



Dissecting Journal Articles

How to find the right article, and how to navigate it.

Finding the Right Article

Using U of T Library
Search and Google
Scholar

Choosing Your Article Type

What are you looking for?

A Research Idea

A Topic Overview/Update

Original Research Articles

Randomized Control or Controlled Clinical Trials

Experimental, Cohort, or Case-Control Studies

Narrative Reviews

Systematic Reviews

Meta-analyses

Choosing Your Search Tool

Google Scholar

Highlight: see the most cited articles first—great for topic browsing

- Sorts by relevance (search terms, publication date, **citation count**)
- Includes articles that have not been peer-reviewed
 - Although Google won't indicate these results, you can check on **Ulrich's**
- **Find related articles**, get citation in popular formats

U of T Library Search

Highlight: see peer-reviewed articles only—great for finding reliable data

- Sorts by relevance (search terms **& where they appear**, publication date)
- Can limit search to **peer-reviewed articles**
 - Scholarly journals
- **See the Abstract** before entering the article
 - Details ▾**

Boolean Operators:

- **OR** (“machine learning” OR “artificial intelligence”)
- **AND** neuroscience AND technology
- **NOT** neuroscience NOT pseudoscience

Other Operators:

- **Quotation marks** “artificial intelligence”
- **Asterisk** neuroscien* / “follow your *”
 - **Google Scholar:** a placeholder in a phrase to see fill-in-the-blank results (“follow your *” would include “follow your heart,” “follow your nose,” etc.)
 - **Library Search:** signals that all possible word endings should be included (neuroscien* would include neuroscience, neuroscientist, etc.)

Search Filters:

- Year/year range

Narrowing Your Results

Want < 200 results—
less is better



U of T Library Search ▼

Advanced Article Search

All Fields

AND

All Fields

Publication

Volume

Issue

+ Add Row

Search

Sort Results by

Relevance

Find articles

with **all** of the words machine learningwith the **exact phrase**with **at least one** of the words

without the words

where my words occur

 anywhere in the article in the title of the articleReturn articles **authored by**

e.g., "PJ Hayes" or McCarthy

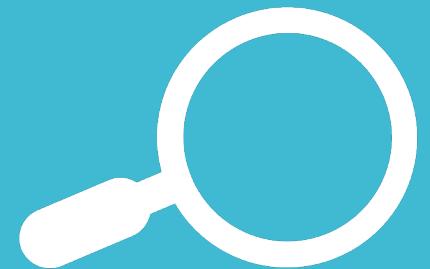
Return articles **published in**

e.g., J Biol Chem or Nature

Return articles **dated between** —

e.g., 1996

Advanced Search



Tips for Finding Articles



Google Scholar only: Found a general topic you're interested in and want to see its applications?

Click "[Cited by #](#)" under the search result



Found an article on a specific topic that you'd like to explore on a more general level?

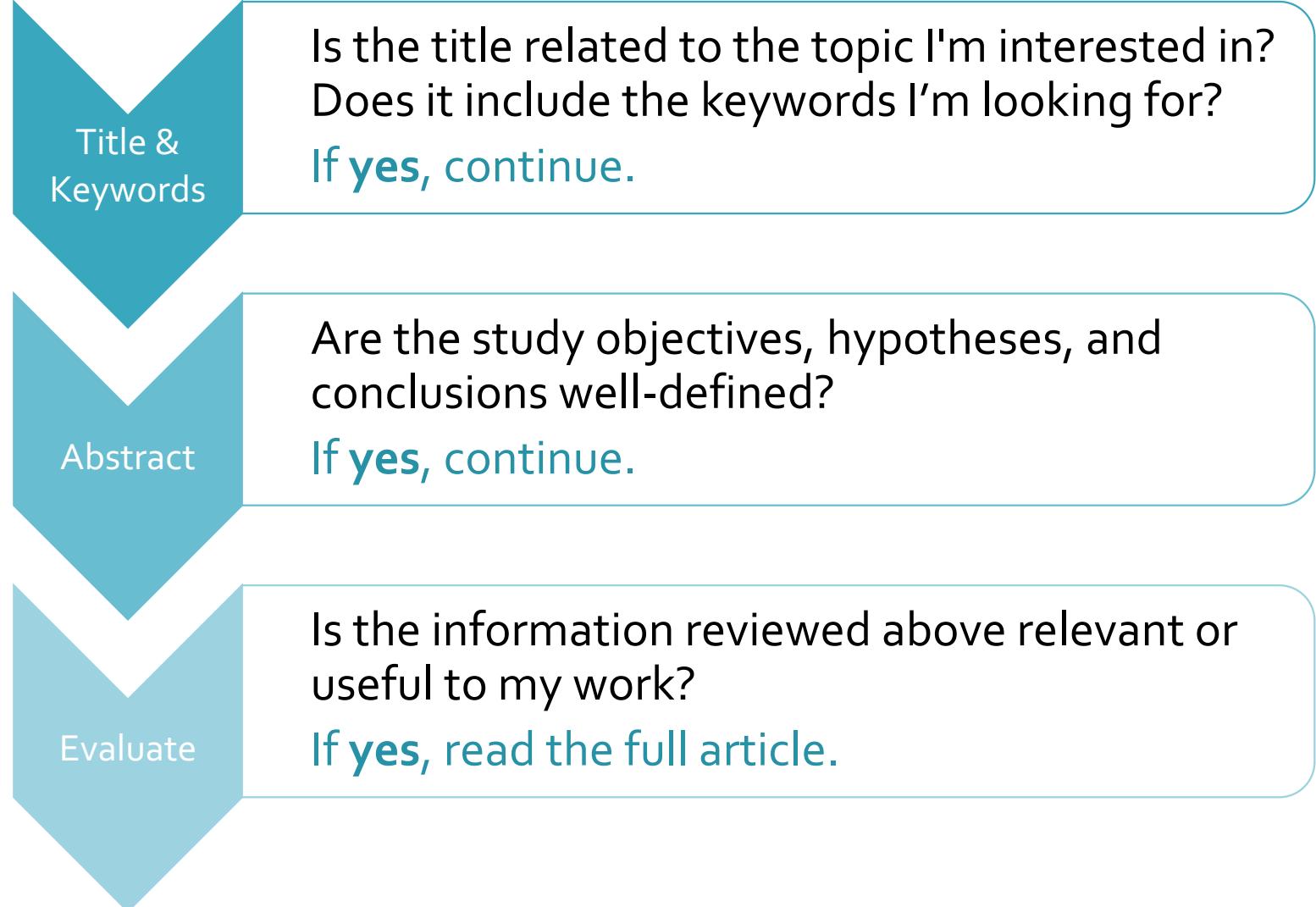
Check the article's [References](#) (especially looking for review articles)



Found the perfect article, but U of T hasn't provided access to it?

Copy the article's DOI and search it at [sci-hub.tw](#) and you'll probably find it for free!

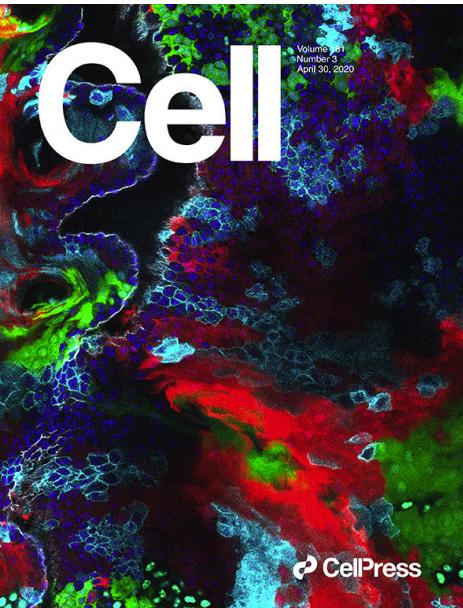
Choosing Which Articles to Read



Another Consideration: Journal Impact Factor

Was this article published
in a respected journal?

- If yes, then you know that you are looking at high-impact research that has previously undergone rigorous evaluation



How do I know if a journal is high-impact?

- Check how it ranks compared to other journals of the same subject—try using **Google Scholar Metrics!**

Example: I'm interested in the event-related desynchrony that occurs while processing a visual stimulus



Search: "event-related desynchronization" AND "visual processing"



ELSEVIER

International Journal of Psychophysiology 16 (1994) 147-153

INTERNATIONAL
JOURNAL OF
PSYCHOPHYSIOLOGY

Title & Keywords ✓

Event-related desynchronization (ERD) during visual processing

G. Pfurtscheller *, C. Neuper, W. Mohl

*Ludwig Boltzmann Institute of Medical Informatics and Neuroinformatics, and Department of Medical Informatics,
Institute of Biomedical Engineering, Graz Technical University, Brockmanngasse 41, A-8010 Graz, Austria*

(Accepted 17 January 1994)

Abstract ✓

Abstract

Event-related desynchronization (ERD) is the short-lasting attenuation or blocking of rhythms within the alpha (beta) band. ERD is found during but also before visual stimulation. Two different types of ERD can be differentiated: one short-lasting, localized to occipital areas and involving upper alpha components; the other longer lasting, more widespread, most prominent over parietal areas and maximal for lower alpha components. The former most likely reflects primary visual processing and feature extraction, the latter is more related to cognitive processing and mechanisms of attention.

Objective

Conclusion

Key words: ERD; Alpha blocking; Visual processing; Cognitive processing

Evaluation ✓

Dissecting Your Article

How to go through
the data step-by-step

Introduction

Purpose: to give rationale behind study, supply pre-existing knowledge on the topic, and identify gaps in knowledge

While reading the **Introduction**, ask yourself these questions:

1. What was the research problem?
2. What previous studies on this topic were mentioned, and were they appropriately applied?
3. What was the rationale behind performing this study?
4. What were the study aims/objectives?
5. What was the study hypothesis?

Research Problem

1. Introduction

Visual stimulation results in two bioelectrical phenomena, the generation of the visual evoked potential (VEP) and the blocking or desynchronization of rhythms within the alpha band. The VEPs are well known and in extensive clinical use [1], the latter, even though known since the time of Berger [2] and for the first time quantified as event-related desynchronization (ERD) by Aranibar and Pfurtscheller [3], is still the subject of experimental investigations [5–7]. In contrast to the visual stimuli-related EEG desynchronization, the movement-related desynchronization is already reported in first clinical trials [8].

* Corresponding author. Tel.: (+43-316) 82 1694; Fax: (+43-316) 81 2964.

Previous studies throughout ✓

Hypothesis?

Rationale

It is important to note that there exists not only one occipital alpha rhythm, but a great variety of alpha rhythms as postulated by Grey Walter (in Mulholland [9]):

"We've managed to check the alpha band rhythm with intracerebral electrodes in the occipital-parietal cortex; in regions which are practically adjacent and almost congruent one finds a variety of alpha rhythms, some of which are blocked by opening and closing the eyes, some are not, some are driven by flicker, some are not, some respond in some way to mental activity, some do not. What one sees on the scalp is a spatial average of a large number of components, and whether you see an alpha rhythm of a particular type or not depends upon which component happens to be the most highly synchronized process over the largest superficial area; there are complex rhythms in everybody."

Factor analysis of the EEG showed that it is possible to differentiate between at least two alpha components. One is located around 9.5 Hz, the other around 11 Hz [10]. The existence of lower and upper alpha band components was also

reported by Klimesch et al. [11,12]. Both studies were based on different analytical procedures: Hermann et al. [10] analysed power spectra whereas Klimesch et al. [11,12] used ERD measurements.

Alpha band rhythms are generated in small cortical modules. From these modules (epicentres) the activity spreads in different directions by way of cortico-cortical connections [13]. Beside these intracortical connections, thalamocortical systems also play an important role in the generation of alpha rhythms [14,15]. Details on the neurophysiological basis of alpha rhythms can be found in Lopes da Silva [16].

In the present study the ERD method is used to analyse the extended alpha band (6–12 Hz) during visual information processing. Calculation of ERD time courses and ERD maps is used to study the spatio-temporal patterns of alpha desynchronization during visual encoding and cognition.

Study Objective

Materials & Methods

Purpose: to give technical details as to how the study's experiments were completed and analyzed

While reading the **Materials & Methods**, ask yourself these questions:

1. How did the researcher attempt to answer their research question?
2. How was sampling done, and might this have been biased?
3. How was grouping/categorization done, and were sample sizes large enough for generalization?
4. What were the inclusion/exclusion criteria, and how does this affect generalization?
5. What procedures were followed?
6. What variables were measured?
7. What equipment/instruments were used to collect data, and were they appropriate?
8. What statistical methods/tests were employed, and were they appropriate?

2. Experimental design and data processing

Three different experiments were subject of this investigation.

Experiment 1

Neutral stimuli in the form of a 1-s red light were presented with a pair of goggles. The inter-stimulus interval was 7 s (for details see Pfurtscheller et al. [17]).

Experiment 2

In this experiment the stimuli were 48 words and 48 numbers. Half of the words belonged to the category "tools" and the other half to "animals". Half of the numbers were "odd" and the other half were "even". The stimuli were displayed for 250 ms on a computer-controlled terminal at intervals of 7 s. The subject's task was to report with "yes" if a word denoted an animal or the number was odd. In the other cases the subject was to respond with "no". Further details are reported by Klimesch et al. [11].

Measured variable

Exclusion criteria

Sampling?

Some measured variables missing

Procedure described with too little detail

Measured variables

Experiment 3

Pairs of words (interval 3 s) were presented visually. The first word (WORD 1) characterized one of four semantic classes, the second word (WORD 2) was an object of one of these semantic classes. In the case of a match between WORD 1 and WORD 2 the subject had to press 2 microswitches with both index fingers; in the case of a mismatch, both thumbs were used to react.

The EEG was recorded with 29 electrodes according to the international 10–20 system with interspaced positions. For the EEG recording a 32-channel amplifier system was used; the upper cut off frequency was set at 30 Hz and the time constant was 0.3 s. Stimulus synchronous data were sampled at 64 Hz. The trials consisted of 3 s of EEG before presentation of WORD 1 and 5 s thereafter. After visual inspection and exclusion of trials with artifacts, event-related potentials (ERPs) and ERD-time courses were calculated from the same data (Fig. 1). For ERD calculation the EEG data were digitally band-pass-filtered, squared and averaged over trials. Thereafter, 8

consecutive samples of the filtered and squared signals were averaged. This resulted in an alpha power time series for each channel with a resolution of 125 ms. After assigning the alpha power in the reference interval (the first second of each trial) to 100% the ERD time course was calculated as the percentage change of power with respect to the reference period. ERD maps were computed using a linear four-nearest-neighbours interpolation algorithm [7].

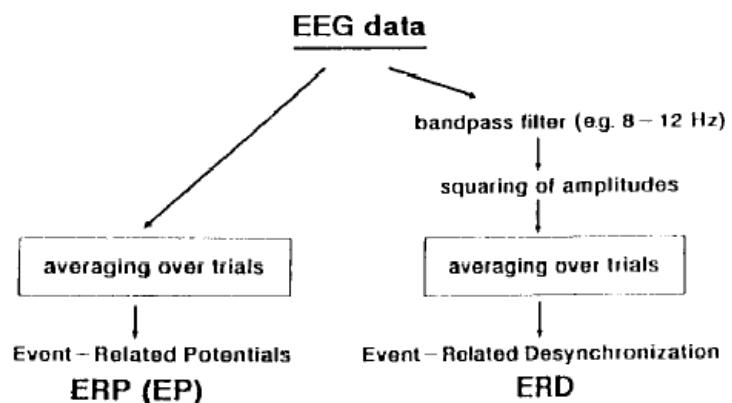


Fig. 1. Scheme of ERD processing; the EEG data are sampled synchronous to externally or internally paced events.

Results

Purpose: to provide details about data collected (often visualized in a graph/figure/table)

While reading the **Results**, ask yourself these questions:

1. What were the key findings?
2. Were all subjects present in the beginning of the study accounted for at the end?
3. Were the results reliable (same results over time) and valid (measure what they're intended to)?
4. Which results were statistically significant, and which weren't?

3. Results

3.1. Experiment 1

ERD time courses (one subject) of 6–8 Hz and 10–12 Hz components are displayed in Fig. 2. It can be seen from this figure that the 10–12 Hz ERD is largest over the occipital region (electrode 17) and the 6–8 Hz ERD is largest over the parietal region (electrode 28). Further, it can be recognized that the desynchronization of the lower frequency components starts clearly after desynchronization of the upper alpha components.

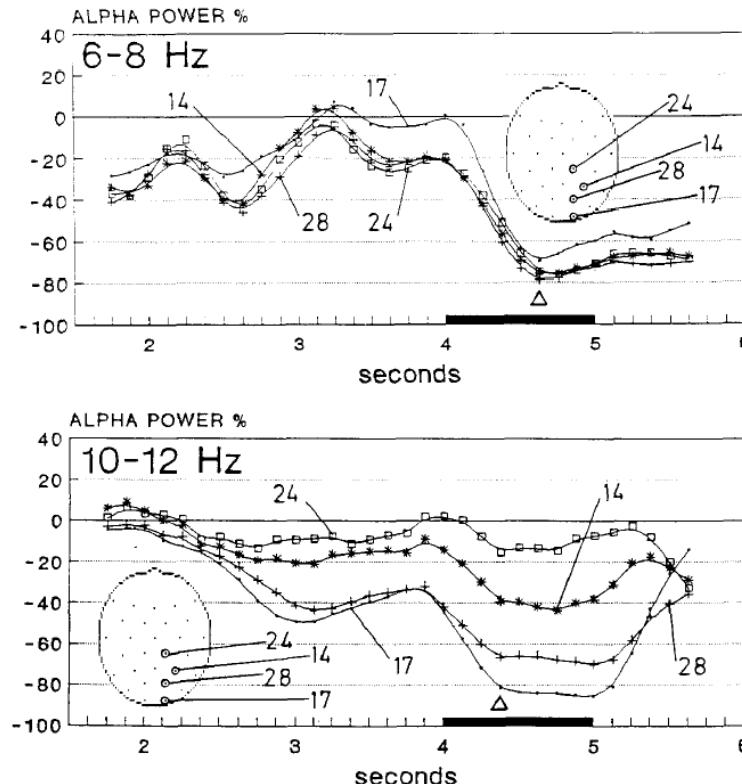


Fig. 2. ERD time courses calculated during 1-s red light stimulation as indicated by a blank bar. Displayed are the power within the 6–8-Hz (upper panel) and the 10–12-Hz band (lower panel) calculated for 4 different electrode positions as marked in the head insert. The power in the reference interval (0.5–1.5 s) was assigned to 100%.

3.2. Experiment 2

Grand average ERD time courses (10 subjects) for the 6–8 Hz and 10–12 Hz components are displayed in the upper half of Fig. 3. It can be seen that the 10–12 Hz ERD is short-lasting and followed by a brief synchronization, whereas the 6–8 Hz ERD is relatively long-lasting and starts clearly after the upper alpha band ERD. Examples of 2 grand average ERD maps for the 6–8 Hz and 10–12 Hz components are shown in the lower half of Fig. 3. Both maps represent a time interval of 125 ms and show that the 10–12 Hz ERD is localized over occipital areas, whereas

the 6–8 Hz ERD is more widespread and localized over centroparietal areas.

3.3. Experiment 3

Examples of ERD maps (one subject, 225 trials) from the first half second after display of WORD 1 are shown in Fig. 4. Data from the 6–8 Hz and 9–11 Hz band are displayed. It can be seen that desynchronization starts over occipital areas in the upper alpha band, followed by a parietal localized ERD in the 6–8 Hz band. The situation after presentation of WORD 2 is more complex, because, in addition to the matching

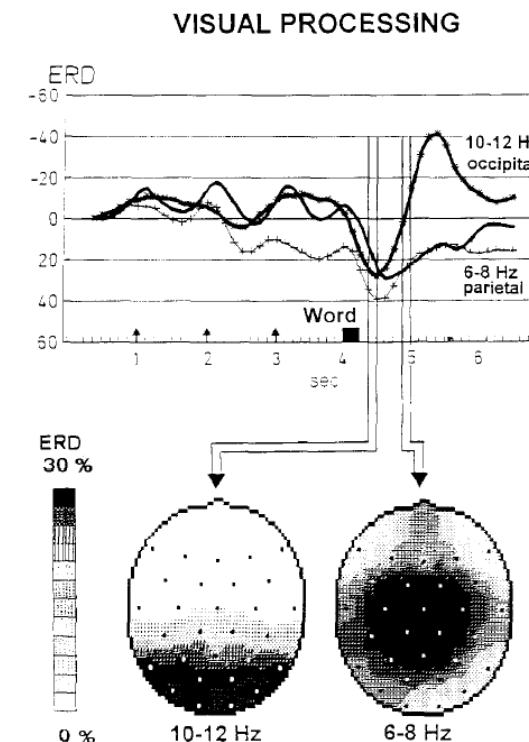


Fig. 3. Grand average ERD time courses of 10 subjects for the 6–8 Hz and 10–12 Hz bands and 2 grand average ERD maps ("black" indicates regions with maximal ERD). The reference power, calculated in the interval 0.2–1 s, was assigned to 0% ERD, the word stimulus was presented after 4 s (modified from Pfurtscheller and Klimesch, 1992).

process, a motor action with both hands was required. In this case it is of interest that visual processing is best reflected in the frequency bands 6–8 Hz and 9–11 Hz. The preparatory process for the hand movement is best reflected by the desynchronization of 10–12 Hz components localized to the electrodes C₃ and C₄, both overlying the sensorimotor cortex. There is, however, an overlap between frequency components desynchronized during preparation and execution of hand movements and the visual encoding process.

ERD time courses of 6–8 Hz, 9–11 Hz and 10–12 Hz components are shown in Fig. 5. Although the bands 9–11 Hz and 10–12 Hz partially overlap, the time courses are different. The occipital 9–11 Hz components demonstrate a trend to synchronization in the interstimulus interval and display a short-lasting ERD during encoding of WORD 2. In contrast, the central 10–12 Hz components desynchronize before the presentation of WORD 2 due to the preparation for the motor response.

Key Findings

Discussion

Purpose: to answer the research questions, provide meaning of analysis, and present interpretation/implications of data with comparisons to related studies

While reading the **Discussion**, ask yourself these questions:

1. Did the results answer the research question?
2. How did the authors interpret the data?
3. Was the data analysis relevant to the research question?
4. How were these results different/similar compared to related studies?
5. What were the strengths and limitations of this study?
6. Were there any extrapolations of the findings beyond the range of data?

4. Discussion

Visual processing is accompanied not only by the generation of a VEP, but also by an ERD. Both have different patterns in time and space. The VEP can be considered as an on (off) effect for a visual stimulus with a duration of some hundreds of milliseconds. It has greatest amplitude over the occipital region and close to the vertex. The ERD, longer lasting than the VEP, can also be observed before stimulation and is composed of at least 2 different components: (i) a short-lasting upper alpha band desynchronization (10–12 Hz) focused over occipital areas; (ii) and a longer lasting lower alpha band desynchronization (6–8 Hz) relatively widespread with a maximum over parietal areas.

Generation of the VEP is related to the excitation of neuronal mass in primary, secondary and other visual areas and interaction between these areas and structures, respectively. One characteristic feature of the alpha desynchronization is that it can also be observed before visual afferences are present, i.e. during expectancy or anticipation of a visual stimulus. How then can this desynchronization be interpreted?

There is strong evidence that high amplitude alpha waves measured by a scalp electrode characterize synchronized oscillations in a relatively large number of cortical modules occupying at least a few square centimetres [16,18]. This cooperative behaviour of distributed cortical modules can be interpreted in such a way that those in-

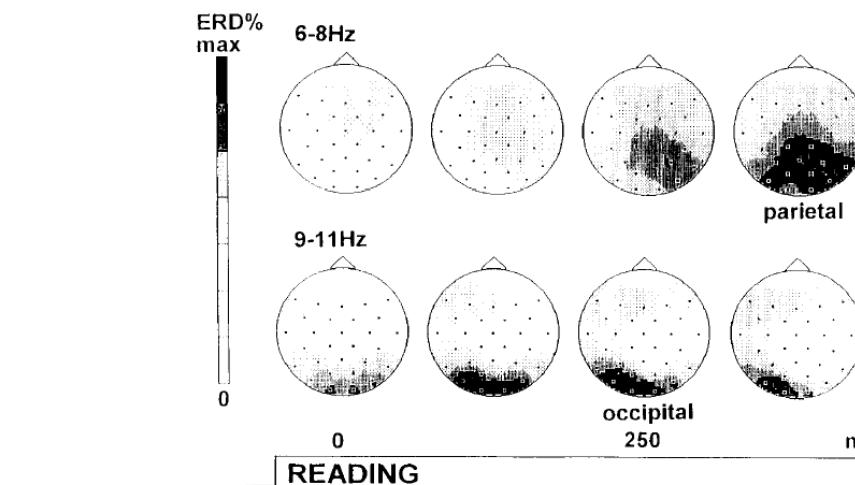


Fig. 4. Serial ERD maps calculated in intervals of 125 ms for the first 500 ms after presentation of WORD 1. Displayed are maps for the 6–8 Hz and 9–11 Hz bands; scale in ERD% from 0 to 70%, “black” indicates regions with maximal ERD.

volved are not prepared or not active for information processing. High alpha waves on the scalp are found during rest and are, therefore, characteristic of an “idling” state of the cortex [19]. The alpha desynchronization over occipital areas after visual stimulation indicates a change from a resting to an activated state. The cortical modules in visual areas display a smaller degree of cooperation and are less synchronized as they become

ready for visual encoding and processing. As can be seen from the data of experiments 2 and 3 the occipital localized desynchronization has its maximum between 200 and 300 ms. Thereafter, the occipital alpha waves display an increasing degree of synchronization and the maximum of desynchronization moves from occipital to parietal regions and involves frequency components between 6 and 8 Hz. Parietal areas display maximal desynchronization between about 300 and 500 ms after stimulation onset.

The encoding of words, including encoding of lines, letters and words and semantic encoding, lasts about 400–500 ms [4]. The last stage of encoding, the semantic encoding, can be related to a time interval of 300–500 ms and includes memory access and cognitive processing. It can be speculated from the data presented that a widespread cortical network centred in parietal regions is desynchronized, and thus becomes prepared for cognitive processing. When this network is “idling” it generates oscillations within the 6–8 Hz band.

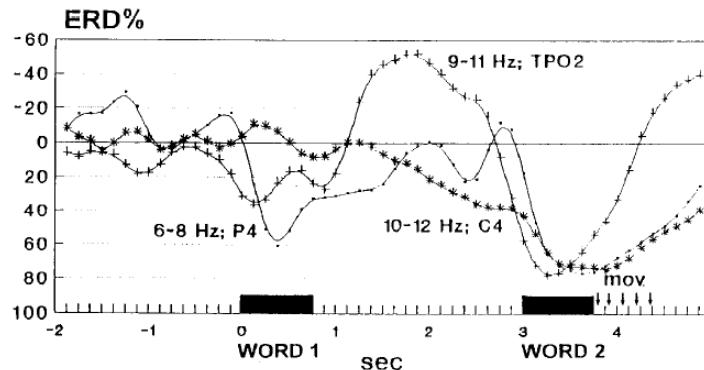


Fig. 5. ERD time courses from different electrodes and different frequency bands. Plotted are data from 6–8 Hz (electrode P₄), 9–11 Hz (electrode TPO₂) and 10–12 Hz band (electrode C₄). The presentation of WORD 1 and WORD 2 is marked; the approximate time of finger movement is also indicated.

Not only the desynchronization of low frequency components, but also the generation of the P₃₀₀ (P₃) component of the event-related potentials is centred in the parietal region. The positive wave of the P₃₀₀ component is interpreted as a short period of reduced cortical excitability necessary for accessing long term memory or updating of the memory [20,21]. At this point in time we have no explanation of how a reduced cortical excitability manifested in a positive wave (P₃₀₀) and the desynchronization of low alpha frequency components can be explained. The anatomical substrate of each of the bioelectric phenomena is also open to interpretation.

Another aspect of the desynchronization of EEG components in the alpha band can be seen as a neuronal mechanism able to increase the signal-to-noise ratio, whereby one part of the signal consists of the long-latency EP components known as electrophysiological correlate of conscious perception and the other of noise in form of spontaneous EEG activity. The “noise” has to be reduced in those cortical areas and structures necessary in the process of encoding and feature extraction. The signals can also be endogenous EP components or the motor potentials in a movement task. The “noise” is of greatest amplitude when cortical modules display a high degree of synchronization and generate coherent alpha band activity. The “noise” is of small amplitude when the cortical modules work relatively independently or, in other words, are desynchronized. It is therefore not surprising that a clear correlation was found between VEP amplitudes and the magnitude of ERD [22].

Interpretations

Limitations

Conclusion

Note: if this section isn't present, look to the end of the Discussion

Purpose: to provide a summary of what was found and the implications of those results, as well as their application to future research

While reading the **Conclusion**, ask yourself these questions:

1. What were the conclusions?
2. Were conclusions based on reported data & analysis?
3. Were conclusions reasonable and logical?
4. Will the results be useful in further research or clinical practice?
5. Do you have any remaining questions unanswered by the article?

In summary, we can state in agreement with other workers that alpha desynchronization reflects a state of cortical activation [16] which is not necessarily limited to visual or other afferences and also characteristic for planning or preparation of movement [23,24]. This desynchronization or ERD is different for upper and lower alpha components. The upper alpha band ERD is localized, more task-specific and most likely reflects computational processes such as feature extraction, stimulus identification, and response preparation in a movement task. The reaction of lower alpha components is more widespread and the ERD of these components reflects more task-independent processes related not only to cognitive processing but also to the energetical mechanisms of arousal, attention and effort [12].

*Now it's your
turn.*

Individually:

1. Choose any topic in neurotechnology
2. Search for an article on this topic published in the last 5 years—be specific
3. Summarize the Abstract in your own words

Within your group:

1. Share your Abstract summaries
2. Choose one article to dissect
3. Answer the provided questions for each section

Introduction	Materials & Methods	Results	Discussion	Conclusion
1. What was the research problem?	1. How did the researcher attempt to answer their research question?	1. What were the key findings?	1. Did the results answer the research question?	1. What were the conclusions?
2. What previous studies on this topic were mentioned, and were they appropriately applied?	2. How was sampling done, and might this have been biased?	2. Were all subjects present in the beginning of the study accounted for at the end?	2. How did the authors interpret the data?	2. Were conclusions based on reported data & analysis?
3. What was the rationale behind performing this study?	3. How was grouping and/or categorization done, and were sample sizes large enough for generalization?	3. Were the results reliable (same results over time) and valid (measure what they're intended to)?	3. Was the data analysis relevant to the research question?	3. Were conclusions reasonable and logical?
4. What were the study aims or objectives?	4. What were the inclusion/exclusion criteria, and how does this affect generalization?	4. Which results were statistically significant, and which weren't?	4. How were these results different and/or similar compared to related studies?	4. Will the results be useful in further research or clinical practice?
5. What was the study hypothesis?	5. What procedures were followed? 6. What variables were measured? 7. What equipment and/or instruments were used to collect data, and were they appropriate? 8. What statistical methods/tests were employed, and were they appropriate?		5. What were the strengths and limitations of this study? 6. Were there any extrapolations of the findings beyond the range of data?	5. Do you have any remaining questions unanswered by the article?

Descriptive statistics

Mean, median, range, and standard deviation

Tables/graphs

Percentages

Sensitivity and specificity

Inferential statistics (hypothesis testing)

Parametric tests (for quantitative data)

Normal curve test (Z test)

Comparing two sample means or proportions

Student's *t* test

Testing for differences between the mean values of two groups of data

Unpaired *t* test (two independent samples)

Paired *t* test (matched or paired samples)

Analysis of variance

To compare means in three or more groups

Pearson correlation coefficient

For testing the strength of the association between two variables

Linear regression

For predicting the value of one variable based on the value of one or more other measured variables

Non-parametric tests (for quantitative data)

Wilcoxon signed rank test (matched data)

Mann-Whitney rank sum test (two independent groups)

Kruskal-Wallis test (for comparing three or more groups)

Non-parametric tests (for qualitative data)

Chi-square test (several groups and several outcomes, unmatched data)

McNemar test (several groups and several outcomes, matched data)

Fisher's exact test (two groups, two outcomes)

Parametric tests assume an underlying normal (bell-shaped) distribution, whereas non-parametric tests do not