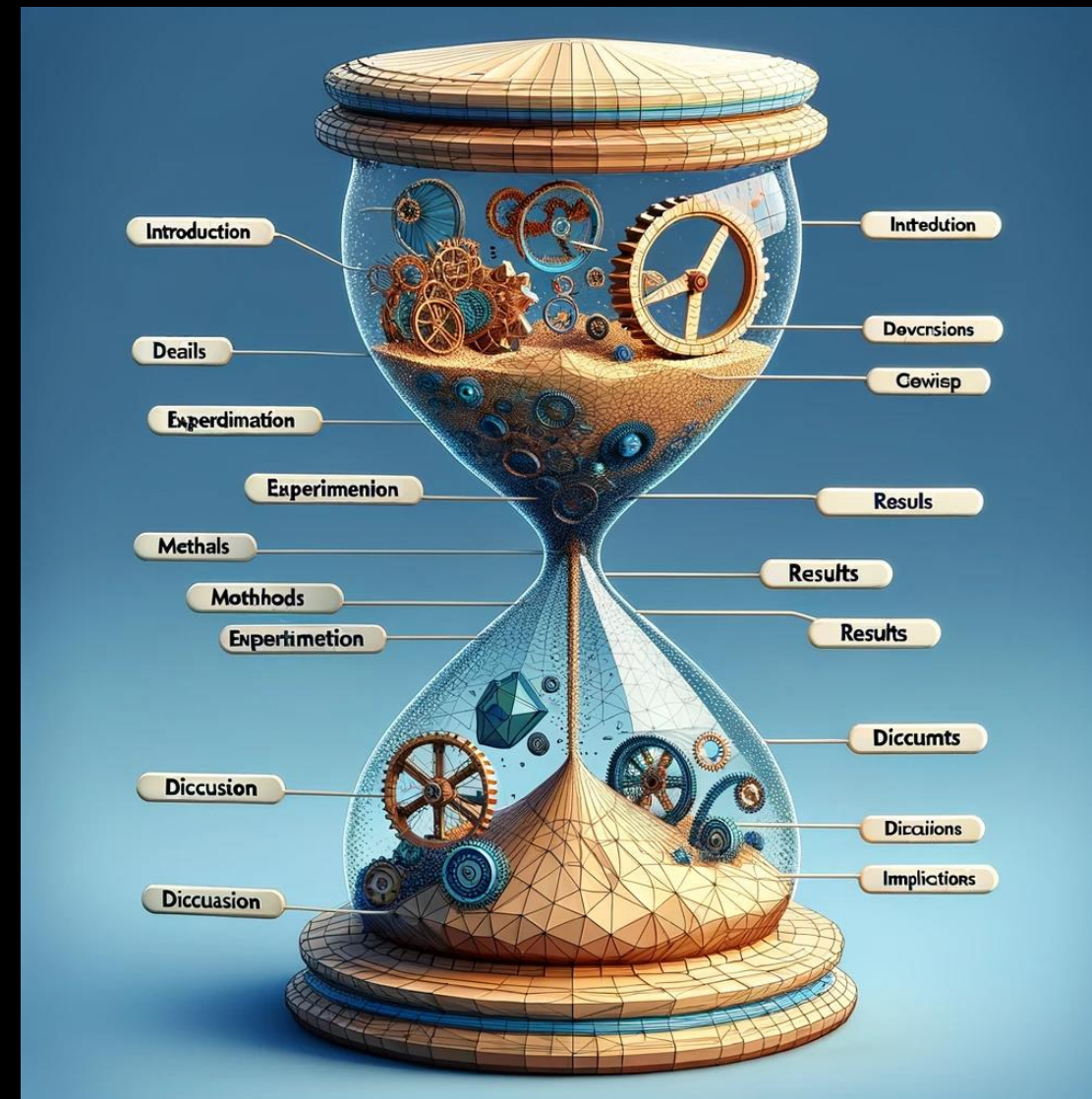
# What to do



Read the paper in a structured way



# What is a paper



Title

Abstract

Introduction

Methods

Results

Discussion

Conclusions

# What is a paper

**IOP Publishing**  
J. Neural Eng. **16** (2019) 054001 (9pp)

Journal of Neural Engineering  
<https://doi.org/10.1088/1741-2552/ab21f2>

**Note**

**Title**

**A comparative evaluation of signal quality between a research-grade and a wireless dry-electrode mobile EEG system**

**Authors**

Francesco Marini<sup>1,2,4</sup>, Clement Lee<sup>1,2</sup>, Johanna Wagner<sup>1,2</sup>, Scott Makeig<sup>1</sup> and Mateusz Gola<sup>1,2,3</sup>

**Affiliations**

<sup>1</sup> Swartz Center for Computational Neuroscience, University of California San Diego, La Jolla, CA, United States of America  
<sup>2</sup> Center for Neuromodulation, University of California San Diego, La Jolla, CA, United States of America  
<sup>3</sup> Institute of Psychology, Polish Academy of Sciences, Warsaw, Poland

**Contact**

E-mail: [francesco.pd@gmail.com](mailto:francesco.pd@gmail.com)

Received 27 February 2019, revised  
Accepted for publication 16 May 2019  
Published 19 September 2019

**Abstract**

*Objective.* Electroencephalography (EEG) is widely used by clinicians, scientists, engineers and other professionals worldwide, with an increasing number of low-cost, commercially-oriented EEG systems that have become available in recent years. One such system is the

  
CrossMark

# What is a paper

## Abstract

**Objective.** Electroencephalography (EEG) is widely used by clinicians, scientists, engineers and other professionals worldwide, with an increasing number of low-cost, commercially-oriented EEG systems that have become available in recent years. One such system is the Cognionics Quick-20 (Cognionics Inc., San Diego, USA), which uses dry electrodes and offers the convenience of portability thanks to its built-in amplifier and wireless connection. Because of such characteristics, this system has been used in several applications for both clinical and basic research studies. However, an investigation of the quality of the signals that are recorded using this system has not yet been reported. **Approach.** To bridge this gap, here we conducted a systematic comparison of signal quality between the Cognionics Quick-20 system and the Brain Products actiCAP/actiCHamp (Brain Products GmbH, Munich, Germany), a state-of-the-art, wet-electrode, research-oriented EEG system. Resting-state EEG data were recorded from twelve human participants at rest in eyes open and eyes closed conditions. For both systems we evaluated the similarity of mean recorded power spectral density, and detection of alpha suppression associated with eyes open relative to eyes closed. **Main results.** Power spectral densities were highly correlated across systems, with only minor topographical variability across the scalp. Both systems recorded alpha suppression during eyes open relative to eyes closed conditions. **Significance.** These results attest to the robustness and reliability of the dry-electrode Cognionics system relatively to the widely used Brain Products laboratory EEG system, and thus validate its utility for clinical and basic research purposes, at least in studies in which participants do not move.

Keywords: electroencephalography, EEG, alpha-band activity, power spectral density, dry-electrode, wireless EEG



# What is a paper

## 1. Introduction

Electroencephalography (EEG) is one of the most versatile and powerful tools for studying brain function. It provides a non-invasive way to record electrical activity from the brain, allowing researchers to study a wide range of neural processes. In this paper, we describe a new EEG setup that is designed to be easy to use and to provide high-quality recordings. The setup consists of a custom-built amplifier, a set of electrodes, and a software package for data acquisition and analysis. We describe the design and construction of the setup, and we present results from a series of experiments that demonstrate its performance. The results show that the setup is capable of recording high-quality EEG signals, and that it is easy to use by non-experts. This makes it a valuable tool for a wide range of research applications.

## 2. Methods

### 2.1. Participants

Twelve healthy volunteers (seven males, five females) participated in the current study. The participants were recruited from the previous study to evaluate the effect of the intervention on the current study.

### 3. Results

### 3.1. Power spectral density

**4. Discussion**

#### 4. Discussion

This study was conducted to evaluate EEG signal quality obtained using a dry-electrode system, the Cognionics Quick-20, which has research-orient

### 4.3. Conclusive remarks

The current work incorporates some relevant methodological advantages relative to existing comparative analyses of EEG systems. First, the sample size of twelve participants was larger than most previous studies (Estep *et al* 2009, Chi *et al* 2012, Oliveira *et al* 2016a, O’Sullivan *et al* 2017, Ratti *et al* 2017; but also see Ries *et al* (2014) and Radüntz (2018) for studies that used larger samples). Moreover, unlike most previous research, here we analyzed data from all (eighteen) scalp channels rather than from a small subset of channels, therefore conducting a more comprehensive assessment. This study provides a simple and concise comparative evaluation of the Brain Products and Cognionics systems that might serve to inform clinical research decisions. However, a poten-

# The brief check paper-reading approach

Why?

- Someone links you a paper and you need to **evaluate** if it is worth reading it
- You need to quickly make sure you have an **idea of the topic** for the seminar
- You found a **reference** to a paper in a paper you read and need to check it
- You try to **win an argument**...





# The brief check paper-reading approach

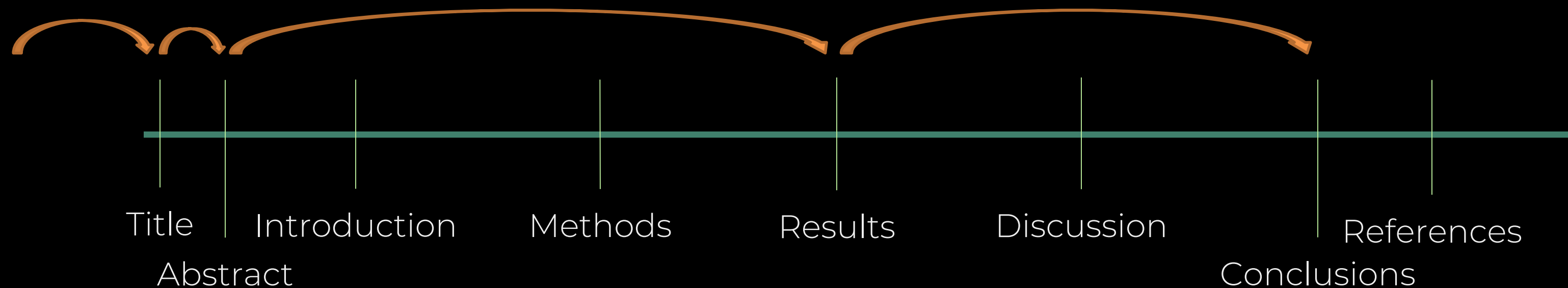
Shrink it down to 1-2 pages (10-30 minutes):

1. Read **title** carefully to grasp the topic and main finding
2. Check **abstract** to get briefed on the entire study
3. Look at **figures** to see experiment design and main results
4. Read **conclusions** to find the main contributions to the field

-> You now know all key points of a paper!



# The brief check paper-reading approach





# What you know after a brief check

## The four Generals:

1. General **topic** of the paper
2. General **knowledge gap** / problem statement
3. General **experimental** approach
4. General **results**

Most of the time one does not read much further than this!





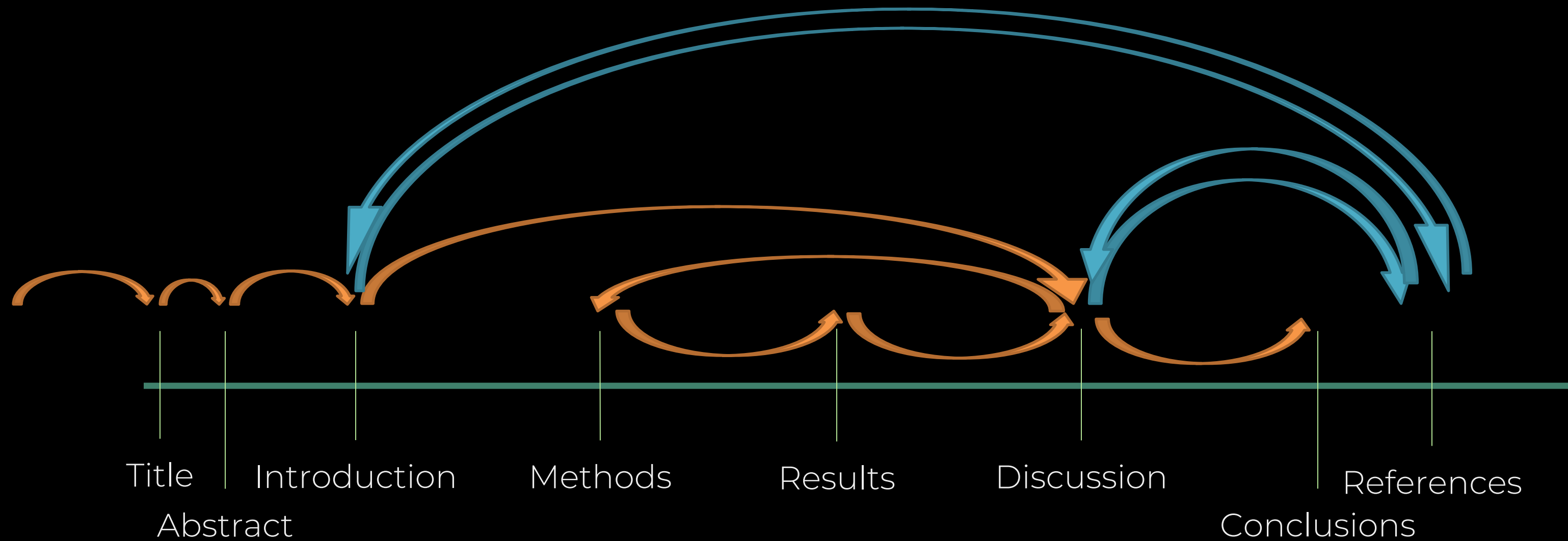
# The detailed reading

Why?

- You found the paper to be **interesting** in your brief check
- You need to go **deep into the topic** for your seminar or essay
- You want to learn more about that particular **field of research**
- You want to learn more about the **methods** and maybe replicate the ideas
- You want to understand thoroughly the **logical argumentation** of the authors



# The detailed reading





# The detailed reading: Introduction

Leads into the topic:

- Starts **wide**, introduces the field as a whole and the relevance
- Explains **previous literature** and its implications and insights
- Explains the **knowledge gap** (what is missing in science)
- Introduces the **concept of the paper**, its goals, and the structure

Why is the paper relevant?





# The detailed reading: Introduction

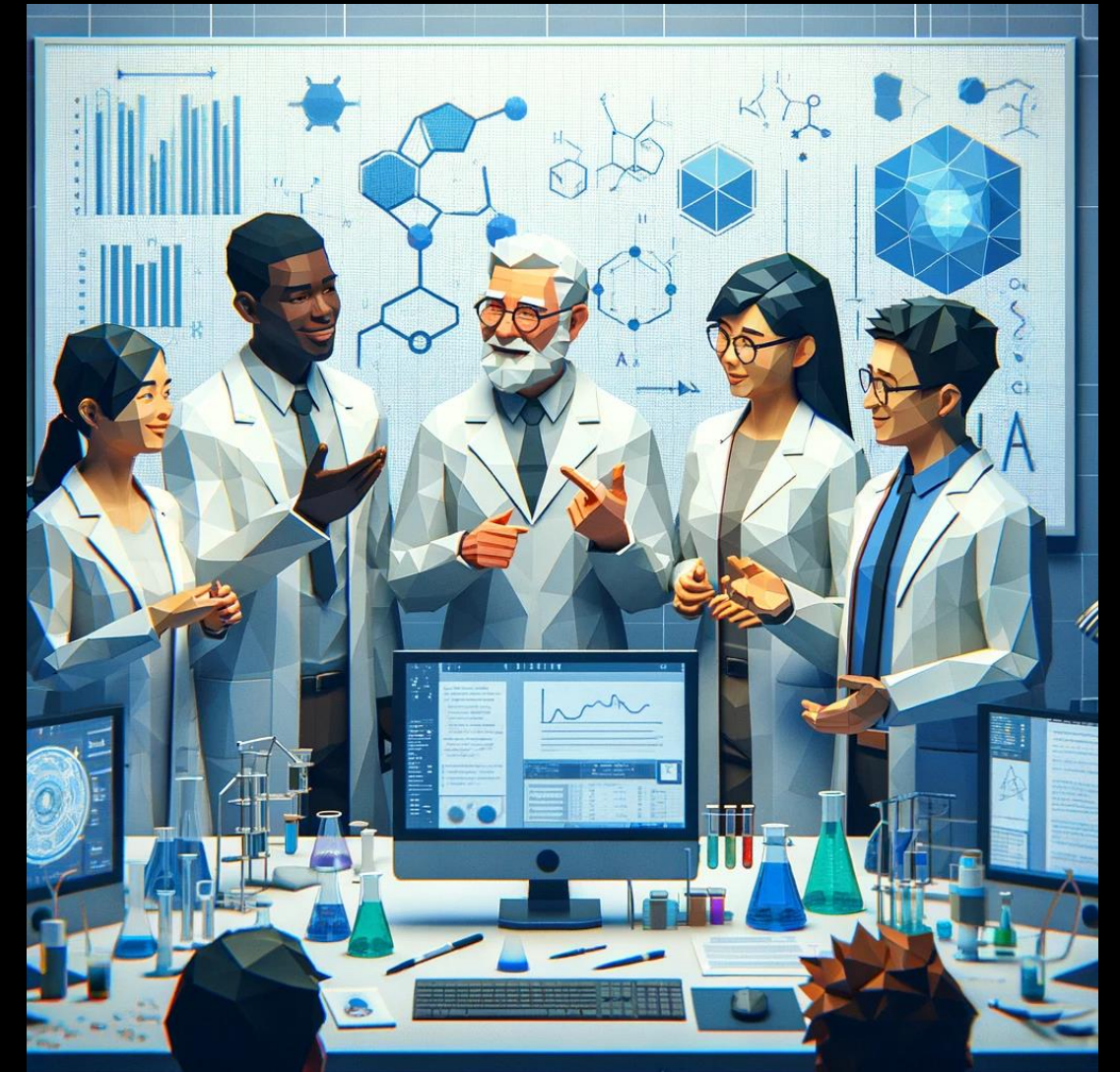
- Mark different **topics**
- Ask ChatGPT for a brief overview of that topic
- Take note of **key references** and check them briefly (see before)
- Try to **sum up** each paragraph in one or two sentences
- You can use ChatGPT for this
- Visualize the **logical flow** of the introduction
- Distill the **research questions** and hypotheses!





# The detailed reading: Discussion

- Yes, Discussion **directly after** Introduction
- **Assume** the methods are sound
- The Discussion should:
  - **Sum up** the methods and the results
  - **Interpret** the results
  - Put the results in context of the **research questions and hypotheses**
  - Explain the **limitations** of the study
  - Explain the **implications** of the findings for the field

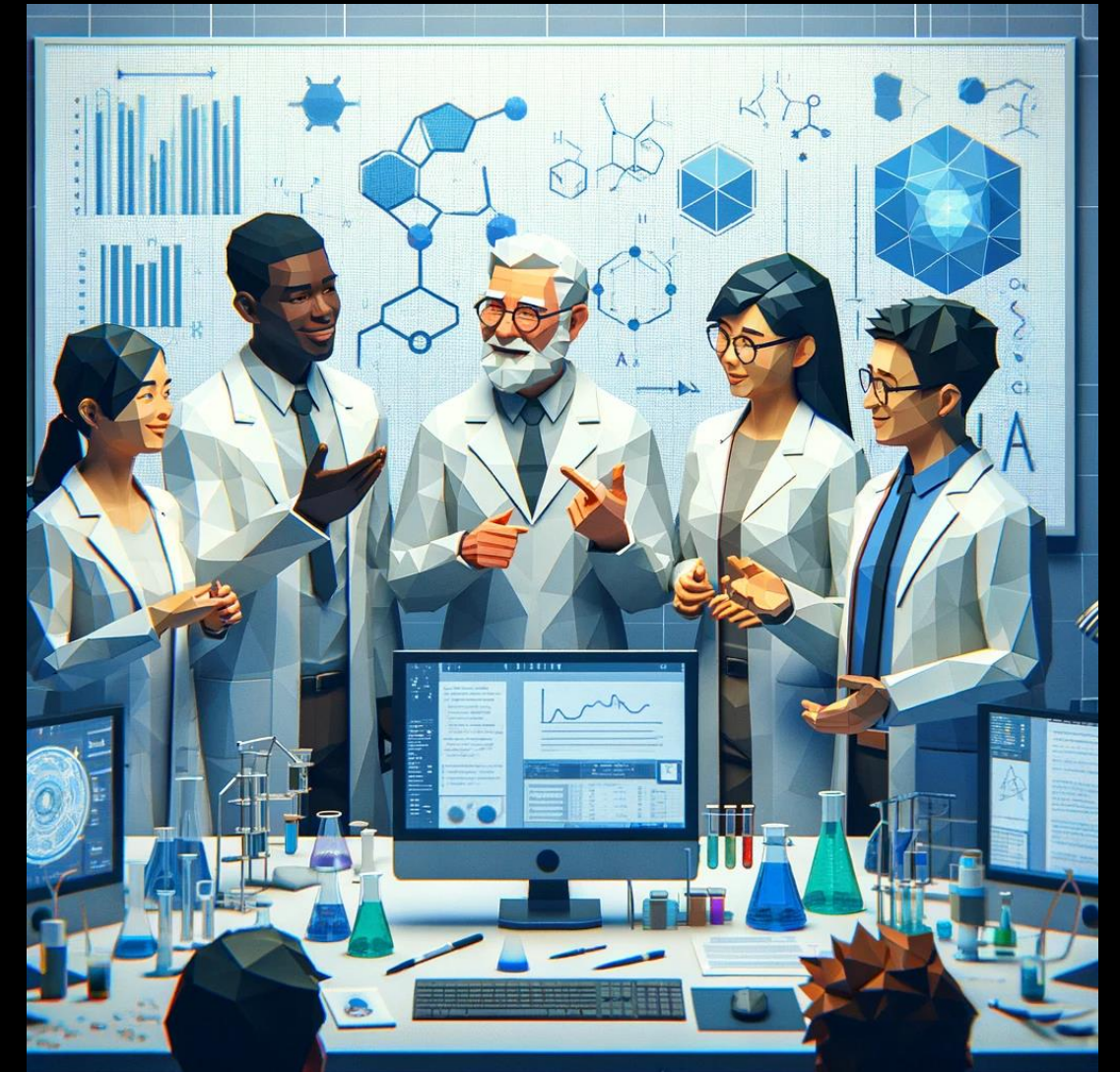




# The detailed reading: Discussion

- Summarize each paragraph
- Are the results explained well?
- Do the results justify the conclusions?
- Are all hypotheses discussed?
- Are limitations shown?
- Is the research put into context of other research?
- Are the implications for the field shown?

What did the researchers find?





# The detailed reading: Methods

Methods **must**:

- Show everything that is necessary to **replicate** the study
- Address the research question and **allow falsification** of the hypotheses
- Show population sample, experimental task, apparatus, data analysis, and statistical approach



Ask ChatGPT to explain you things!

# The detailed reading: Methods

- **Summarize** each paragraph
- **Visualize** the experimental paradigm
- **Think!** Before reading the results, think about what you expect – what figures or tables should be shown? What Results do you **expect**? What would make you question the validity of the results?



What did the researchers actually do?



# The detailed reading: Results

Results **must**:

- Show all relevant data
- Show statistics (effect sizes, p-values)

Results **should**:

- Visualize the results in figures
- Figure caption, axes labels, legends
- Error bars / box plots / sample points

Results **must not**:

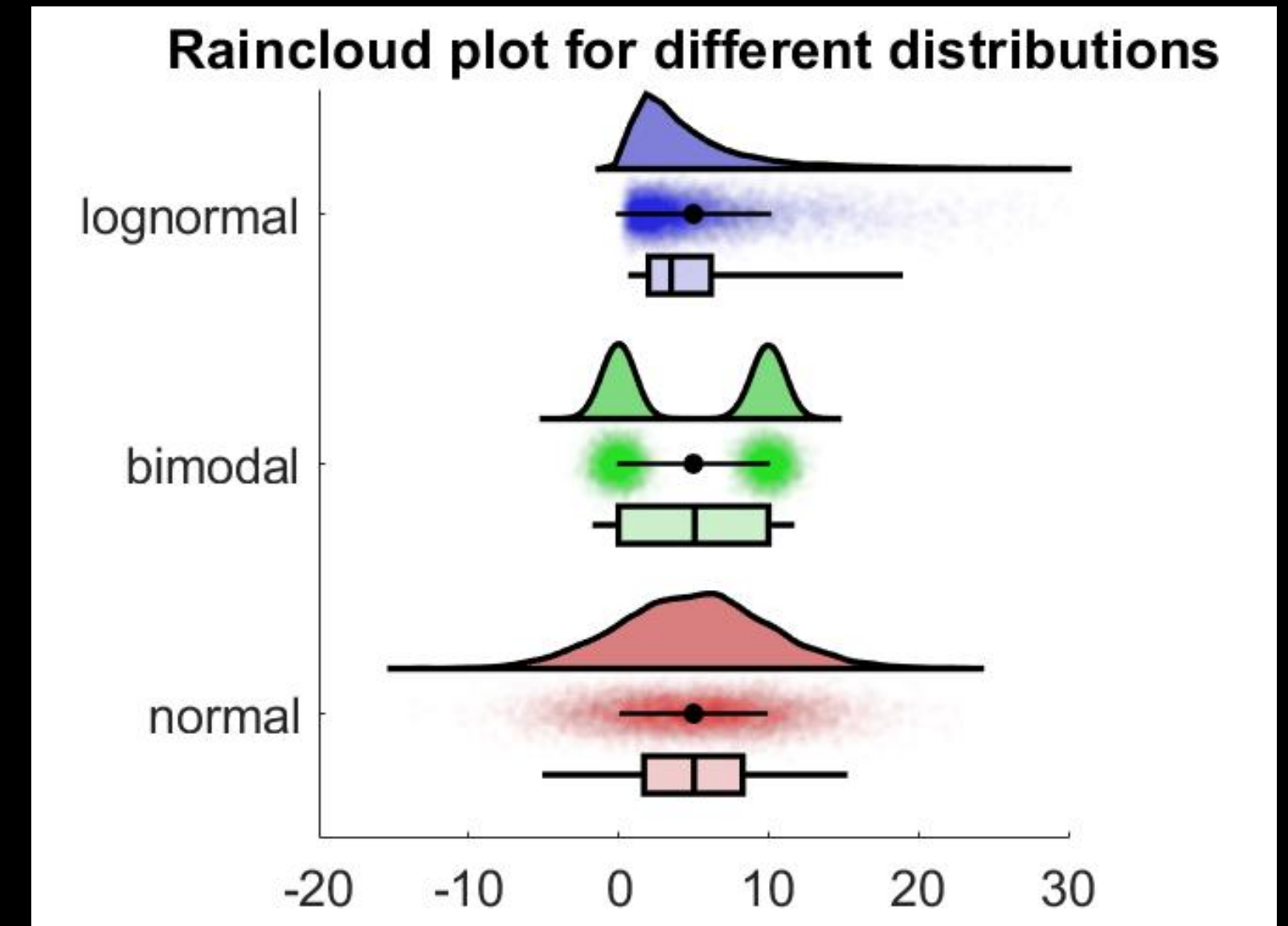
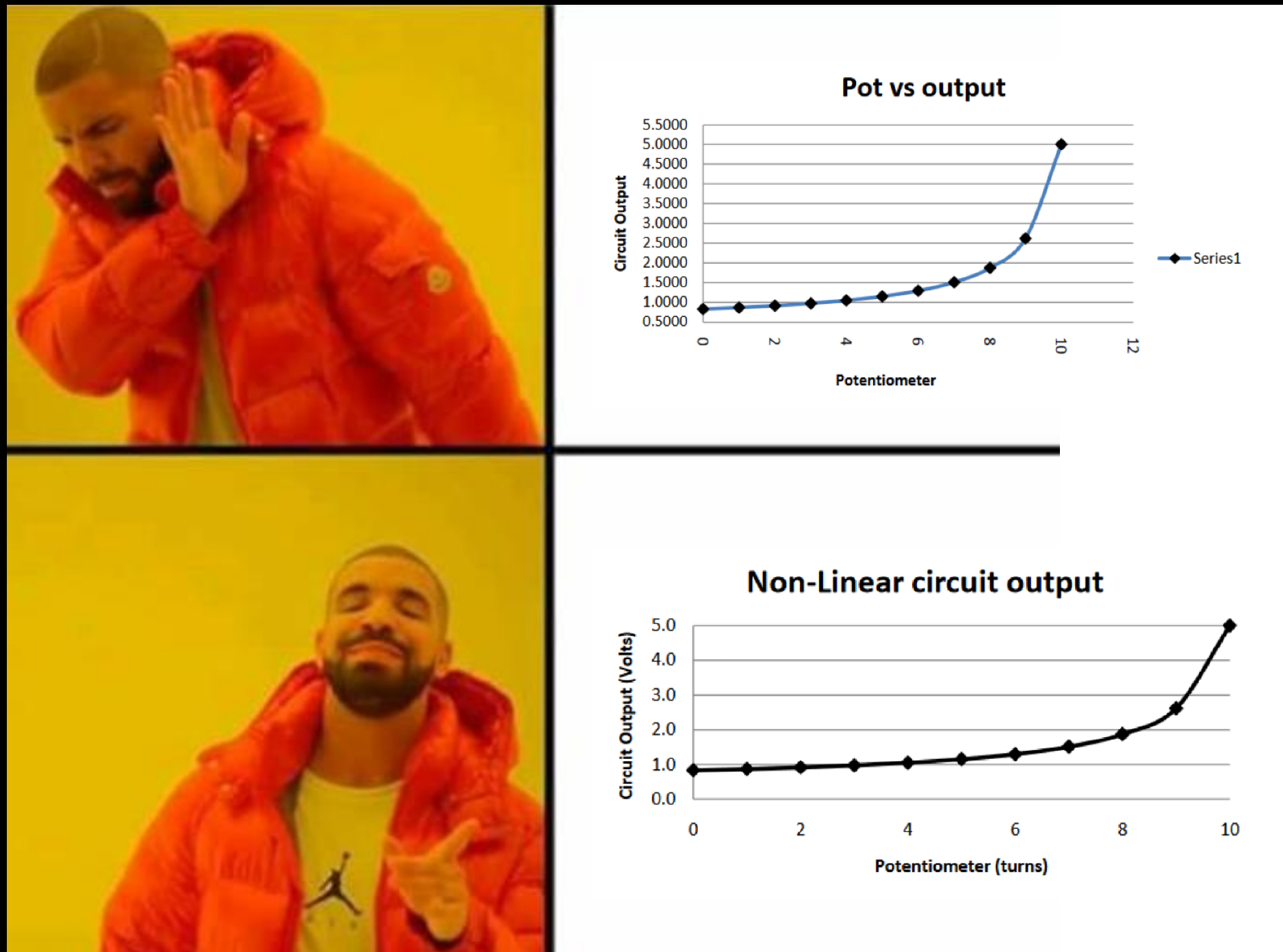
- Interpret the data

Ask ChatGPT to explain you things!





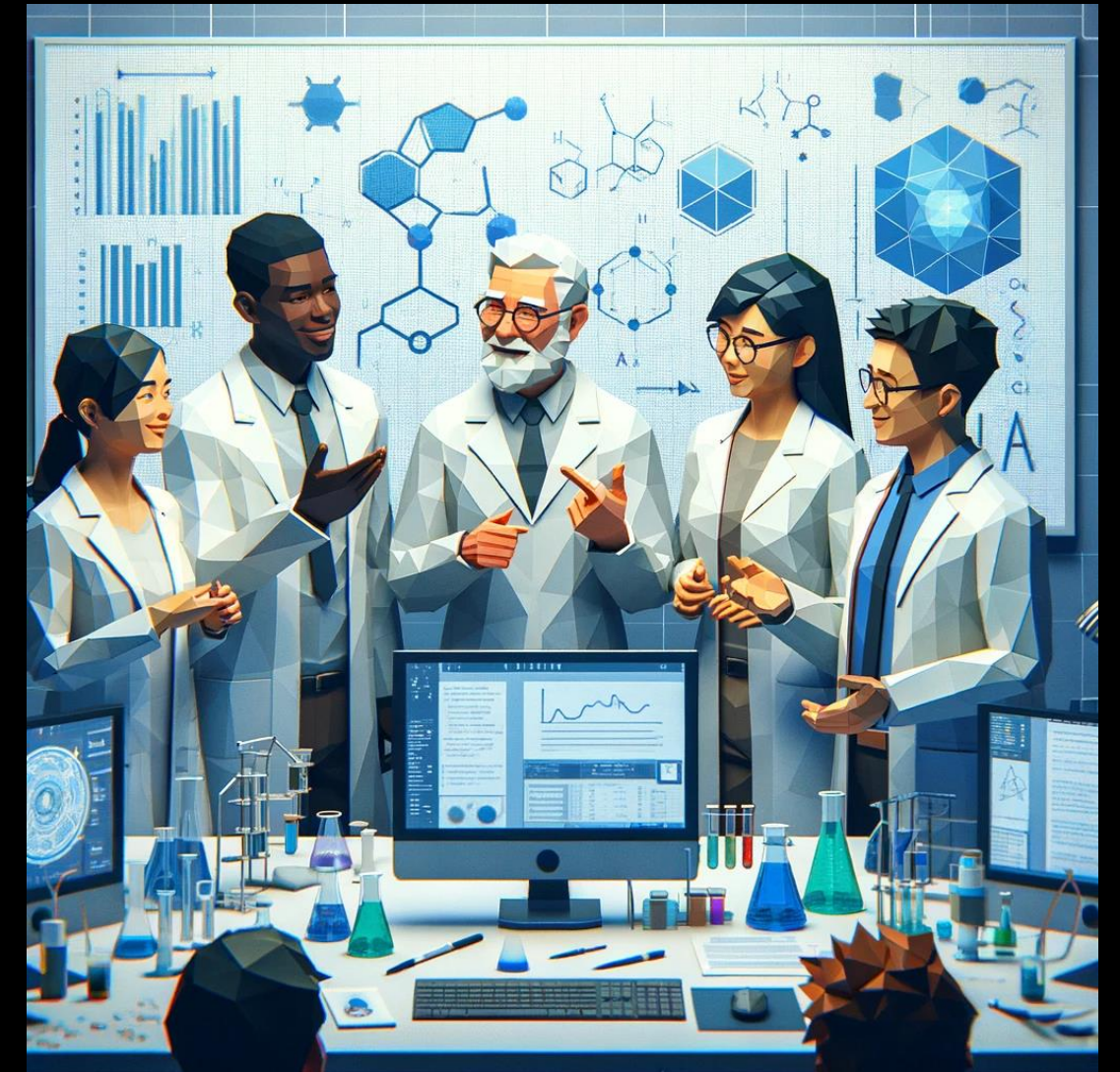
# Excursion: Good **scientific** figures



# The detailed reading: Discussion II

- Yes, Discussion **again**
  - You now know the methods and the results
- Check the discussion for:
  - Missing **explanations** of results
  - Missing **limitations**
  - Flaws in **logical reasoning**

Are the interpretations justified?  
**Can the findings be trusted?**





# The detailed reading: Conclusions

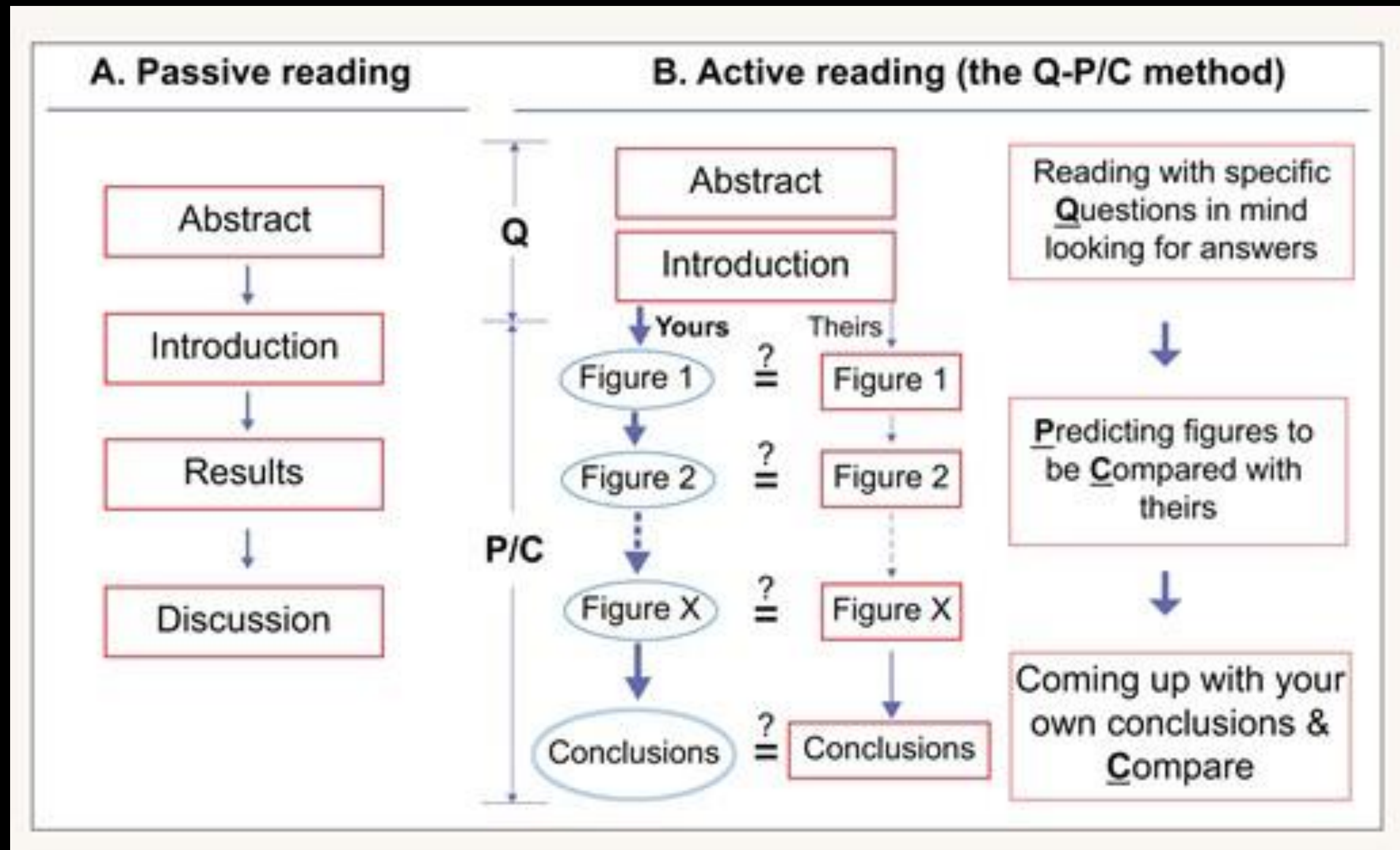
Answer these questions to yourself:

- What was the research **investigating**?
- **Why** did the research investigate this?
- What was **found**?
- Are the findings **unusual** or do they support other research in the field?
- What are the **implications** of the results?
- What experiments could be carried out to answer any **further questions**?



# Read actively!





Tung-Tien Sun, Active versus passive reading: how to read scientific papers?,  
 National Science Review, Volume 7, Issue 9, September 2020, Pages 1422–  
 1427, <https://doi.org/10.1093/nsr/nwaa130>

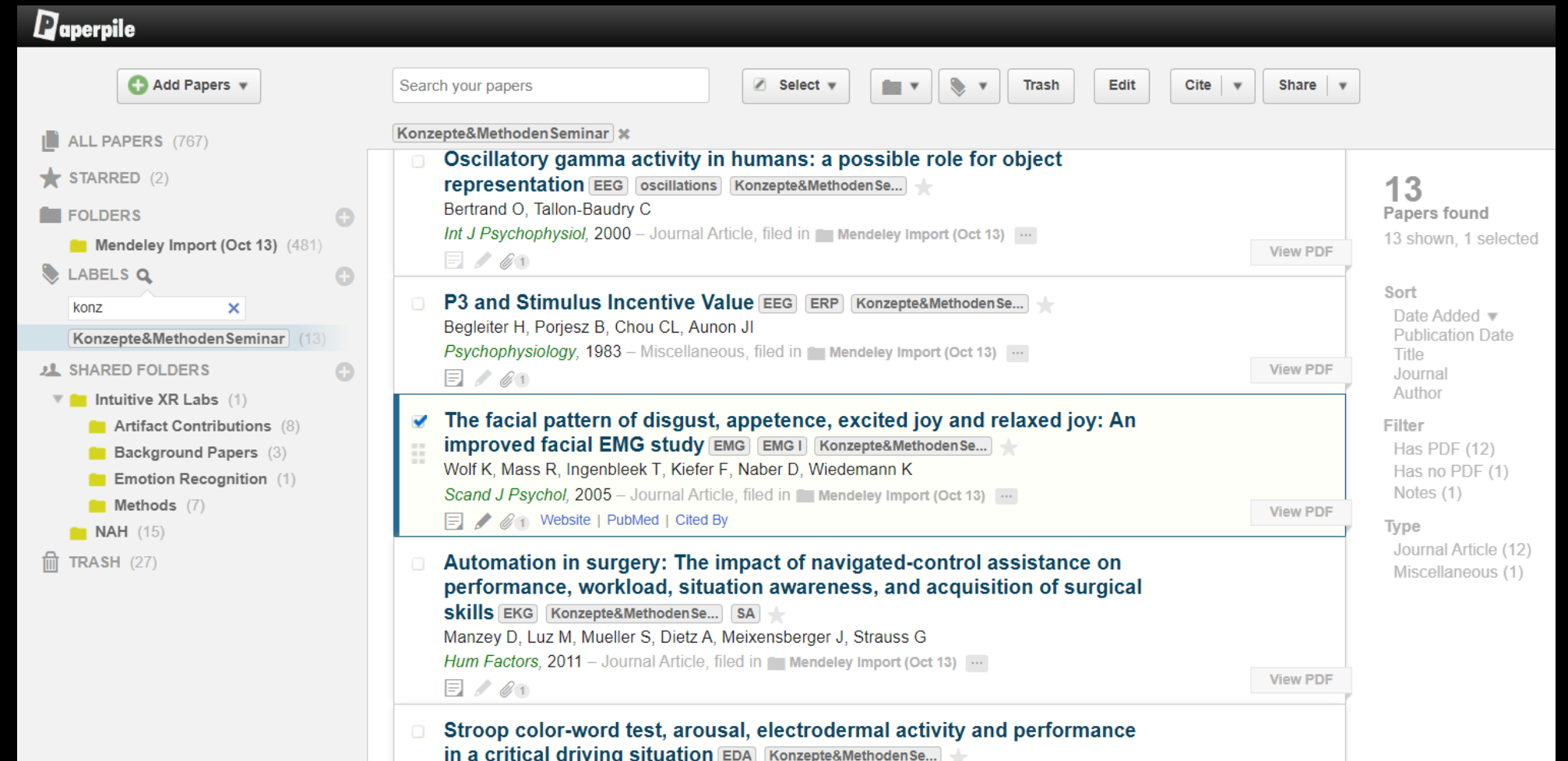
# Relevant tools





# Paperpile

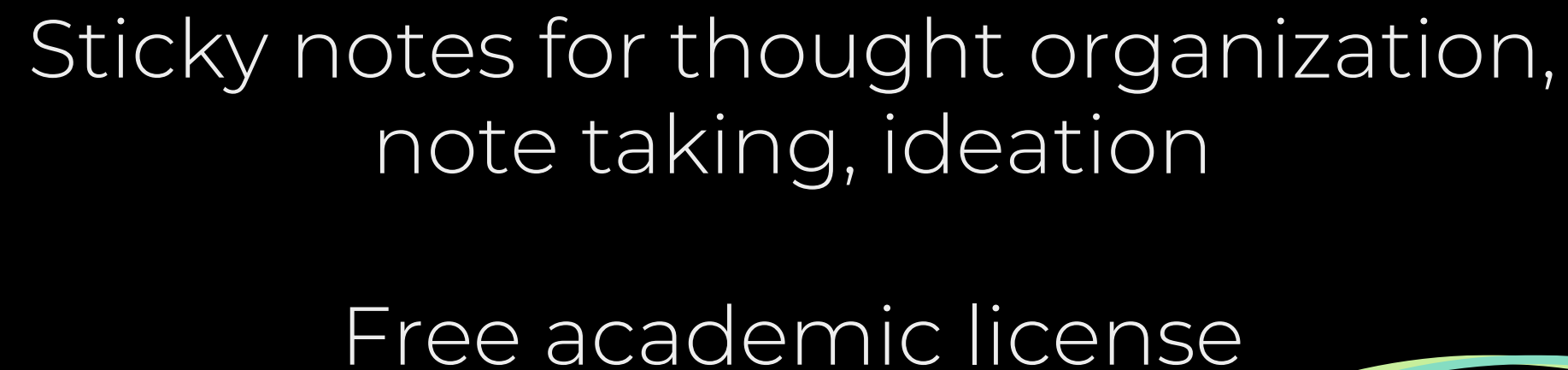
<https://paperpile.com/app>



Organize Papers, easy citation in Google Docs or MS Word, annotate, take notes

Not free...

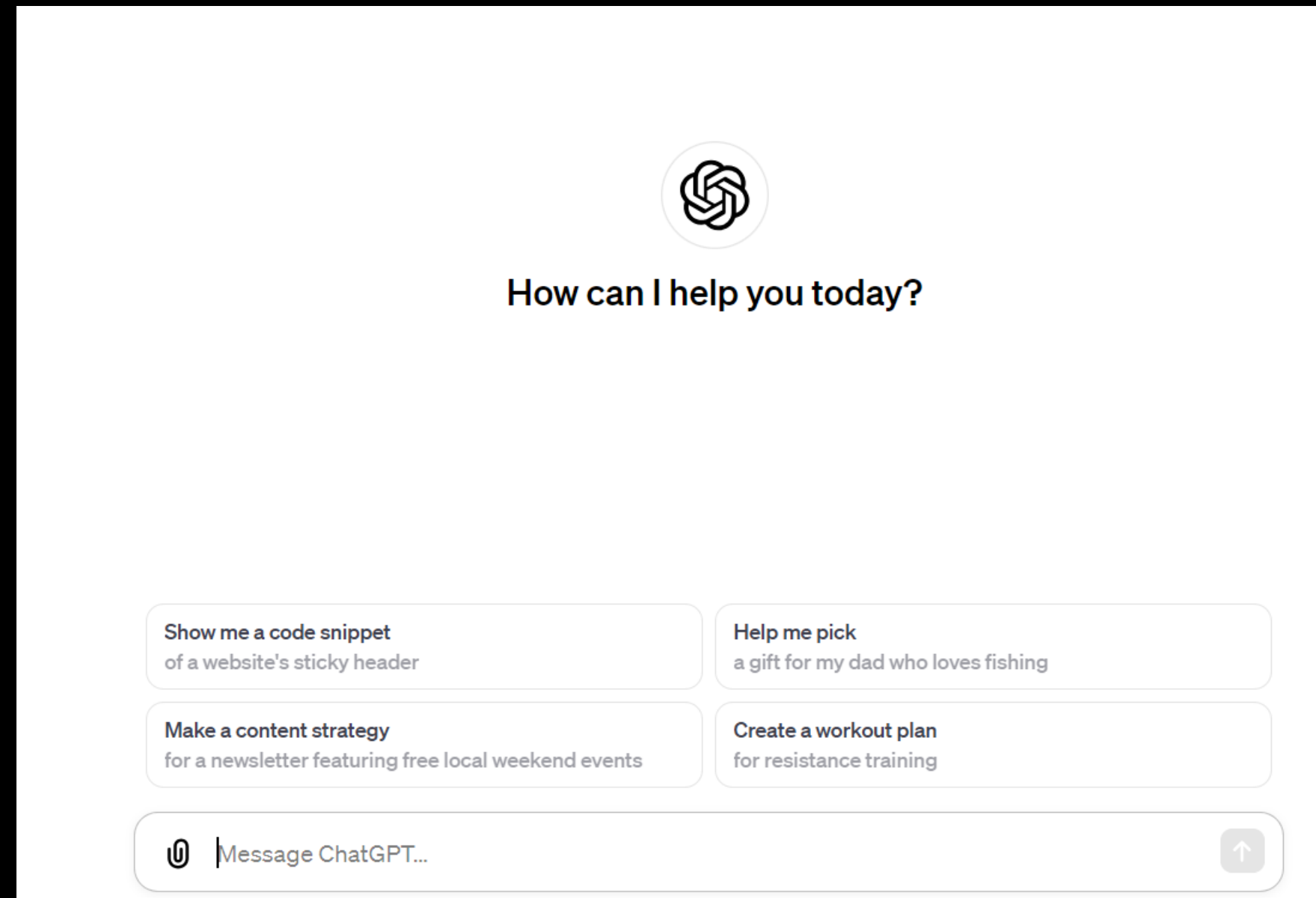
<https://miro.com/>





# ChatGPT

<https://chat.openai.com/>

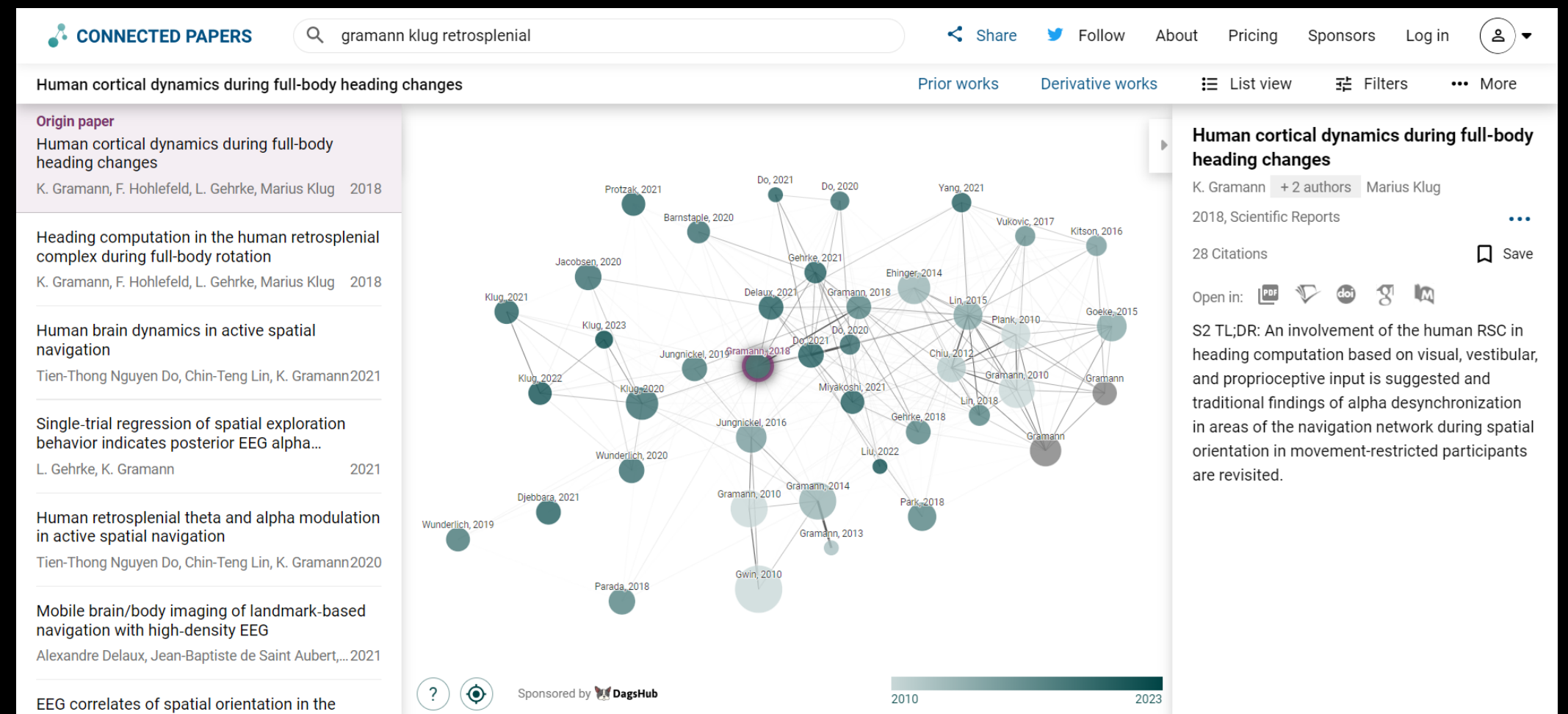


Summaries, basic questions

**NOT:** critical thinking

# Connected Papers

<https://www.connectedpapers.com/>



Finding related research



# Research Rabbit

<https://researchrabbitapp.com/>

The screenshot displays the Research Rabbit app interface, which is designed for discovering related research. The interface is divided into several sections:

- Filter:** A dropdown menu set to "Custom" with checkboxes for "Abstracts" and "Comments".
- Untitled Collection:** A list of papers with checkboxes and author names. The first paper is "EEG Negativity in Fixations Used for Gaze-Based Control: Toward Converting Intentions into Actions with an Eye-Brain-Computer Interface." by Shishkin and Velichkovsky (2016).
- EXPLORE PAPERS:** A section with buttons for "Similar Work" (851), "Earlier Work" (23), and "Later Work" (3).
- EXPLORE PEOPLE:** A section with buttons for "These Authors" (15) and "Suggested Authors" (85).
- EXPLORE OTHER CONTENT:** A section with a button for "Linked Content".
- EXPORT PAPERS:** A section with buttons for "BibTeX", "RIS", and "CSV".
- PUBLIC COLLECTION:** A toggle switch.
- SHAREABLE LINK:** A button labeled "Copy".
- COLLABORATORS:** A button labeled "Edit".
- Similar Work:** A section with a filter dropdown set to "Relevance" and checkboxes for "Abstracts" and "Comments". It lists papers like "A passive brain-computer interface for supporting gaze-based human-machine interaction" by Protzak and Zander (2013).
- Connections between your collection and 50 papers:** A network graph visualization showing connections between nodes representing papers and authors. The graph type is set to "Network" and labels are set to "First Author".
- 1 selected paper:** A section showing the details of a selected paper: "A passive BCI for monitoring the intentionality of the gaze-based moving object selection" by Darisy G. Zhao and S.L. Shishkin (2021). It includes the journal name "Journal of Neural Engineering" and a PDF download button.

Finding related research

# Google Scholar

<https://scholar.google.com/>

The screenshot shows the Google Scholar interface with the search query "mobile EEG BCI passive". The results are sorted by relevance. The left sidebar contains filters for time (Beliebige Zeit, Seit 2023, Seit 2022, Seit 2019, Zeitraum wählen...), sorting (Nach Relevanz sortieren, Nach Datum sortieren), language (Beliebige Sprache, Seiten auf Deutsch), types (Alle Typen, Übersichtsarbeiten), and checkboxes for "Patente einschließen" (unchecked) and "Zitate einschließen" (checked). There is also an "Alert erstellen" option.

The search results list three articles:

- [HTML] Pass: a multimodal database of physical activity and stress for mobile passive body/brain-computer interface research** [HTML] frontiersin.org  
M Parent, I Albuquerque, A Tiwari, R Cassani... - Frontiers in ..., 2020 - frontiersin.org [Paperpile]  
... This makes the development of **mobile passive** B/BCIs ... advance **mobile passive** B/BCIs for use in everyday settings. ... and **passive** B/BCIs in realistic settings where the user is **mobile** and ...  
☆ Speichern Zitieren Zitiert von: 21 Ähnliche Artikel Alle 6 Versionen Web of Science: 6 In BibTeX importieren
- [HTML] A new EEG recording system for passive dry electrodes** [HTML] sciencedirect.com  
G Gargiulo, RA Calvo, P Bifulco, M Cesarelli... - Clinical ..., 2010 - Elsevier [Paperpile]  
... asked to perform a **BCI** 1D cursor control task (left-right movement) and generating a mu-rhythm. Random left and right targets were presented to the subject from the **BCI** computer (...  
☆ Speichern Zitieren Zitiert von: 171 Ähnliche Artikel Alle 11 Versionen Web of Science: 107 In BibTeX importieren
- A passive EEG-BCI for single-trial detection of changes in mental state** [PDF] ieee.org  
A Myrden, I Chau - IEEE Transactions on neural systems and ..., 2017 - ieeexplore.ieee.org [Paperpile]  
... It has recently been proposed that **passive** brain-computer ... the feasibility of a **passive brain-computer interface** that uses ... of human attention using **EEG** signals from **mobile** sensors," ...  
☆ Speichern Zitieren Zitiert von: 94 Ähnliche Artikel Alle 4 Versionen Web of Science: 54 In BibTeX importieren

Finding related research



# Semantic Scholar

<https://www.semanticscholar.org/>

The screenshot displays the Semantic Scholar search interface. At the top, the Semantic Scholar logo is on the left, and a search bar contains the text "mobile passive eeg bci". Below the search bar, it states "622 results for 'mobile passive eeg bci'". A row of filters includes "Fields of Study", "Date Range", "Has PDF", "Author", and "Journals & Conferences". Two search results are visible. The first result is titled "A Comparison of Mobile VR Display Running on an Ordinary Smartphone With Standard PC Display for P300-BCI Stimulus Presentation" by G. Cattán, Anton Andreev, César Mendoza, and M. Congedo, published in IEEE Transactions on Games on February 6, 2020. It has a TLDR summary, 14 citations, a PDF icon, and buttons for IEEE, Save, Cite, and Paperpile. The second result is titled "Neurophysiological Closed-Loop Control for Competitive Multi-brain Robot Interaction" by Bryan Y. Hernández-Cuevas, Elijah Sawyers, L. Bentley, Chris S. Crawford, and Marvin Andujar, published in Computer Science at the International Conference on Applied Human Factors on July 24, 2019. It also has a TLDR summary, 1 citation, a Publisher icon, and buttons for Save, Cite, and Paperpile.

Finding related research

- <https://web.stanford.edu/class/ee384m/Handouts/HowtoReadPaper.pdf>
- <https://www.eecs.harvard.edu/~michaelm/postscripts/ReadPaper.pdf>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3687192/>
- <https://blogs.lse.ac.uk/impactofsocialsciences/2016/05/09/how-to-read-and-understand-a-scientific-paper-a-guide-for-non-scientists/>
- <https://bitesizebio.com/11060/how-to-read-a-scientific-paper/>
- <https://www.science.org/content/article/how-seriously-read-scientific-paper>
- <https://academic.oup.com/nsr/article/7/9/1422/5859953>

## Resources