How to read a Research Paper

Scientific reading in the age of AI

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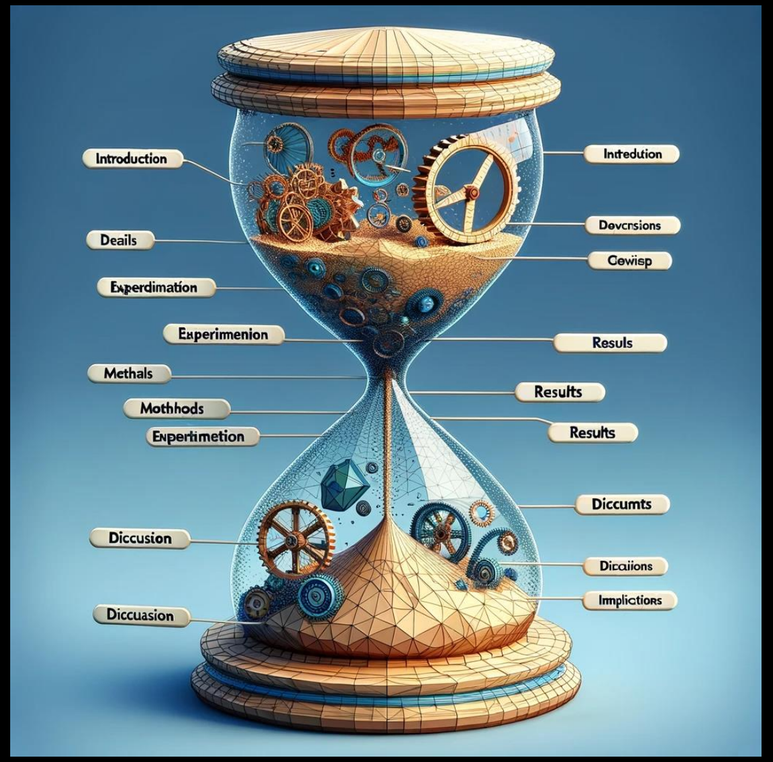
What not to do

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

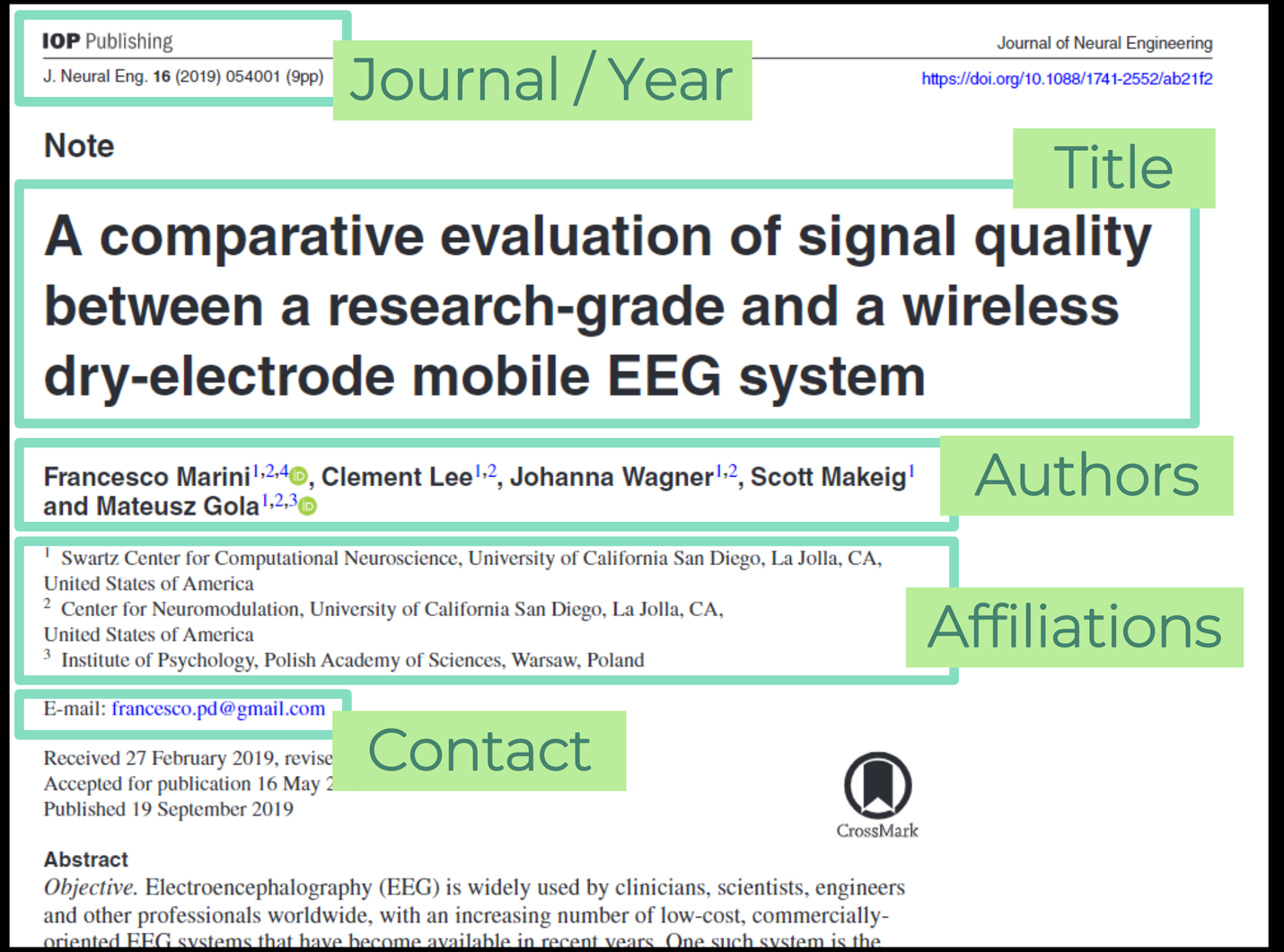
Methods

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

Journal / Year

Note

Title

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

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CrossMark

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

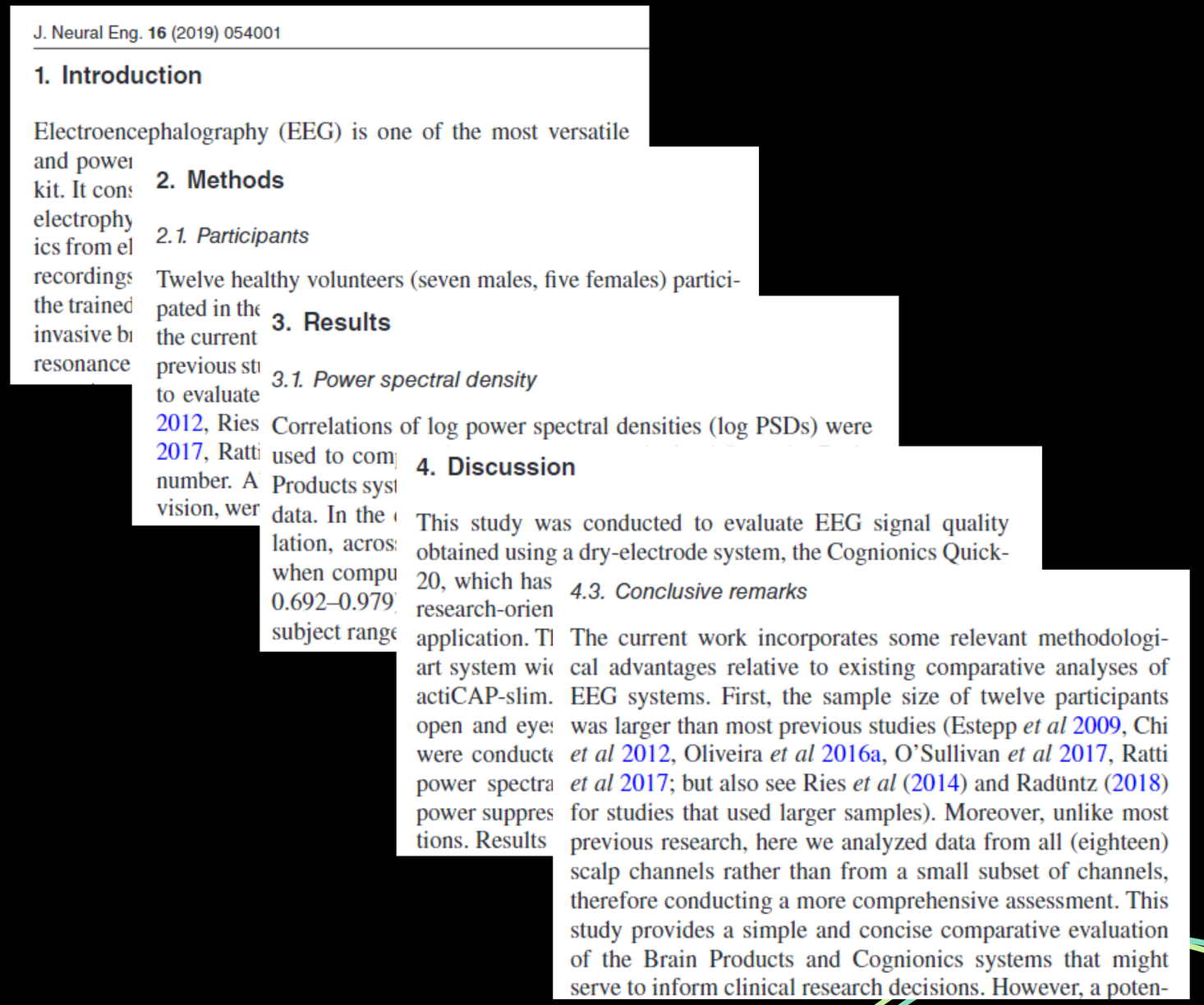
What is a paper

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

What is a paper



J. Neural Eng. **16** (2019) 054001

1. Introduction

Electroencephalography (EEG) is one of the most versatile and power
kit. It cons
electrophy
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resonance

2. Methods

2.1. Participants

Twelve healthy volunteers (seven males, five females) partici-
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the current
previous stu
to evaluate
2012, Ries
2017, Ratti
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vision, wer

3. Results

3.1. Power spectral density

Correlations of log power spectral densities (log PSDs) were
used to com
Products syst
data. In the
lation, acros
when compu
0.692–0.979
subject range

4. Discussion

This study was conducted to evaluate EEG signal quality obtained using a dry-electrode system, the Cognionics Quick-
20, which has
research-orien
application. Th
art system wi
actiCAP-slim.
open and eye
were conducte
power spectra
power suppres
tions. Results

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 (Estepp *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...

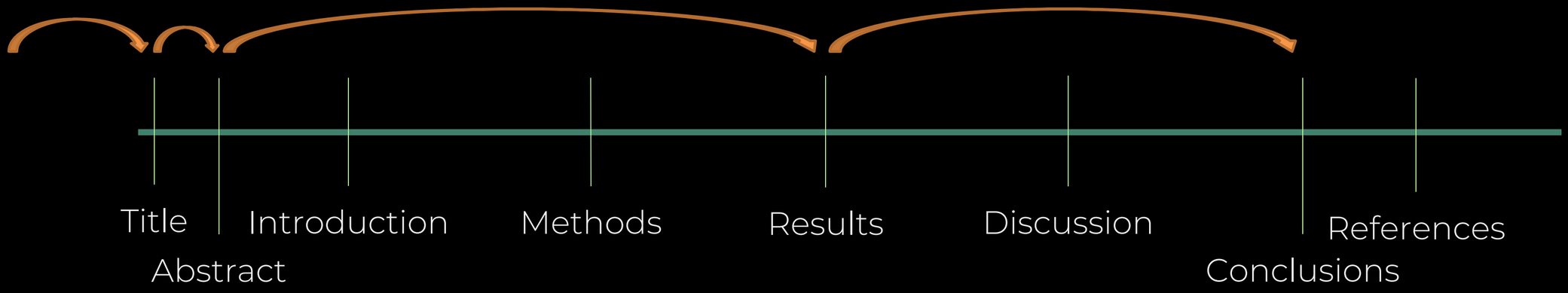
The brief check paper-reading approach

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

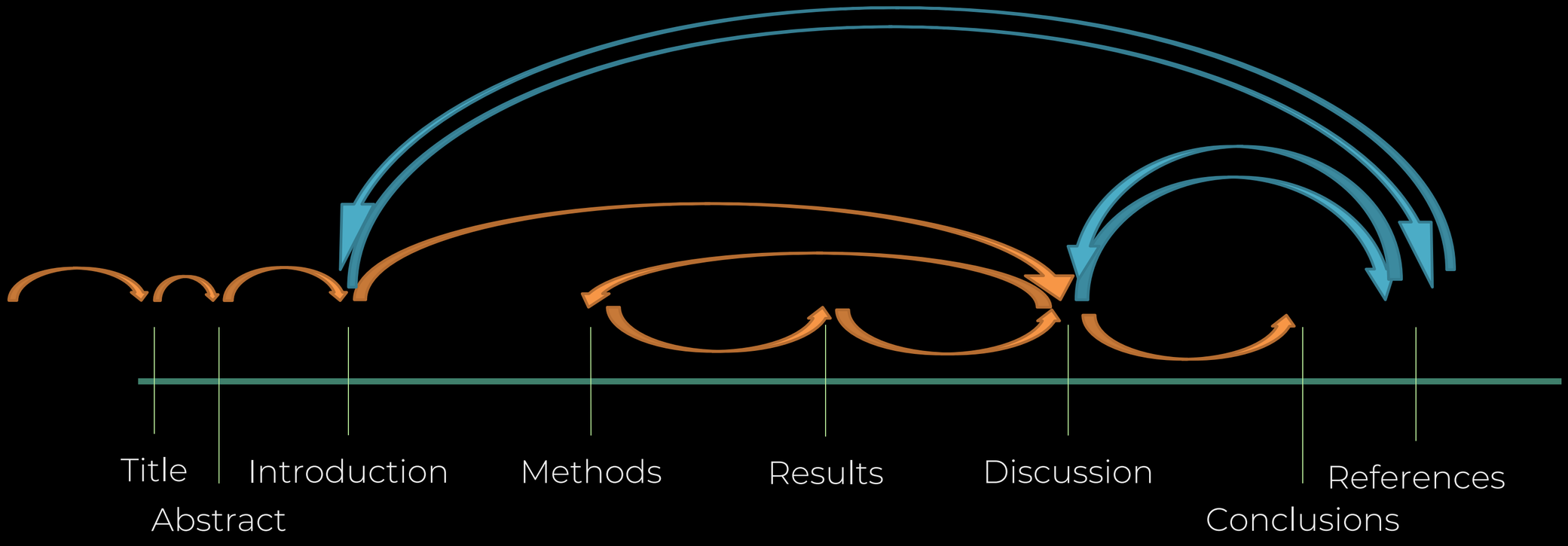
Most of the time one does not read much further than this!

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

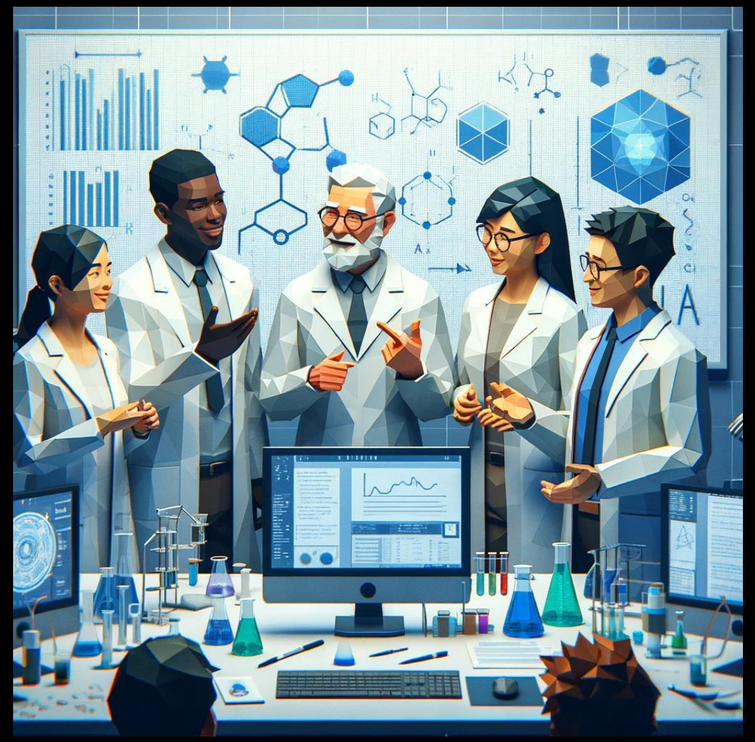
Why is the paper relevant?

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!

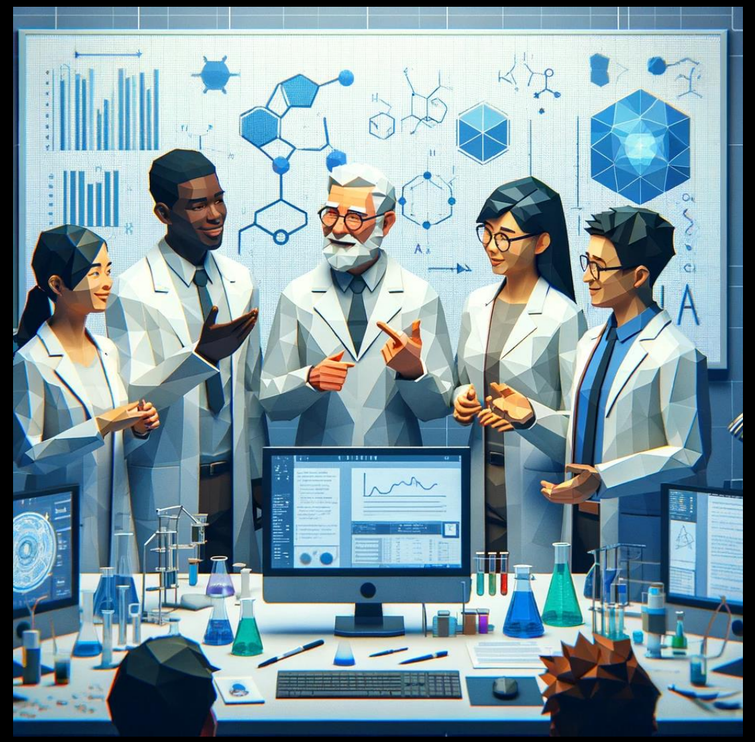
The detailed reading: Discussion

- 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:

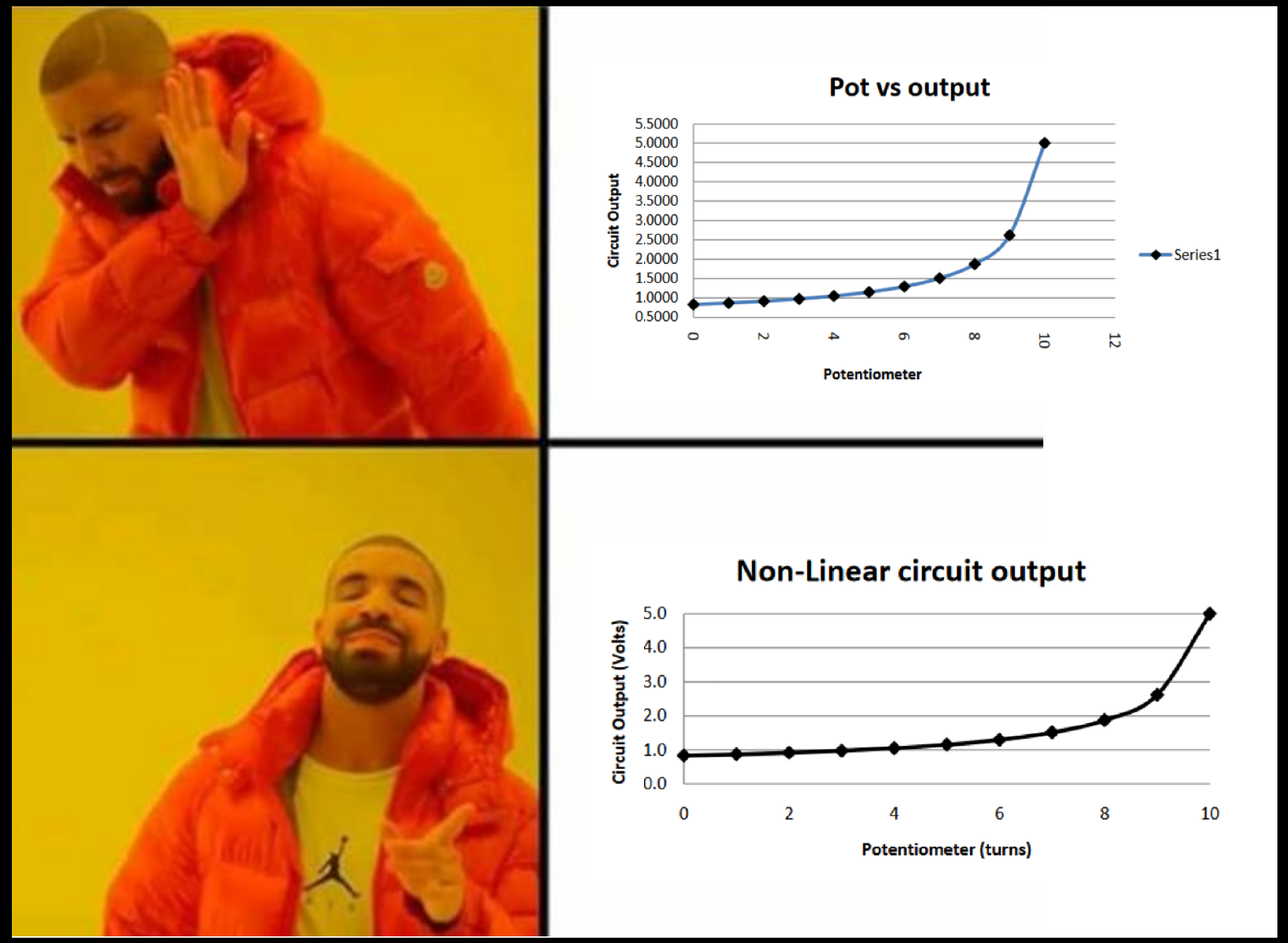
- Visualize the results in figures
  - Figure caption, axes labels, legends
  - Error bars / box plots / sample points

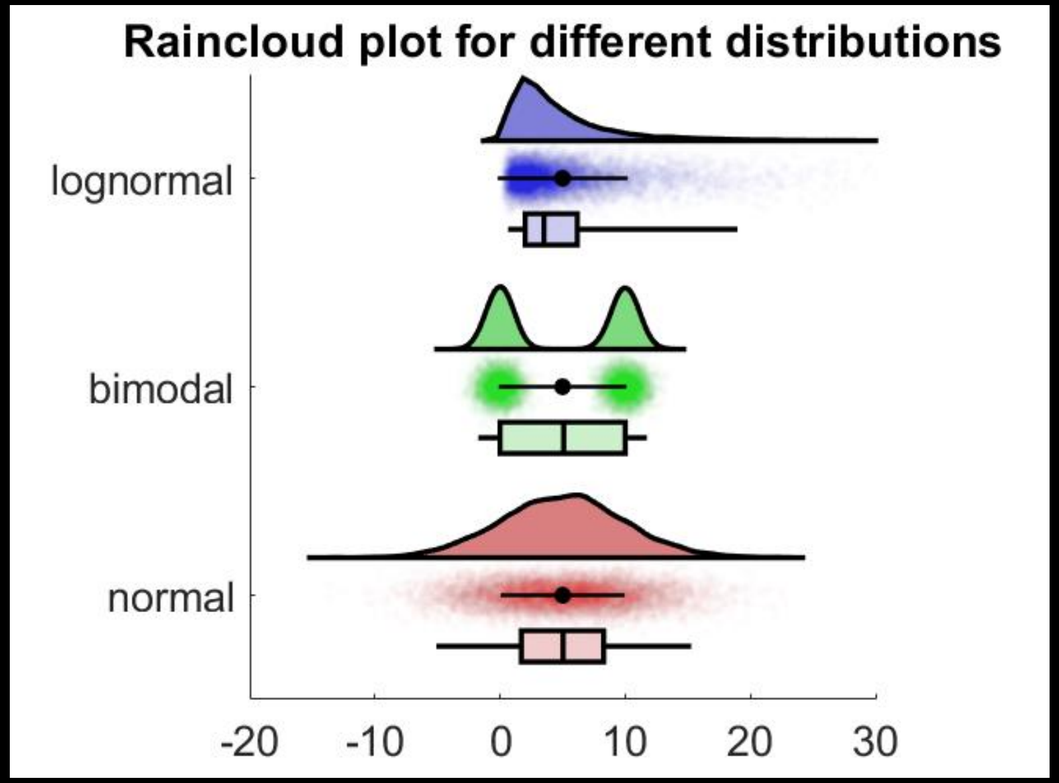
Results must not:

- Interpret the data

Ask ChatGPT to explain you things!

Excursion: Good scientific figures



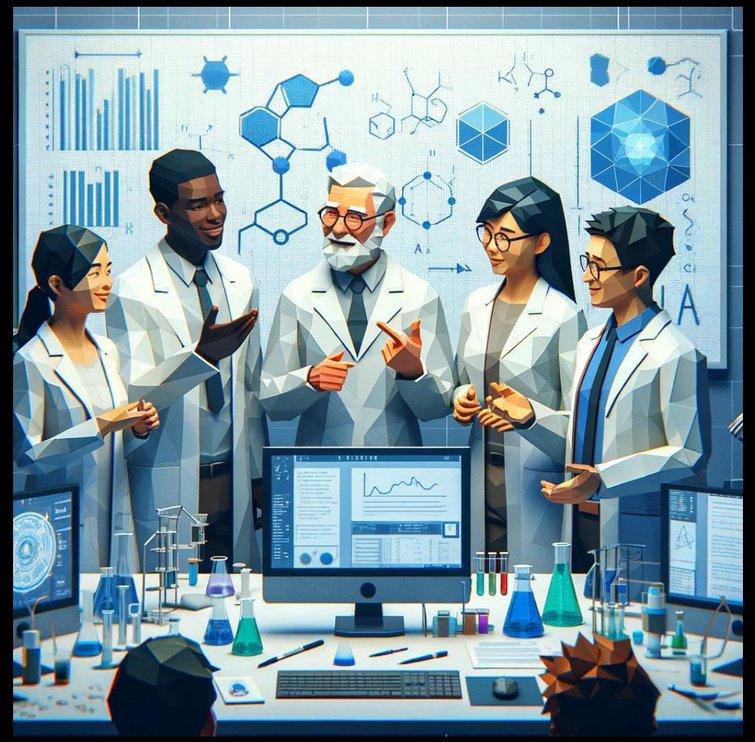


The detailed reading: Discussion II

- 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

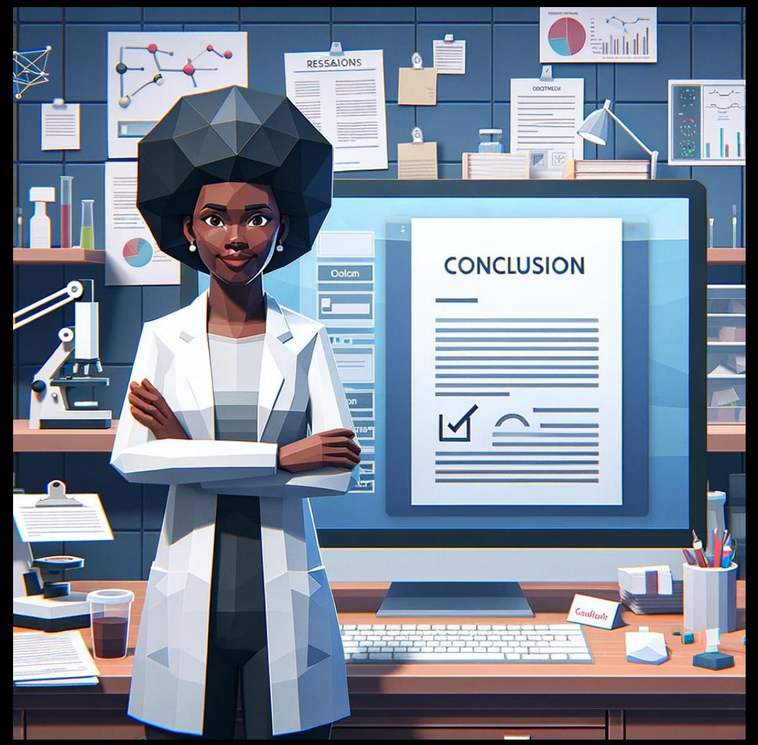
Are the interpretations justified?
Can the findings be trusted?



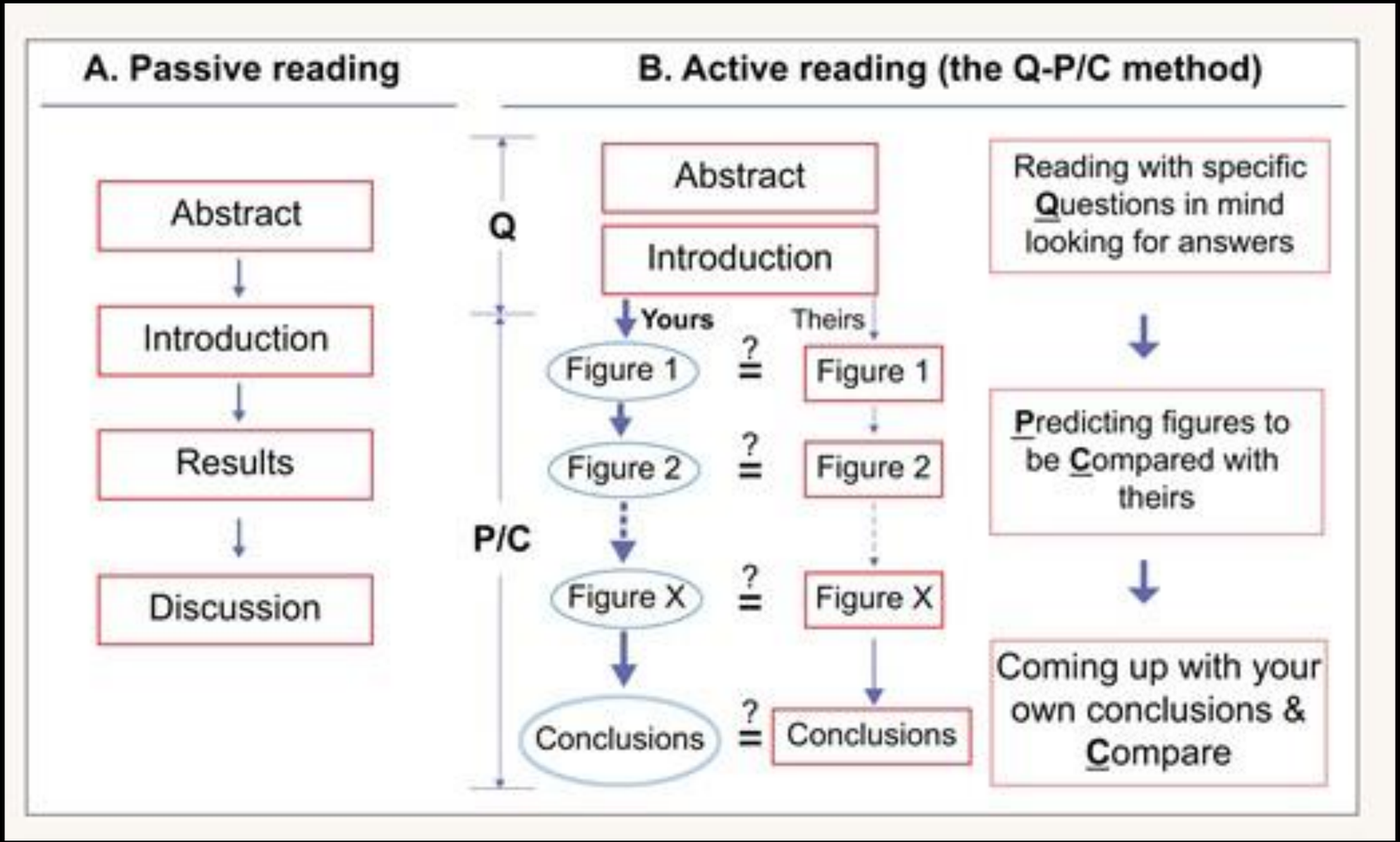
The detailed reading: Conclusions

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!

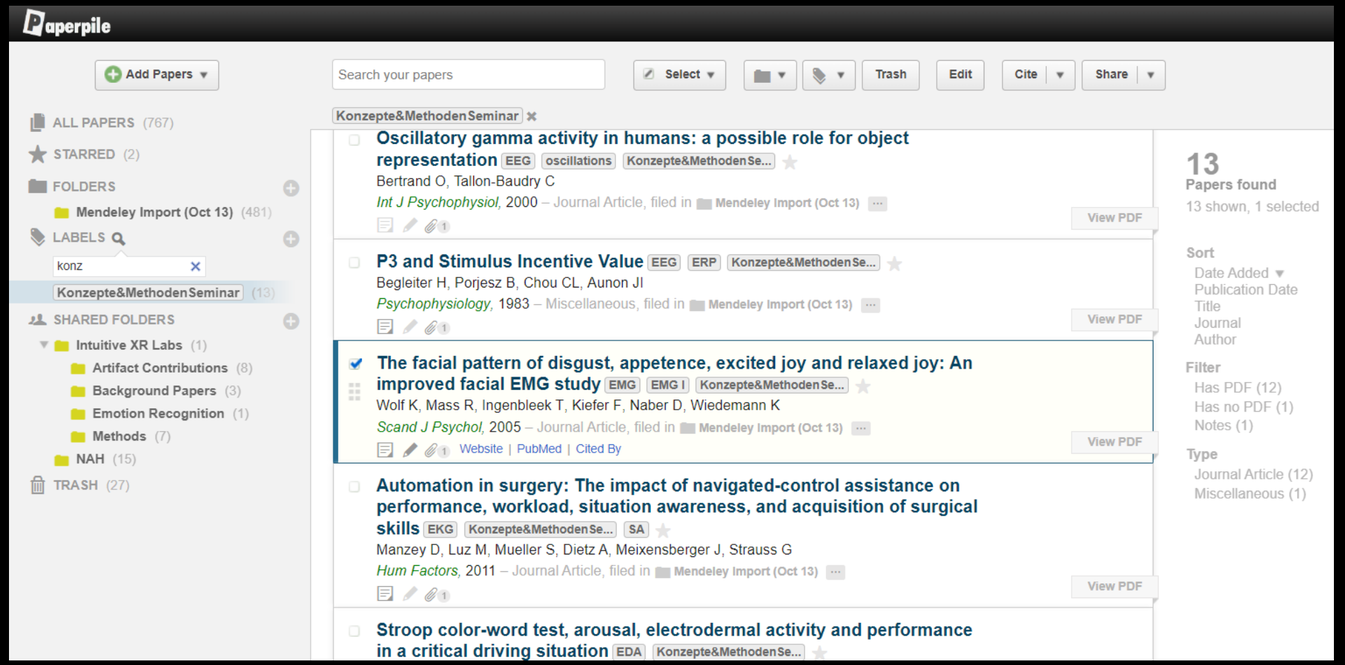


Tung-Tien Sun, Active versus passive reading: how to read scientific papers?, National Science Review, Volume 7, Issue 9, September 2020, Pages 1422–1427, https://doi.org/10.1093/nsr/nwaa130

Relevant tools

Paperpile

https://paperpile.com/app



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

Not free...

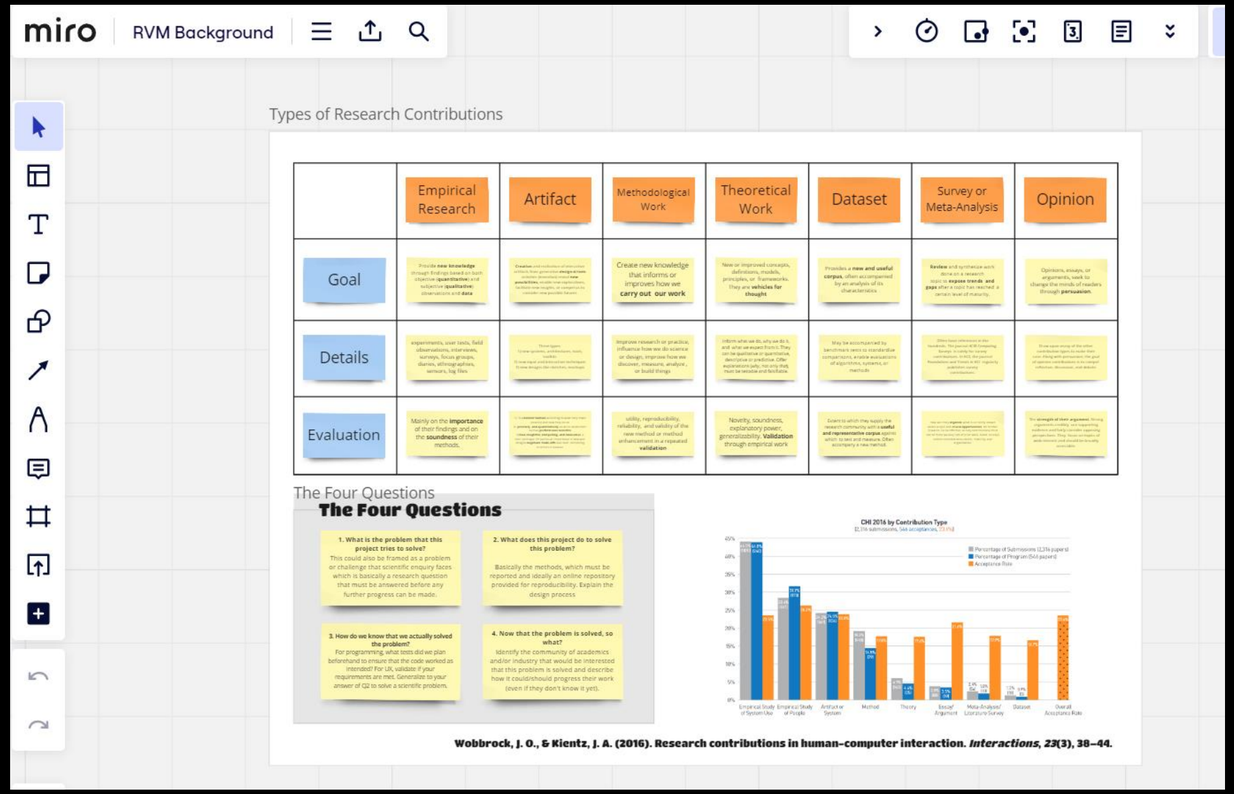
INTUITIVE XR LABS

discord.gg/7MJjQ3f

twitch.tv/intuitivexrlabs

Miro

https://miro.com/

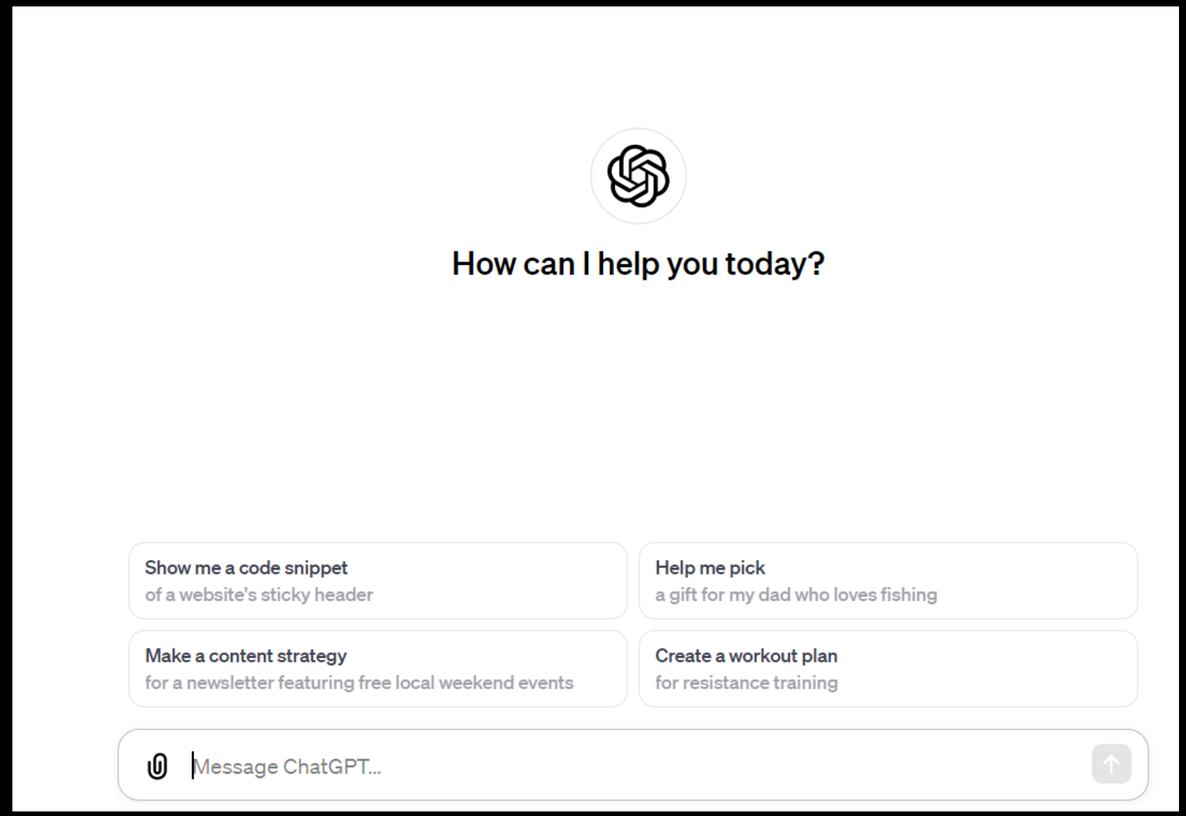


Sticky notes for thought organization, note taking, ideation

Free academic license

ChatGPT

https://chat.openai.com/

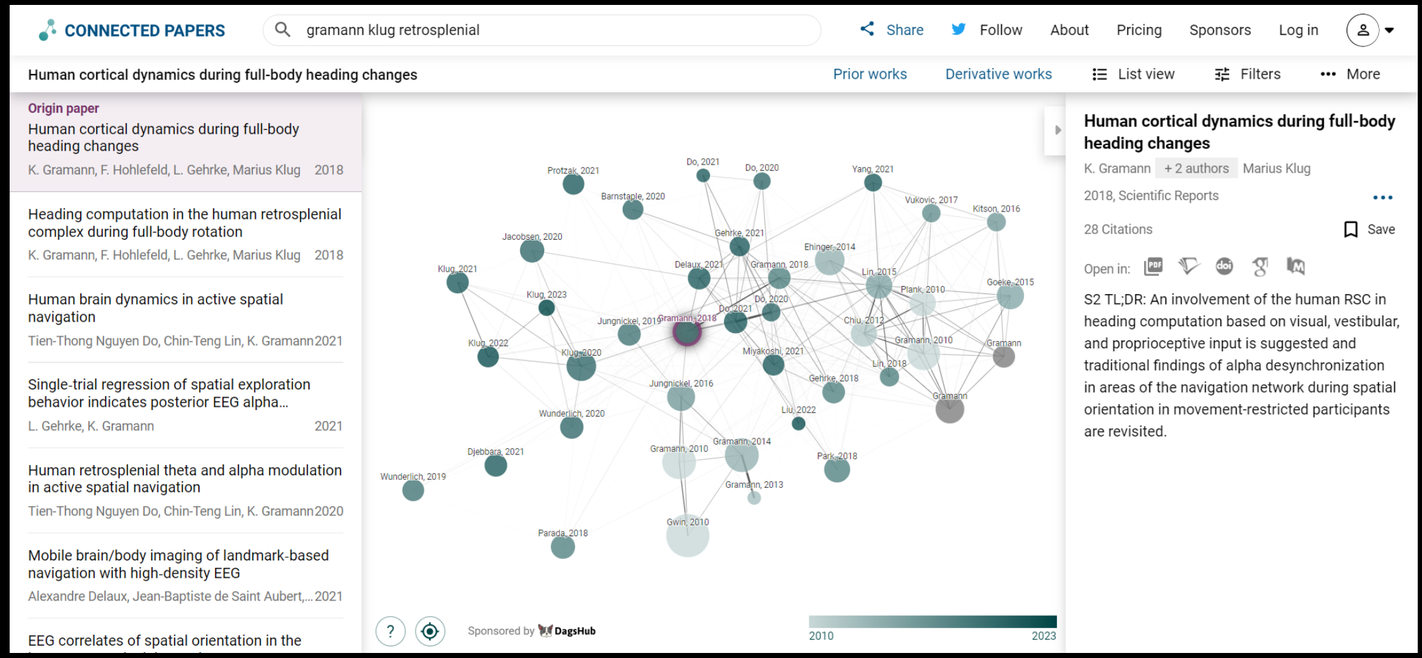


Summaries, basic questions

NOT: critical thinking

Connected Papers

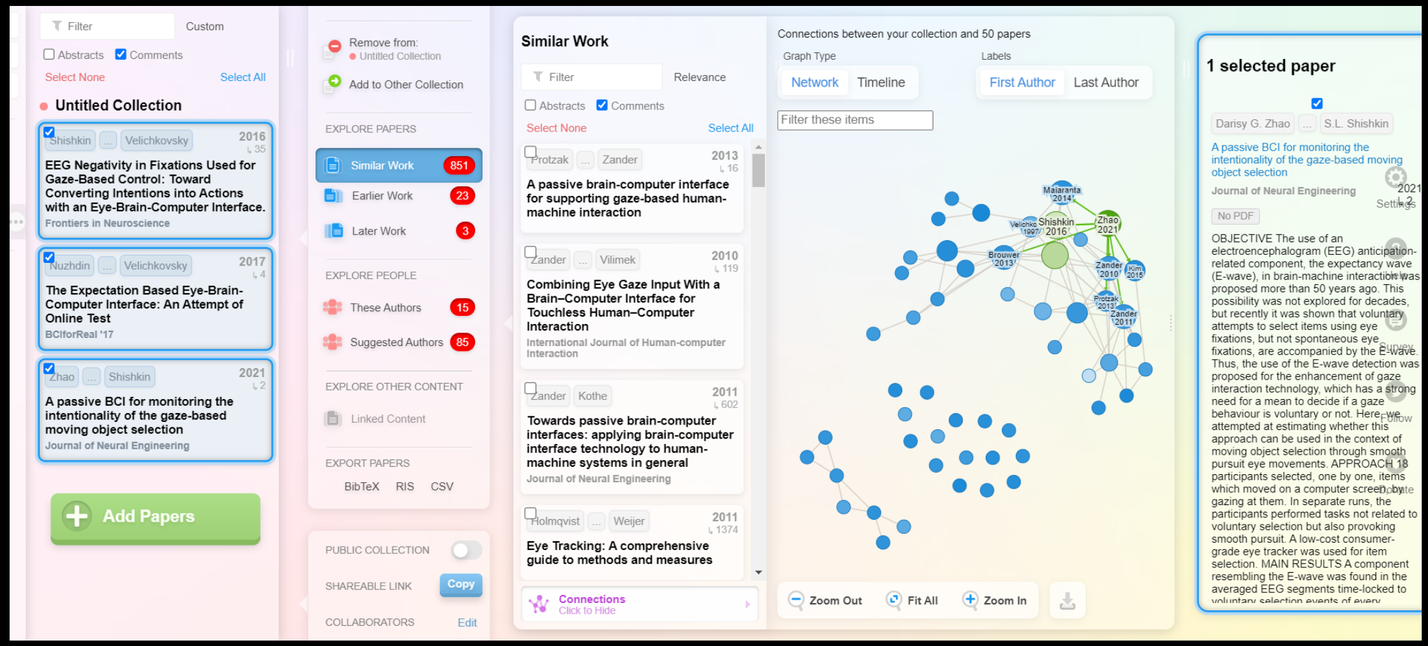
https://www.connectedpapers.com/



Finding related research

Research Rabbit

https://researchrabbitapp.com/



Finding related research

INTUITIVE XR LABS

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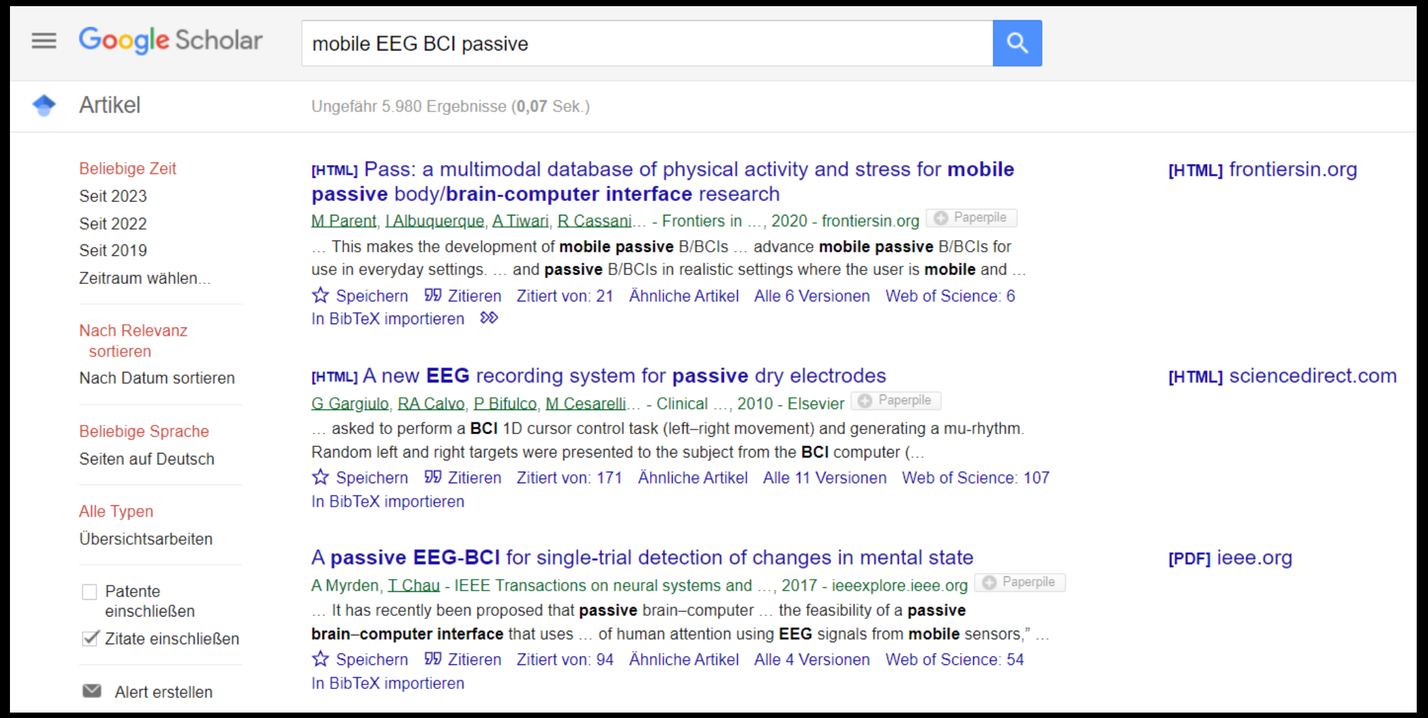
Google Scholar

https://scholar.google.com/



Finding related research

Semantic Scholar

https://www.semanticscholar.org/

Finding related research

Resources

- 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/
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