Analysis of Event-Related Potentials

BrainVision Analyzer 2 Webinar 02 / 2018

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May 2018

Scientific Support Team
Brain Products GmbH

Webinar Team

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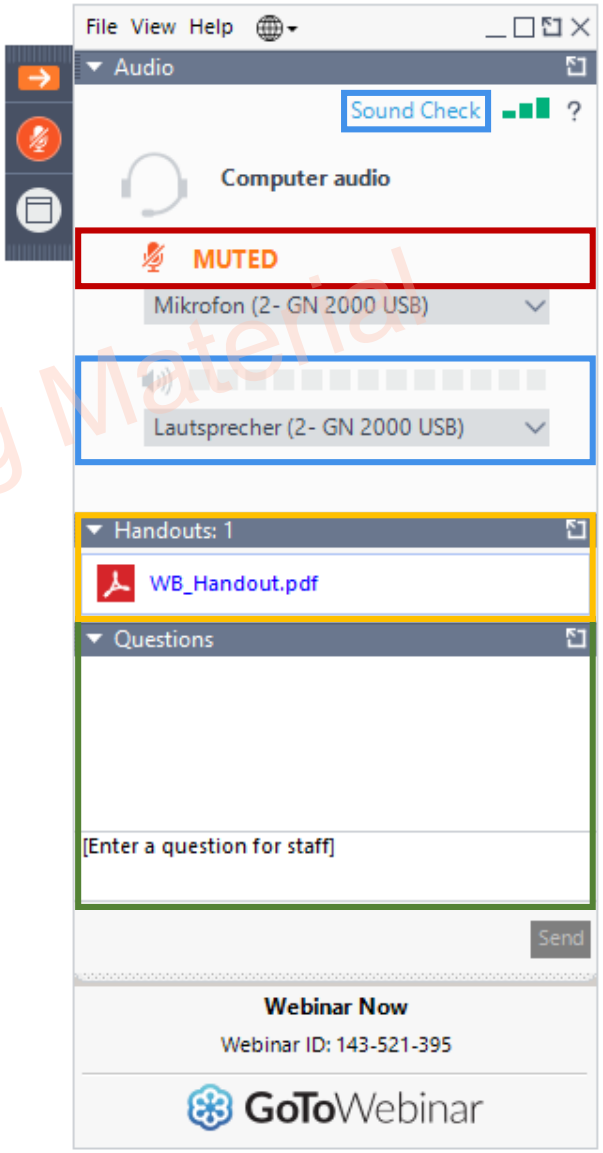
Scientific Consultant

Webinar Procedure

- Please note that your microphones are **muted**. All attendees will stay in ***listen-only mode*** throughout the webinar.
- You can change your **audio output device** at any time and also perform a **sound check**.
- Please note that we only offer Computer audio (VoIP) and no audio via phone call.

- Please ask questions only via the **Questions pane**.
- Your question will be handled by the moderation team and either answered directly or compiled for the Q&A session at the end of the webinar.

- If any material is provided, please download via clicking the file in the **Handouts pane**.



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Goals of this webinar

Goals

- An introduction to the transformations in BrainVision Analyzer 2 that are commonly used in ERP analyses
- Showcase two classical cognitive paradigms in an analysis demonstration

Learning Outcomes

- What tools are available to analyze your ERP data
- How to generate the exports needed for statistical analysis

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Disclaimer

The demonstrated processing pipelines are just examples based on scientific practice and do not claim to represent any recommended standard.

Outline

- Introduction - Background of ERP Methodology

ERP Analysis – the Basics

- Common preprocessing steps
- Ocular artifacts – how to deal with them?
- ERP peak detection & export

ERP Analysis – extended

- Segmentation with Advanced Boolean Expressions
- Grand Average across subjects

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- Q & A Session
- Concluding Remarks

Background of ERP Methodology

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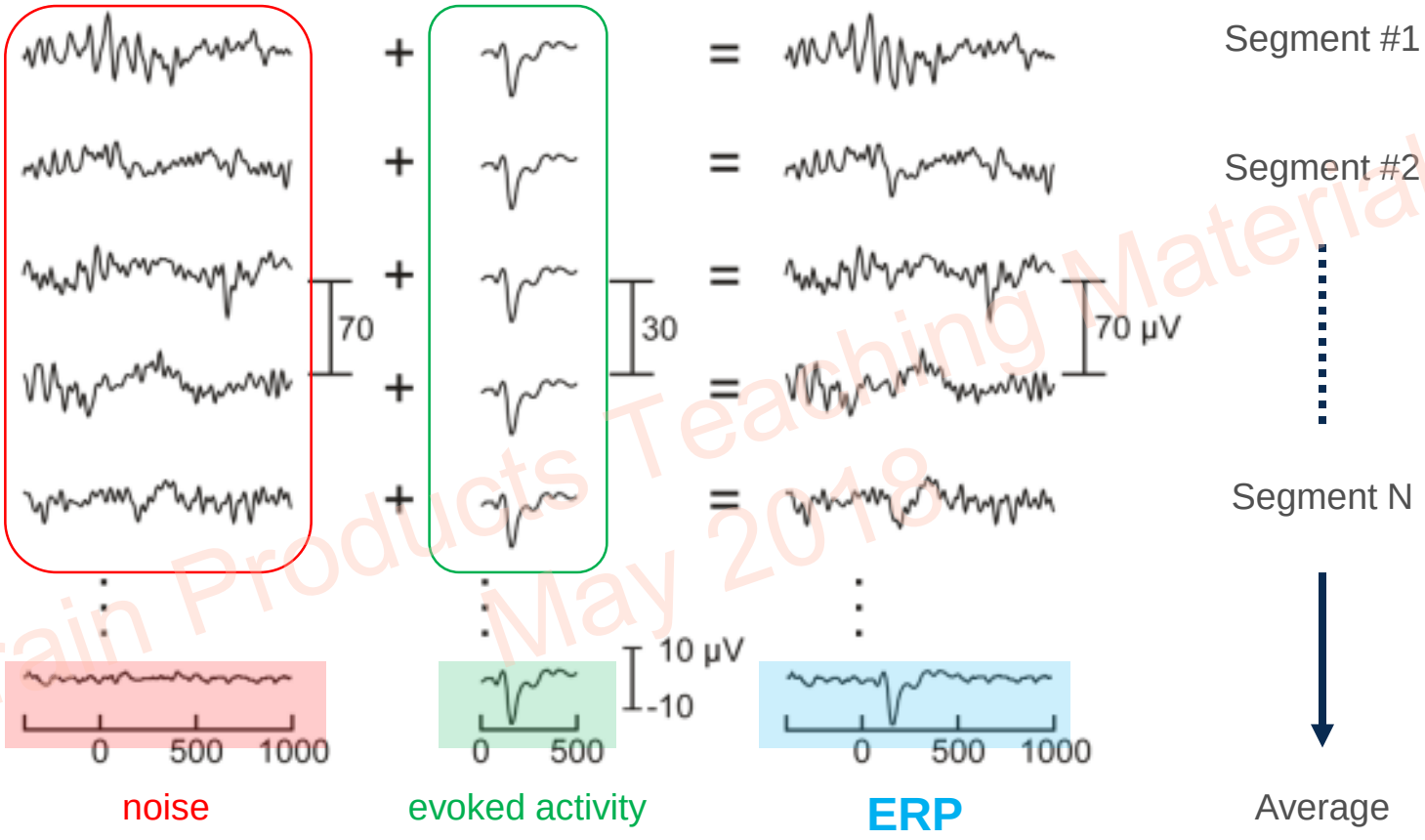
The Event-Related Potential (ERP)



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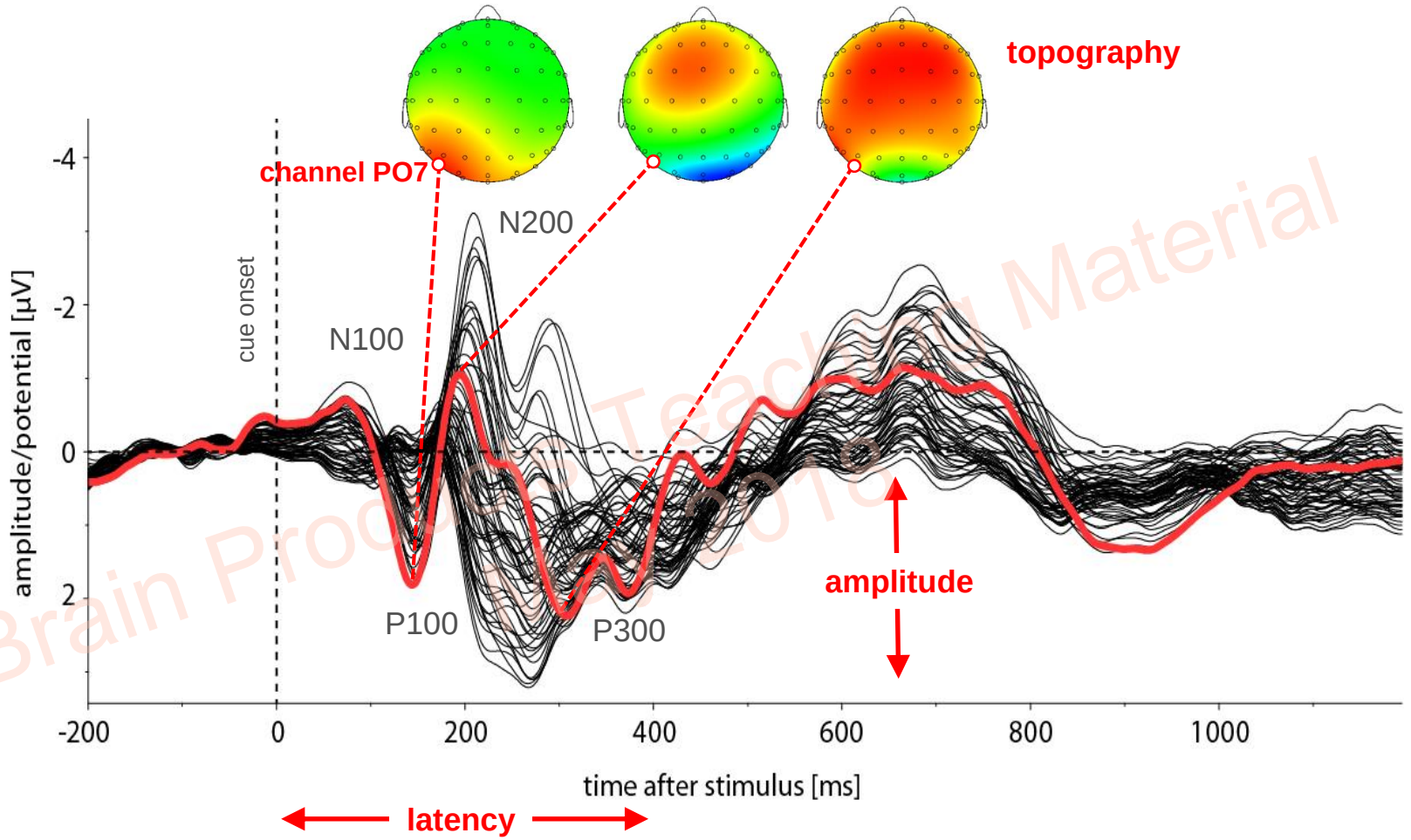
Adapted from S. Debener

ERP characteristics



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ERP Analysis – the Basics

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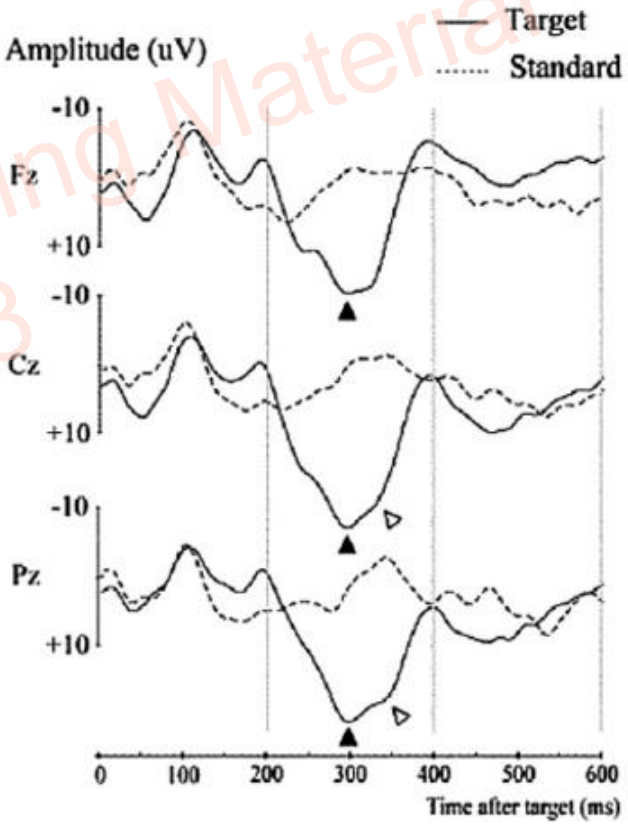
The Auditory Oddball task

- Frequently appearing **standard tones** and rarely occurring **deviant/target tones.**
- P300 larger for deviants/targets
- Amplitude varies with e.g. probability of target appearance
- Latency varies with detection complexity of deviants/targets



from Elting et. al, 2008

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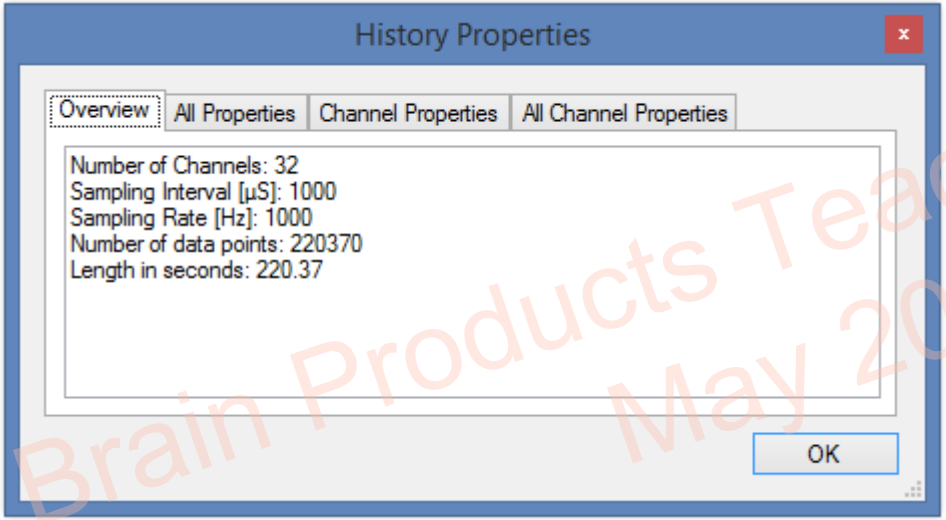
Recording information

- Number of channels: 32 (incl. 4 EOG, 2 mastoids)
- Sampling rate: 1000 Hz
- Recording length: ~3.7 min (220.37 s)



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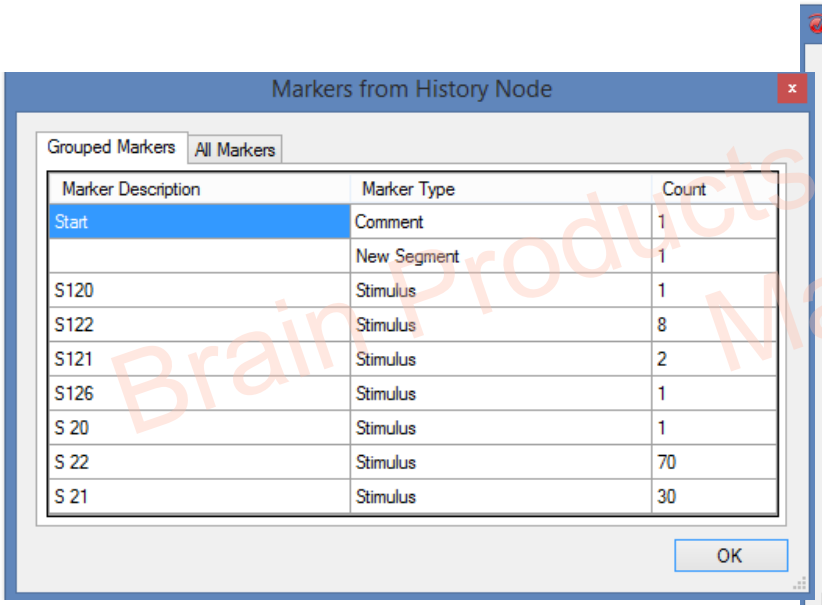
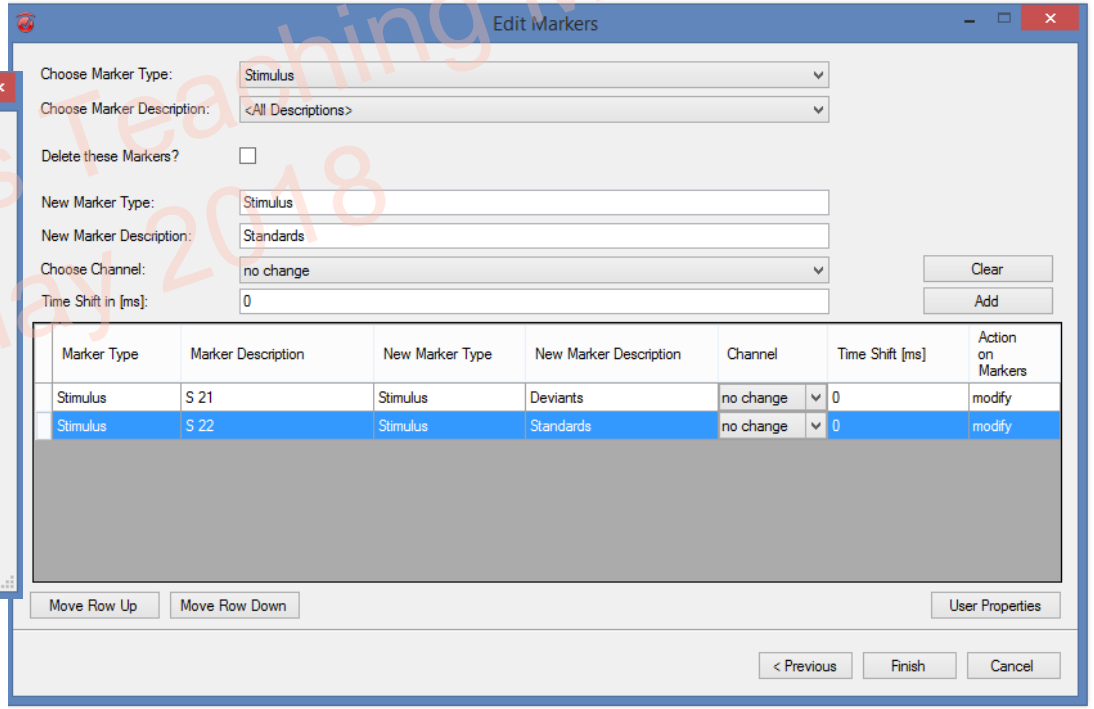
- Additional Information:
  - Recording reference: FCz
  - Number of trials: 100 (30% Deviants, 70% Standards)

Check and rename markers

- Do my markers exist? Are they correctly coded? Are any missing?
- Markers can be adapted easily, e.g. renamed → *Edit Markers*
  - Use automatic mode to edit all instances of a marker
- More information: http://pressrelease.brainproducts.com/markers/





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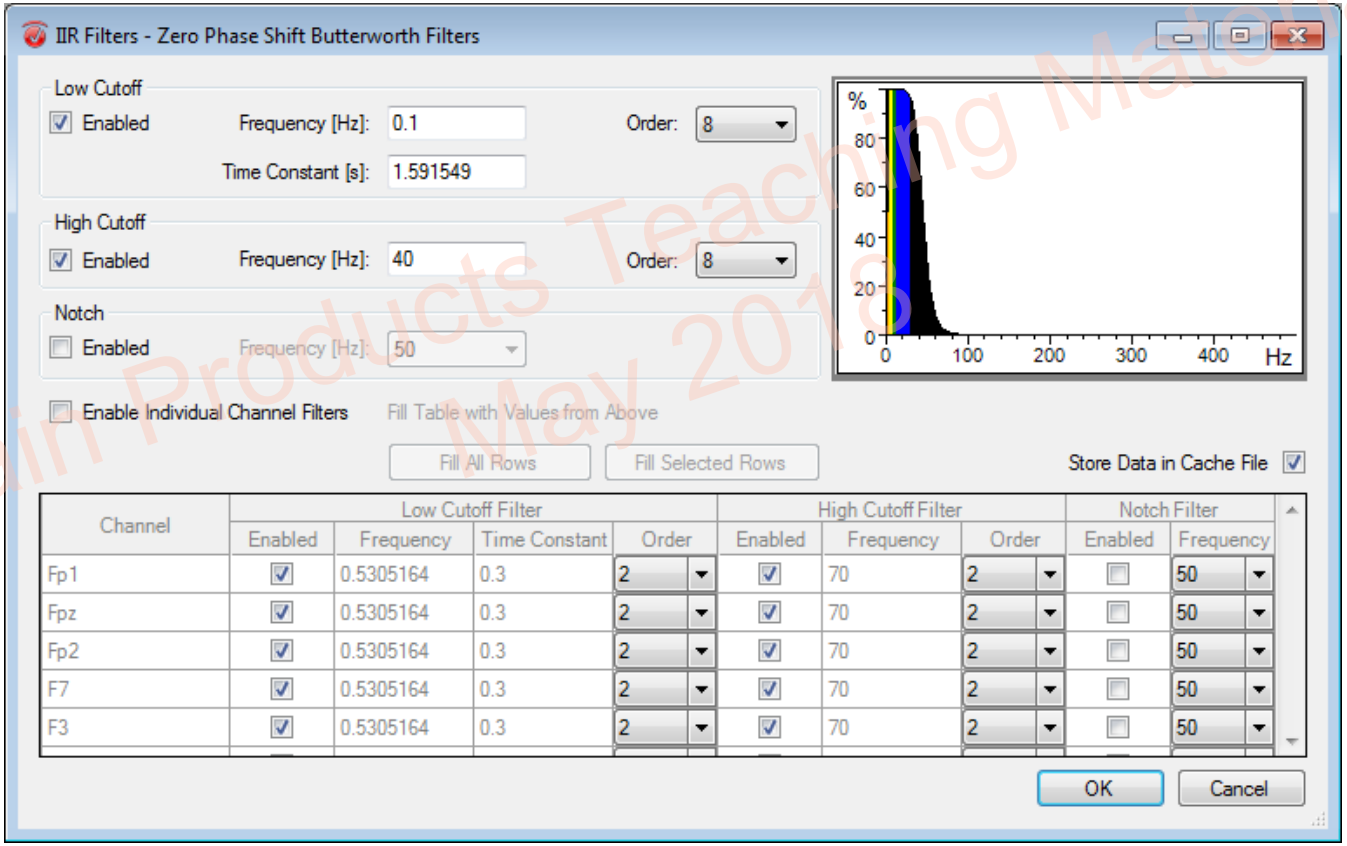
IIR Filters

- The filter settings should be selected according to the goals of the analysis.
- The data quality may also influence the filter settings.
- The caching option is recommended for high-pass filters to avoid filter artifacts.



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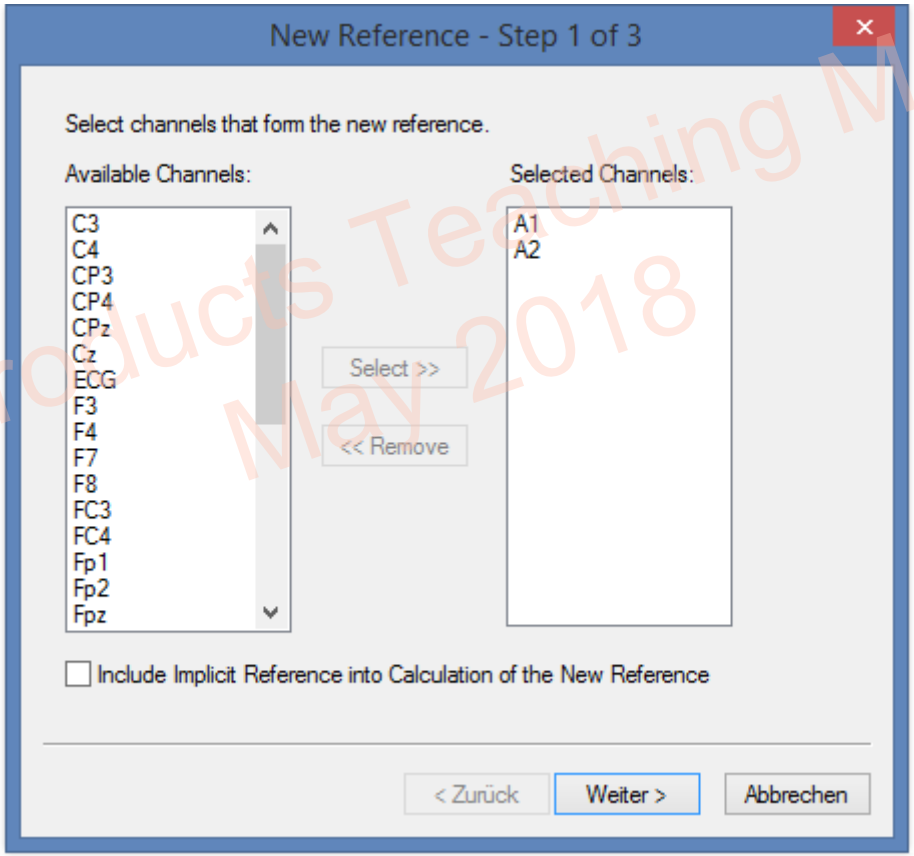
Re-referencing

- Consider to re-reference offline → *New Reference*
- Which reference depends on the goals of your analysis.
- Often the recording reference is not the best for the analysis.



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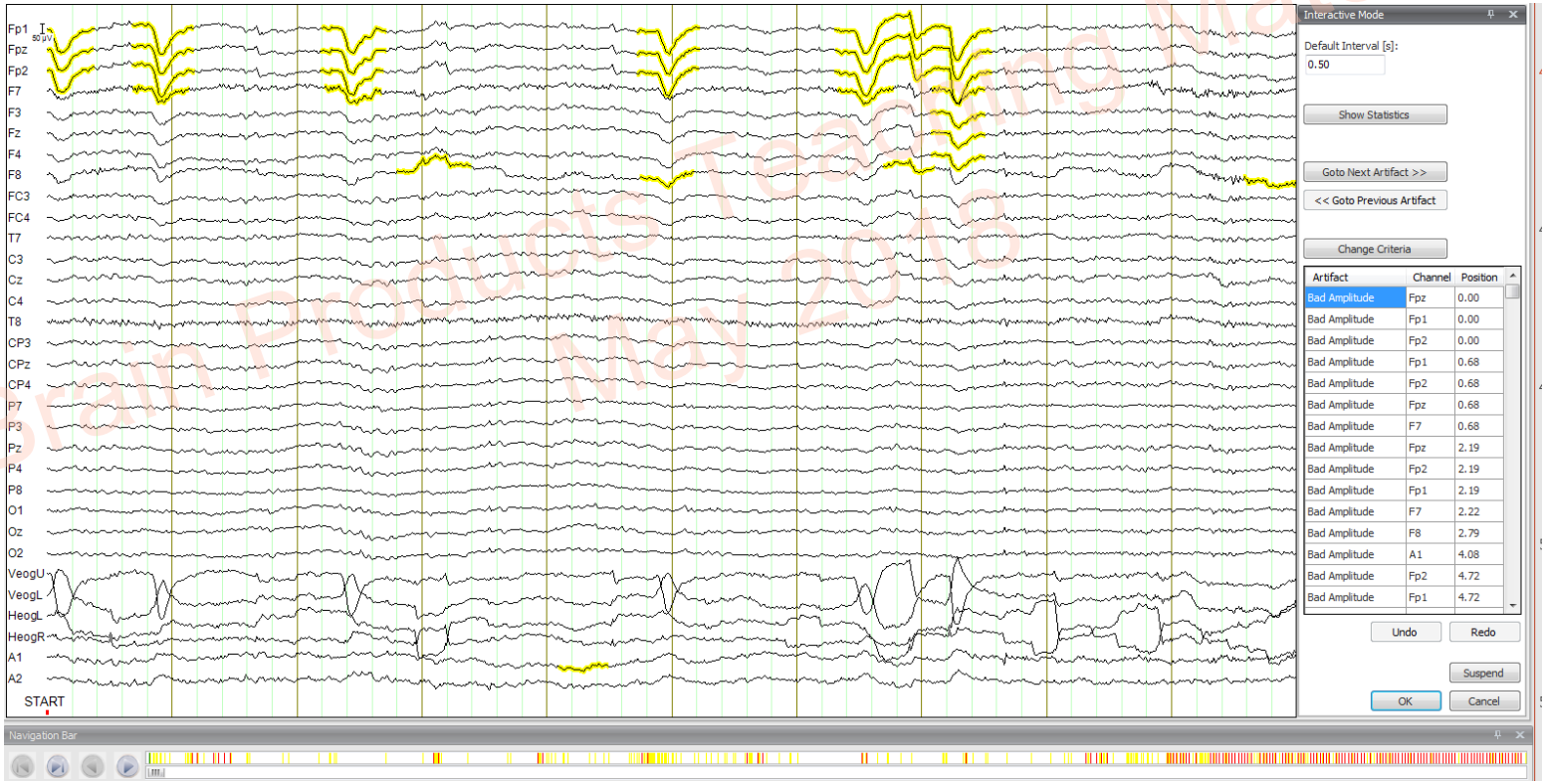
Raw Data Inspection

- Portions of data containing artifacts should be marked. These intervals will be ignored/rejected in subsequent processing steps.
- Always visually inspect all individual datasets and outputs.
- Semiautomatic mode is recommended.



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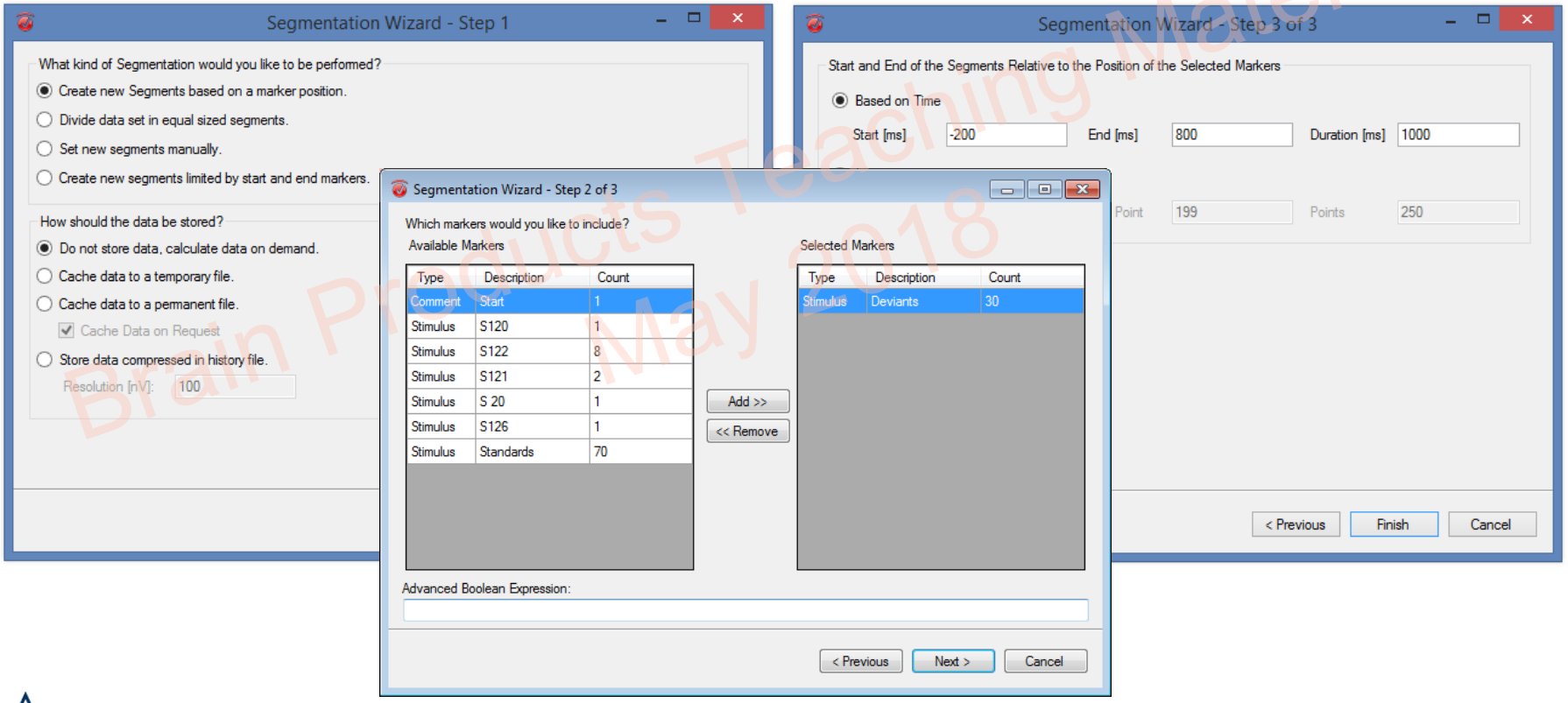
Segmentation

- Consider a baseline period.
- Consider relevant time interval of expected effects.
- Check the resulting trials. Are trials lost after segmentation due to Bad Intervals?
  → only if 'Skip Bad Intervals option' is enabled, otherwise just marked.



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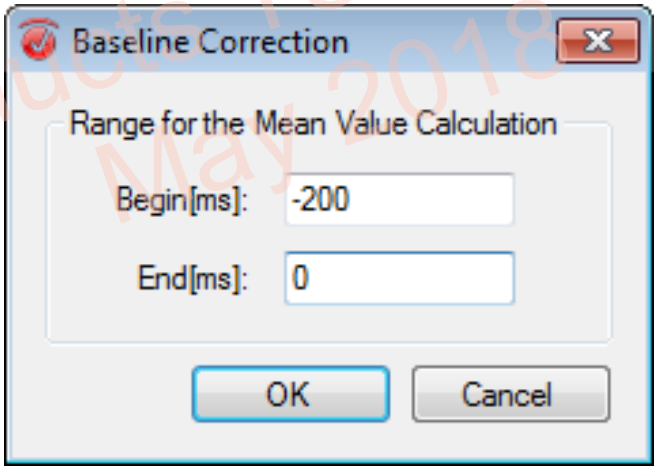
Baseline Correction

- Pre-stimulus baseline period.
- not too short
  - e.g. twice the length of an alpha frequency cycle (100 ms) → 200 ms
- not too long
  - avoid overlap with effects of previous trials



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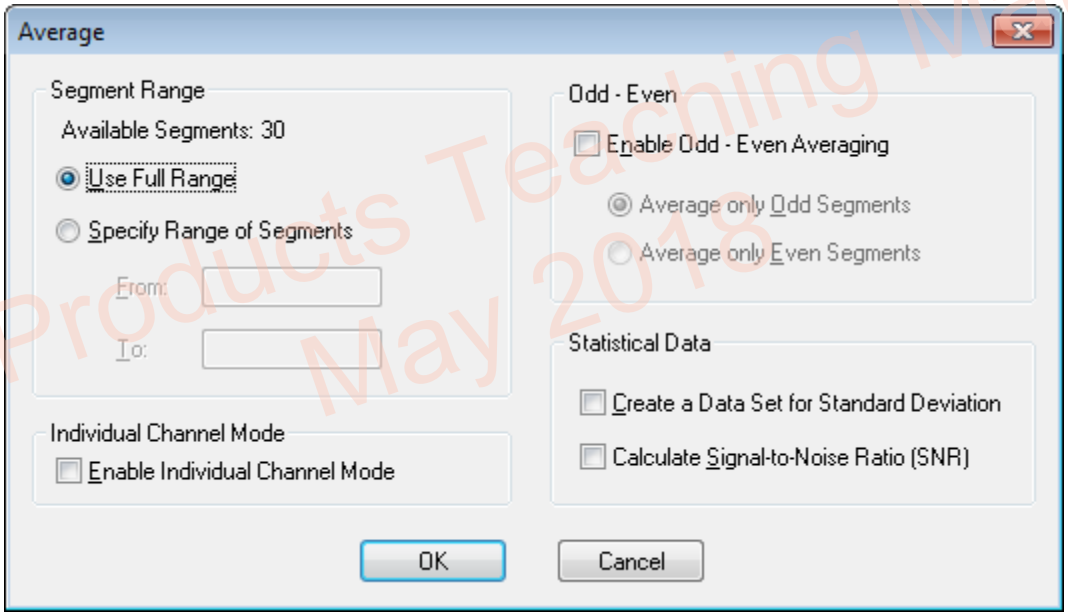
Average

- Use all or specify a range/subset of segments.
- Consider to calculate statistical data (e.g. standard deviation).



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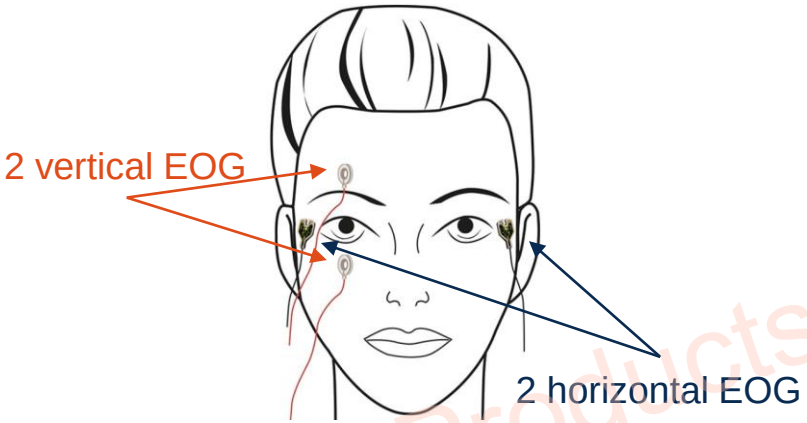
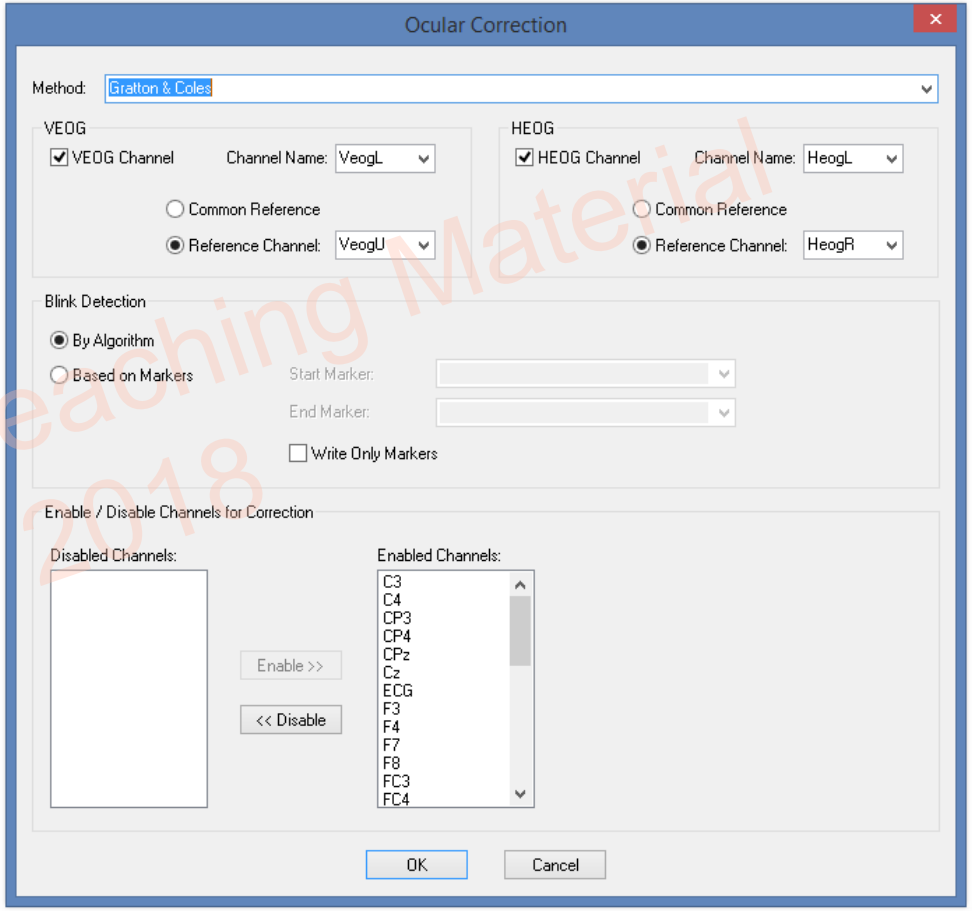
Ocular Correction

- Based on the linear regression algorithm by Gratton & Coles.
- Dedicated EOG channels recommended.





- Cave: Blinks should not be marked as Bad Intervals prior to Ocular Correction.
- Check the Operation Infos for reasonable number of detected blinks and distribution of regression coefficients.

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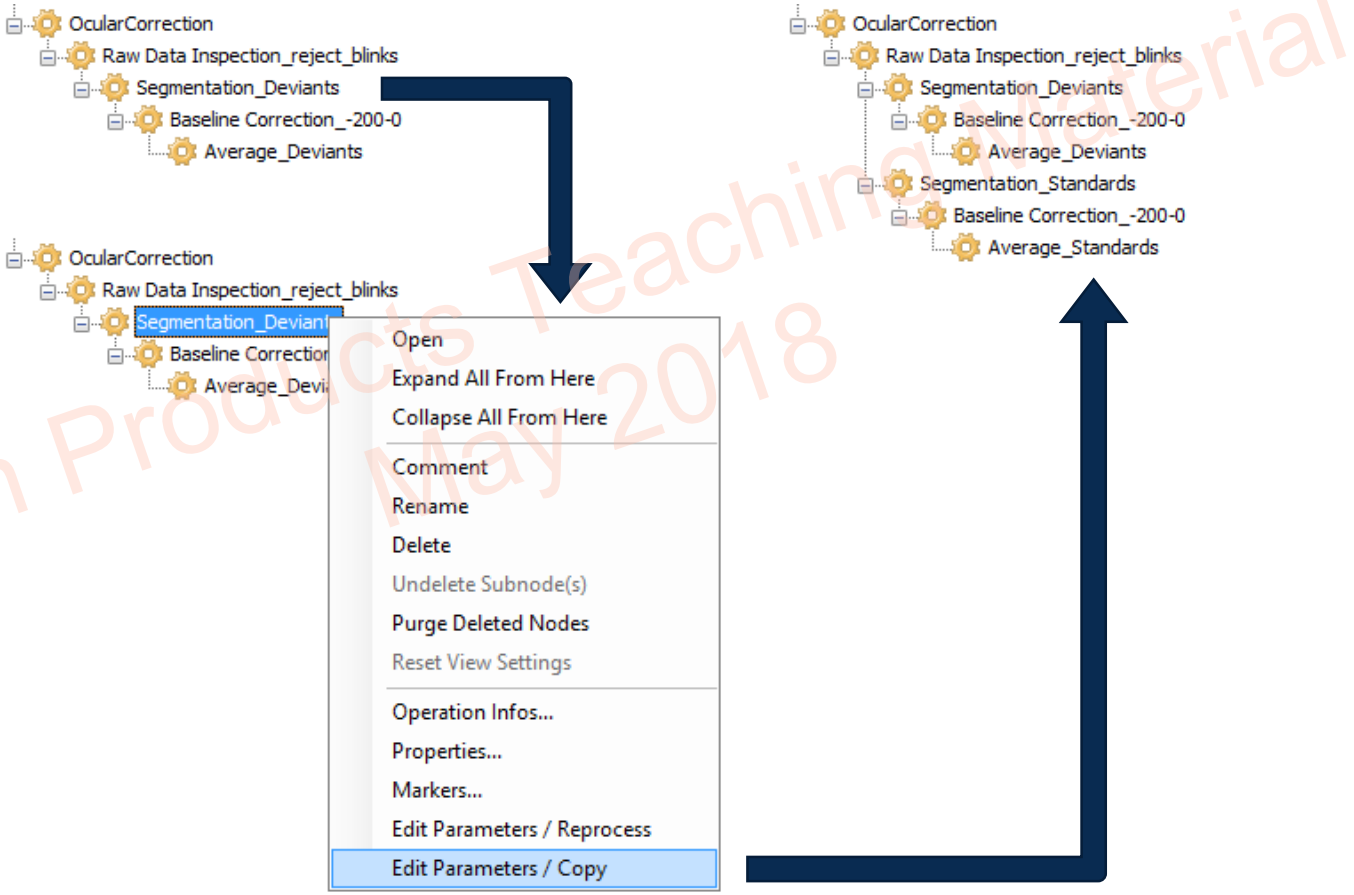
Ocular Correction

- Overlay the correct data with the uncorrected data from the previous node.
- Blinks and horizontal eye movements are attenuated.

Edit Parameters / Copy

- Create the segmentation of the second condition by using *Edit Parameters / Copy* from the right-click menu of the first condition‘s segmentation node.
- Adapt all necessary parameters, e.g. select a different reference marker.



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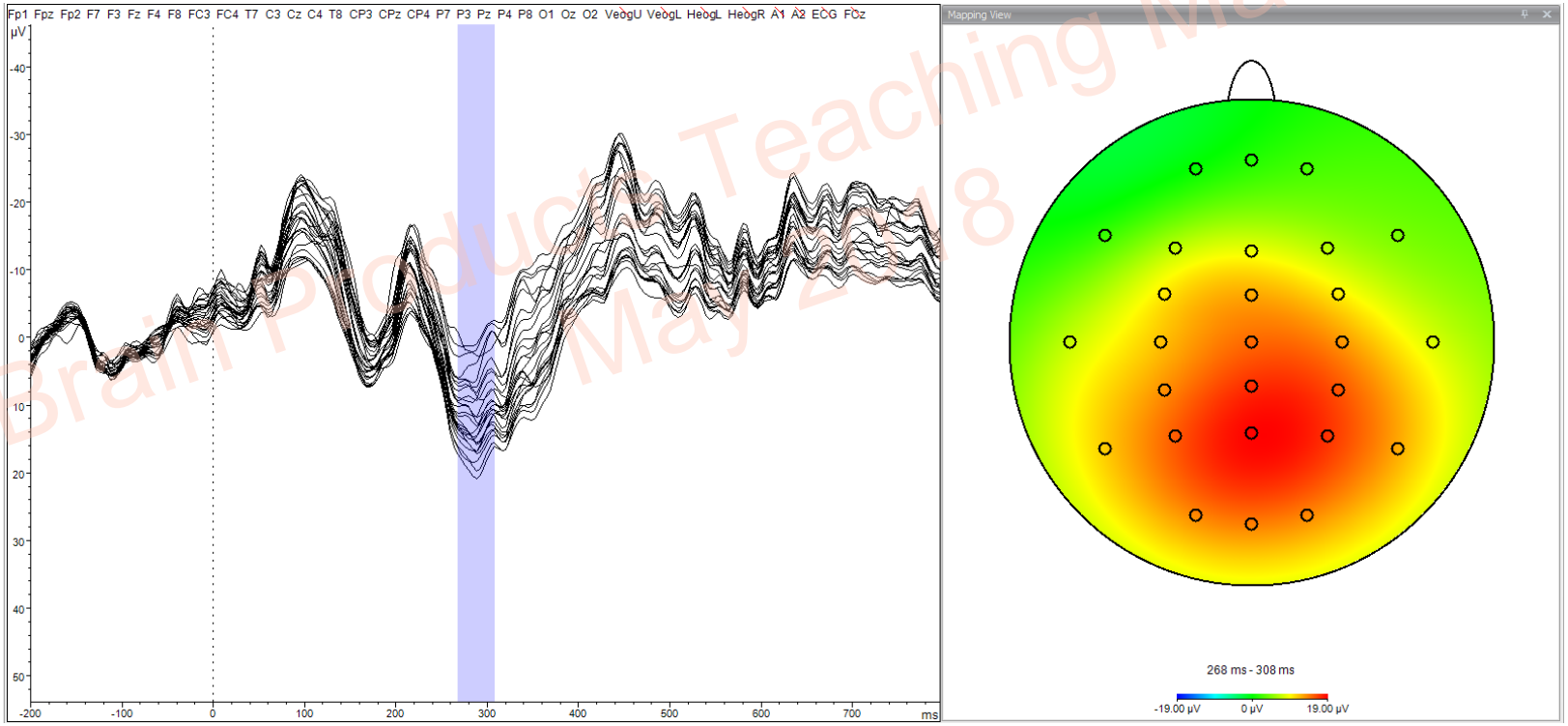
Butterfly Plot & Mapping View

- Inspect your resulting ERPs for latency, polarity and topography.
- Disable non-scalp channels for a better overview.
- Add a topographic map to display the distribution of potentials over the scalp.



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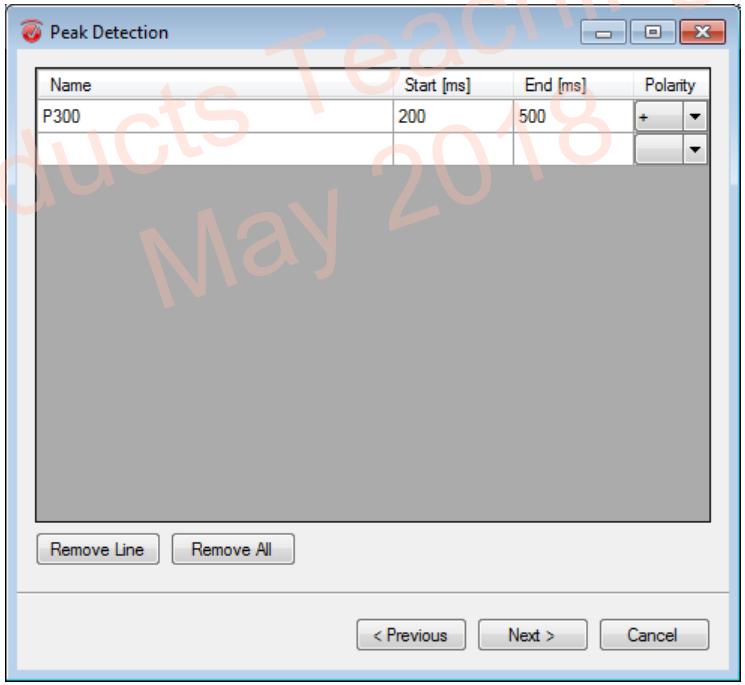
Peak Detection

- Automatically detect positive and/or negative peaks within a specified time range relative to the reference marker.
- Peak Markers will be added to each specified channel.
- Peaks can be calculated for each channel individually or globally with respect to a reference channel.



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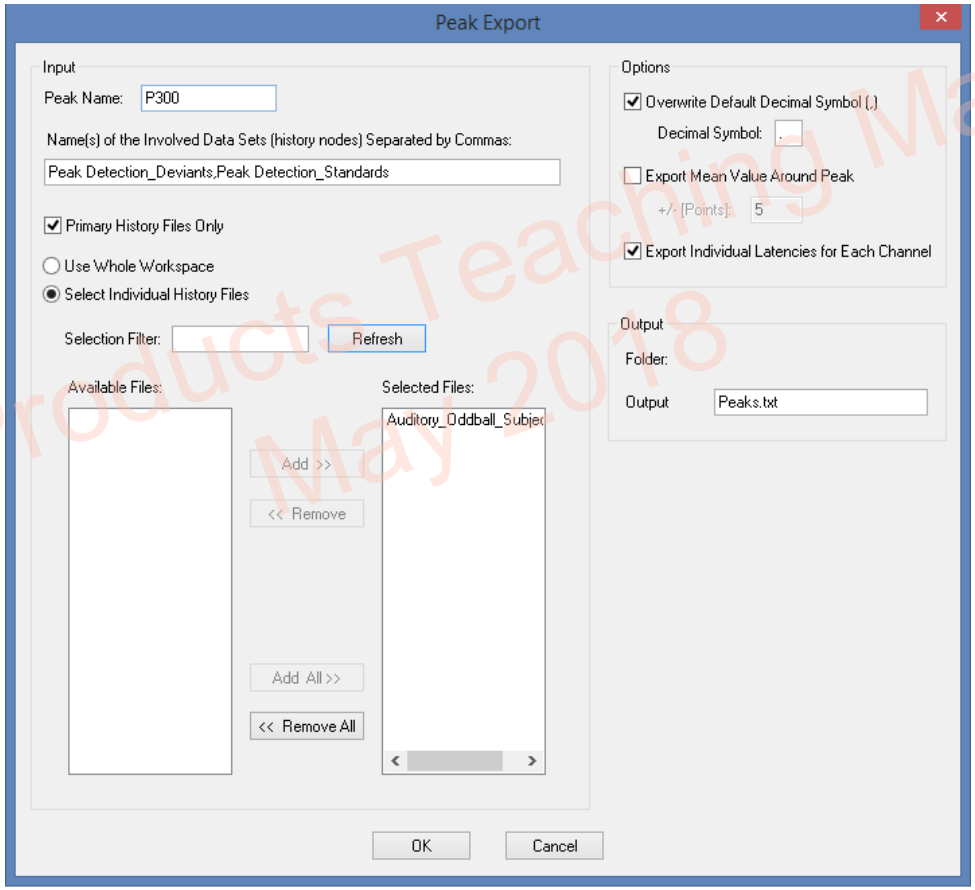
Peak Information Export

- Export peak latency and amplitude for further (statistical) analysis outside of Analyzer.
- More information: http://pressrelease.brainproducts.com/analyzer-export/



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Interim summary – Basic topics

- The filter settings should be selected according to the goals of the analysis. The data quality may also influence the filter settings.
- Portions of data containing artifacts should be marked as bad. These intervals will be ignored/rejected in subsequent processing steps.
- Check how many trials are lost after preprocessing.
- Consider applying a correction for EOG artifacts.
- Always visually inspect all individual datasets and outputs.
- Inspect your resulting ERPs for latency, polarity and topography.
- Export peak information to finalize your analysis.

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ERP Analysis – extended

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The Cross-Modal Semantic Priming paradigm

auditory prime
environmental sound

visual target
picture of an object

response
Does the object in the picture fit into a box?

CONGRUENT PAIR
sound and picture match

INCONGRUENT PAIR
sound and picture do not match

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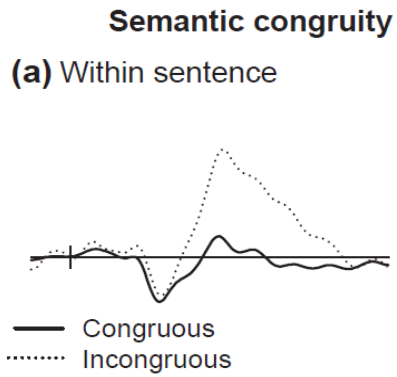
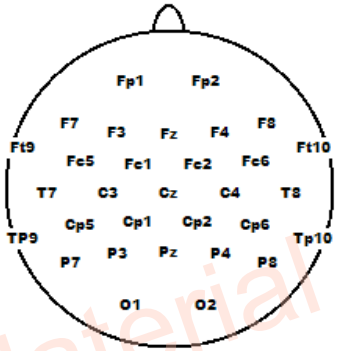
- The processing of congruent trials should be facilitated, e.g. higher accuracy or faster reaction times.
- The N400 to incongruent pairs should be larger than to congruent ones.

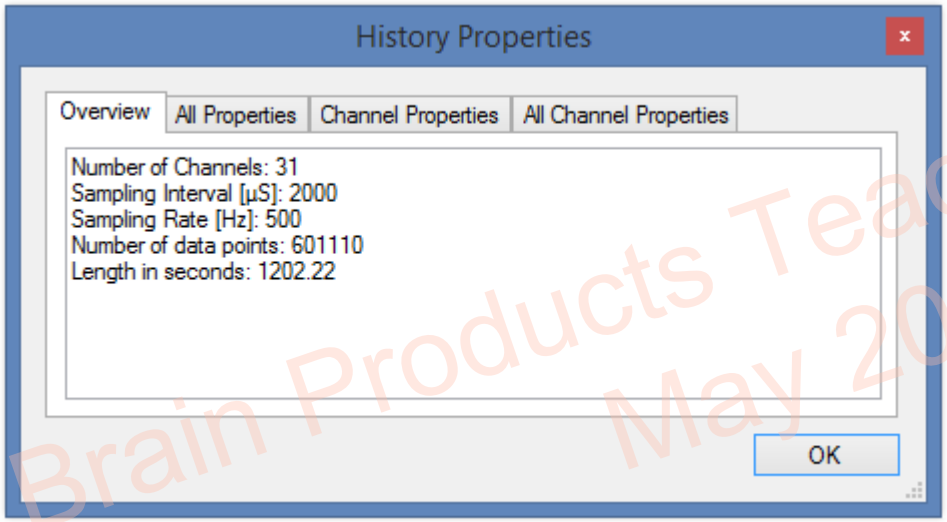


adapted from Kutas & Federmeier, 2000

Recording information

- Number of channels: 31
- Sampling rate: 500 Hz
- Recording length: ~20 min (1202.22 s)





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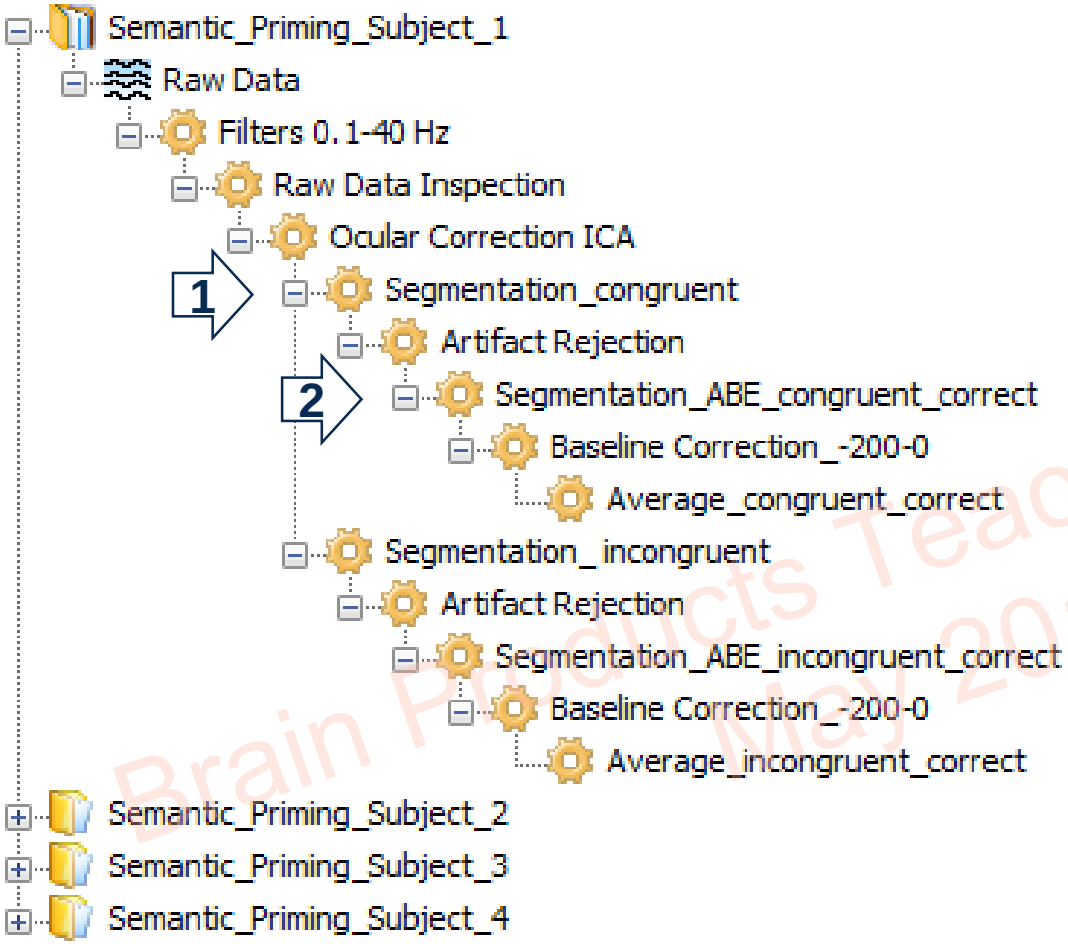
- Additional Information:
  - Recording reference: nose
  - Number of trials: 2 blocks of 80 (50% congruent, 50% incongruent)

Processing tree for semantic priming



- Common preprocessing similar to Oddball.
- Ocular Correction ICA due to missing EOG channels.
- Two conditions
  - congruent
  - incongruent
- Two-step segmentation
  1. global: all (in)congruent trials
  2. specific: only correct trials

↓

Advanced Boolean Expressions

For more information, please check our tutorial on Ocular Correction ICA:
http://www.brainproducts.com/files/public/products/brochures_material/pr_articles/1304_OC-ICA.pdf

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Advanced Boolean Expression (ABE)

Operators	Description	Examples
FIRST/ LAST	Selects the first/last matching marker	FIRST(Response, R51, 1000, 2000)
CURR	Selects the reference marker if it matches the specifications	CURR(Stimulus, S30)
STEP	Selects from the list of matching markers the one at the specified position	STEP(1,*,*,1000,*).$Description="R 57"
AND/ OR/ NOT	Allows combinations of the above	FIRST(Response, R51,1000, 2000) OR FIRST(Response, R57,1000, 2000)

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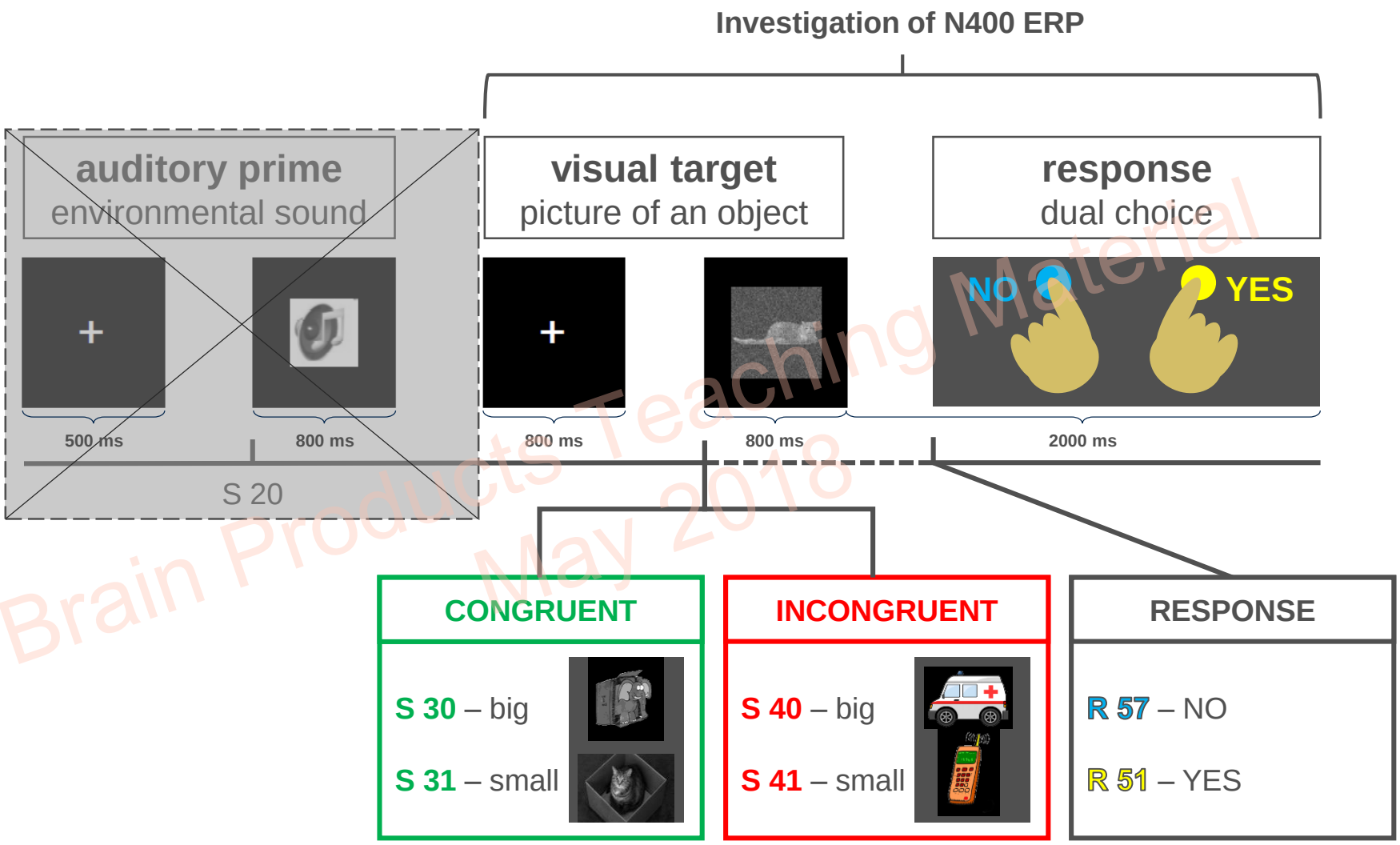
For more information, please see:

Analyzer User Manual, Appendix J, *Segmentation using advanced Boolean expressions*

http://www.brainproducts.com/files/public/products/brochures_material/pr_articles/1002_Supporttip_RC.pdf

http://www.brainproducts.com/files/public/products/brochures_material/pr_articles/1204_SupportTip_AdvBooleanExp.pdf

Experimental design and markers



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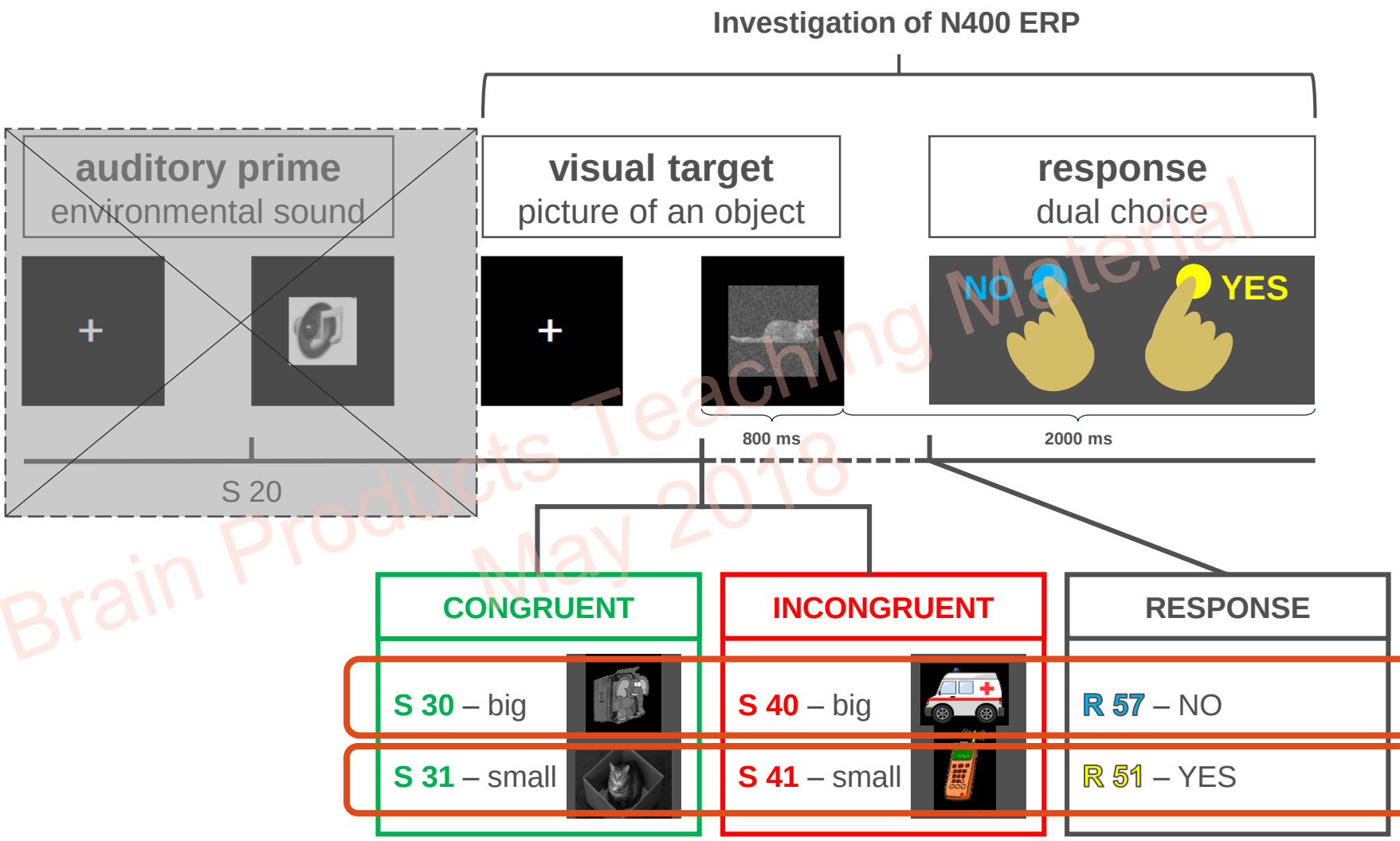
ABE: Extraction of Trials of Interest



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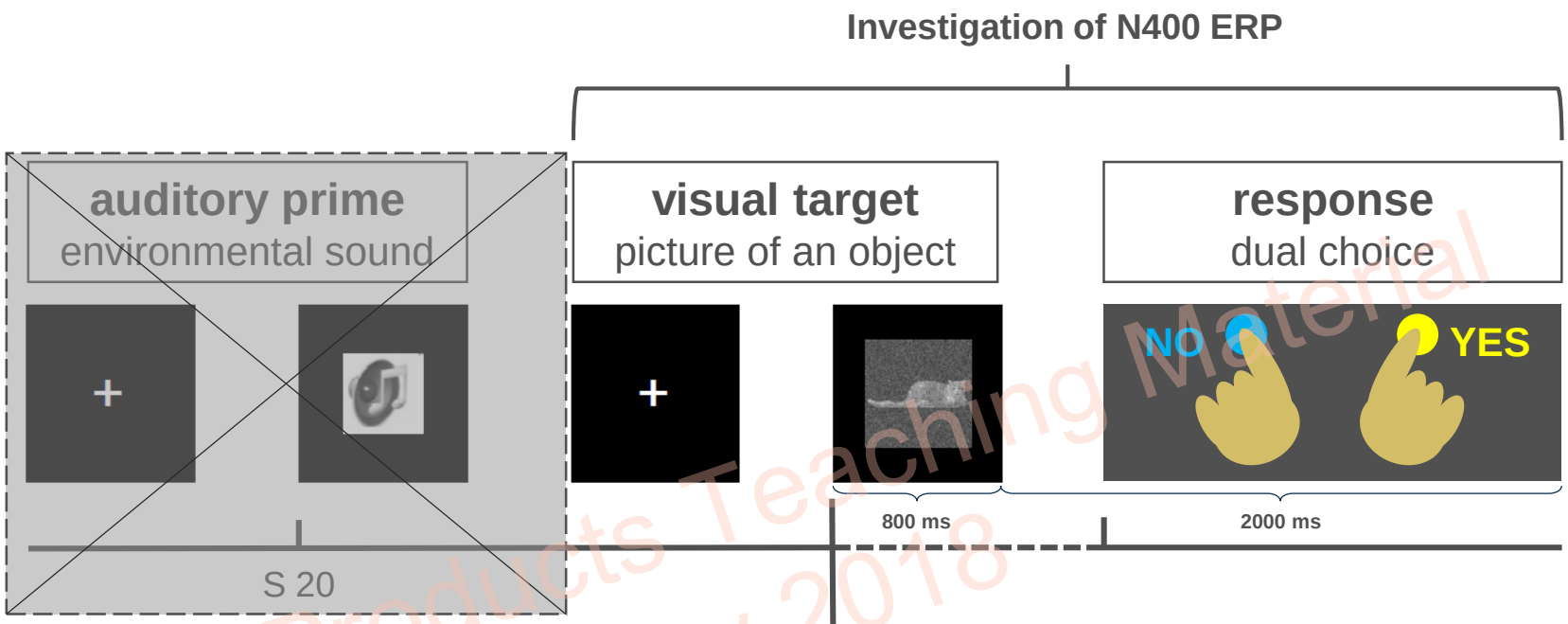
ABE: Extraction of Trials of Interest



- Reference Marker:
  - S30 and S31

CONGRUENT

S 30 – big

S 31 – small

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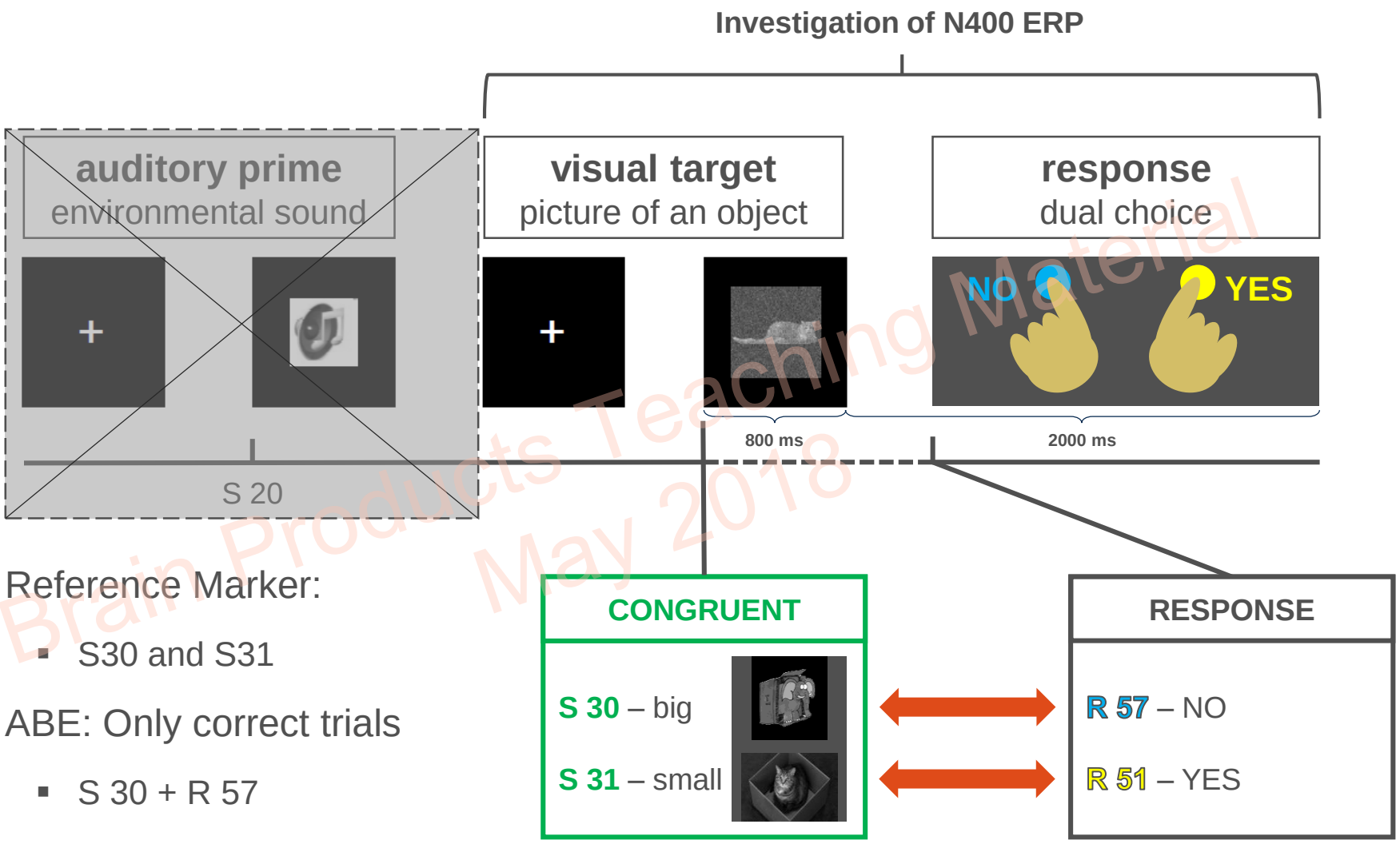
ABE: Extraction of Trials of Interest



- Reference Marker:
  - S30 and S31
- ABE: Only correct trials
  - S 30 + R 57
  - S 31 + R 51

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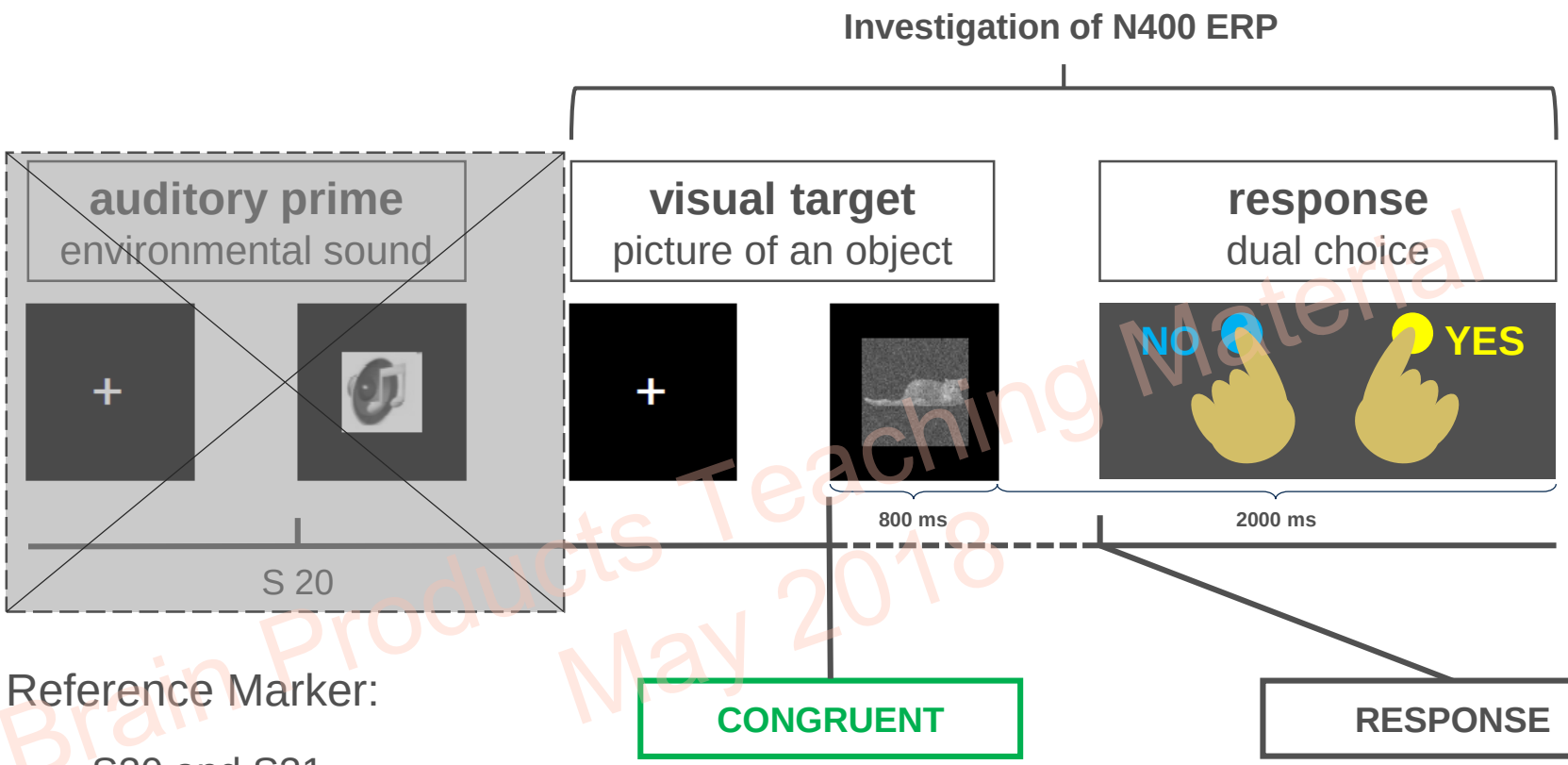
ABE: Extraction of Trials of Interest



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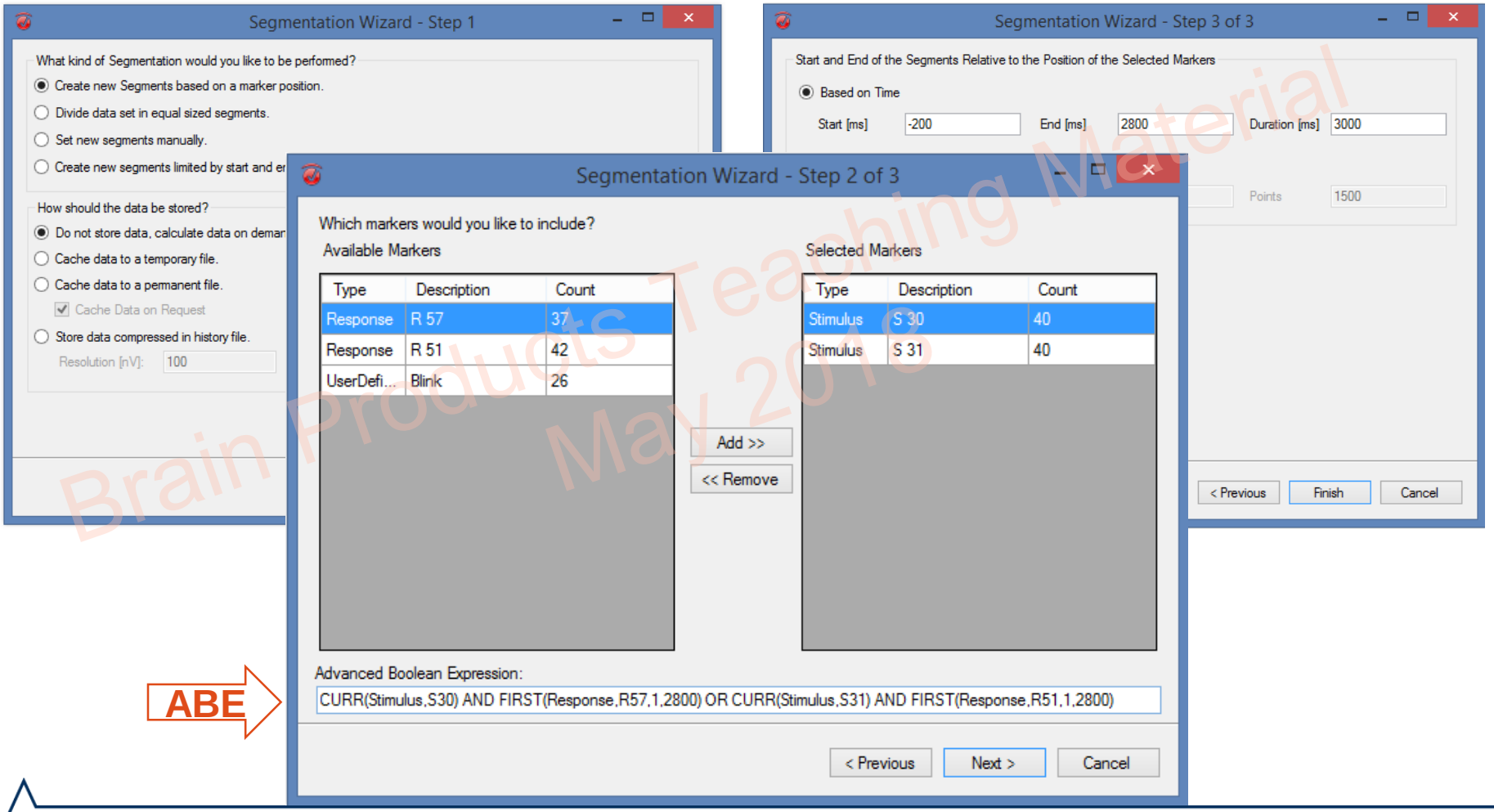
- Reference Marker:
  - S30 and S31
- ABE: Only correct trials
  - S 30 + R 57 **CURR**(Stimulus, S30) **AND** **FIRST**(Response, R57,1, 2800) **OR**
  - S 31 + R 51 **CURR**(Stimulus, S31) **AND** **FIRST**(Response, R51,1, 2800)

Segmentation with ABE

- Enter the ABE that should constrain your reference marker selection in the respective field.



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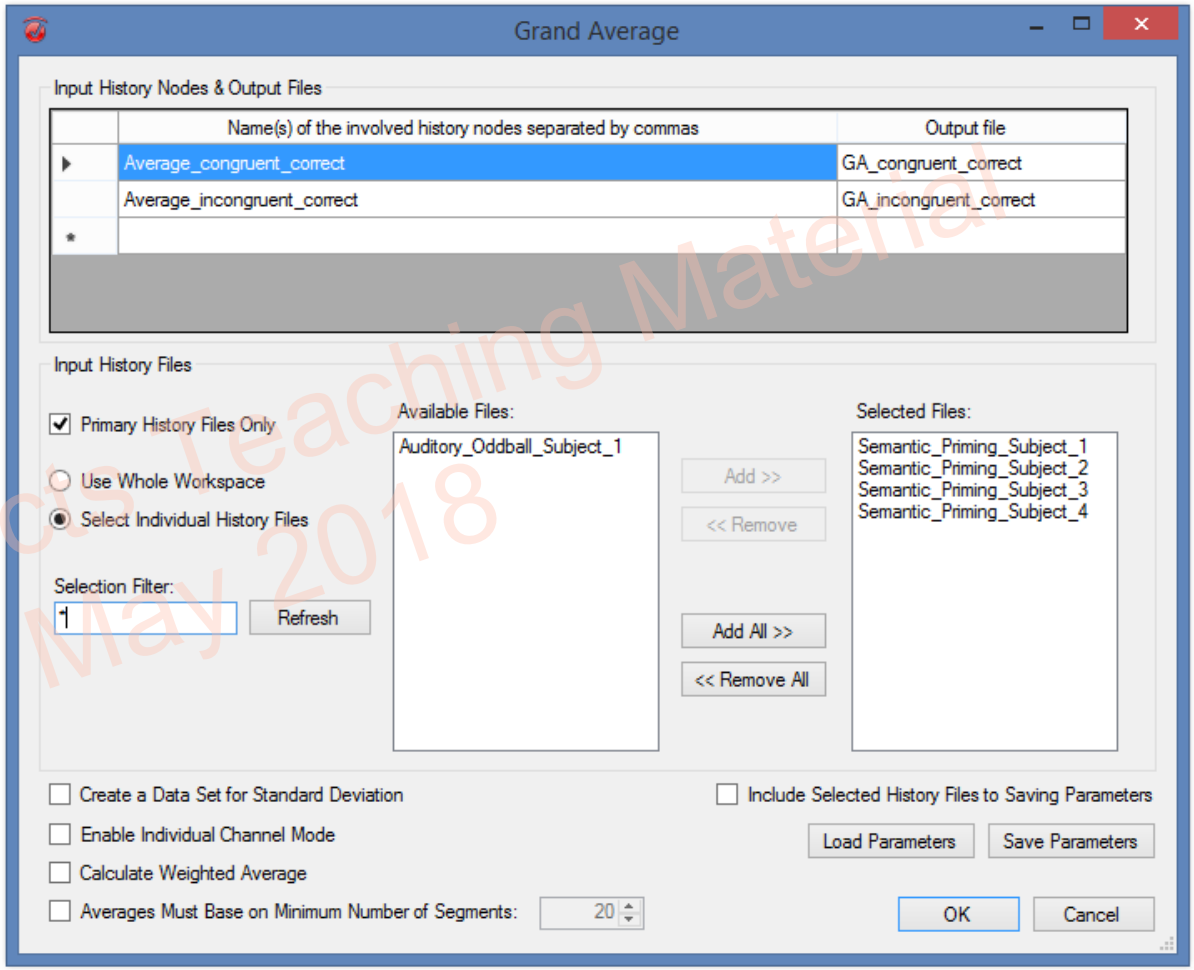
Grand Average

- Specify the names of the nodes containing the single subject averages.
- More than one average node can contribute to a Grand Average, the data will be collapsed.
- Make sure the nodes are named identically in all subjects.



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Interim summary – Extended topics

- Take care of your markers when you prepare your experiment.
  - Markers that should later differentiate between conditions need to be named appropriately.
  - Do not code too few markers but avoid coding unnecessary ones.

- Advanced Boolean Expressions (ABEs) can handle conditional segmentations, e.g. only segment the correct trials.
  - Check for the right syntax and operators.
  - Check for the correct search time windows.

- Use Grand Average to create your mean ERPs across single subjects.
  - Use identical node names across and unique node names within subjects.
  - Single subject averages should have the same properties when you apply Grand Average to them.

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Q & A Session

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Concluding Remarks

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Goals of this webinar

Goals

- An introduction to the transformations in BrainVision Analyzer 2 that are commonly used in ERP analyses
- Showcase two classical cognitive paradigms in an analysis demonstration

Learning Outcomes

- What tools are available to analyse your ERP data
- How to generate the exports needed for statistical analysis

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Further reading – Brain Products materials

- Analyzer User Manual
  - available in Analyzer via Help tab
  - http://www.brainproducts.com/downloads.php?kid=5&tab=2#dlukat_52

- Press release articles and support tips
  - http://www.brainproducts.com/downloads.php?kid=21&tab=1
    - Markers
    - Exports
    - Ocular Correction ICA
    - Advanced Boolean Expressions
    - …and many more…

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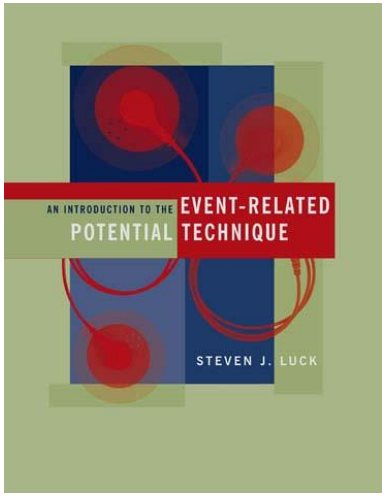
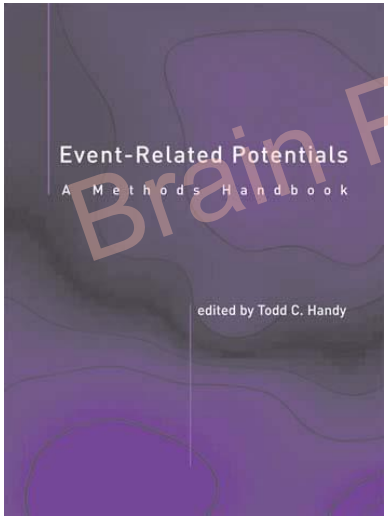
Further reading – Text books



Luck, S. J. (2014). *An introduction to the event-related potential technique.* MIT Press.



Handy, T. C. (2005). *Event-related potentials : a methods handbook*. MIT Press.

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Further reading – Guideline articles

Psychophysiology, *37* (2000), 127–152. Cambridge University Press. Printed in the USA.
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COMMITTEE REPORT

Guidelines for using human event-related potentials to study cognition: Recording standards and publication criteria

Picton et al. (2000), Psychophysiology
https://doi.org/10.1111/1469-8986.3720127

Clinical Neurophysiology 120 (2009) 1883–1908

Contents lists available at ScienceDirect

Clinical Neurophysiology

journal homepage: www.elsevier.com/locate/clinph

Guidelines

Event-related potentials in clinical research: Guidelines for eliciting, recording, and quantifying mismatch negativity, P300, and N400 ☆

Duncan et al. (2009), Clinical Neurophysiology
https://doi.org/10.1016/j.clinph.2009.07.045

Psychophysiology, •• (2013), ••–••. Wiley Periodicals, Inc. Printed in the USA.
Copyright © 2013 Society for Psychophysiological Research
DOI: 10.1111/psyp.12147

Committee report: Publication guidelines and recommendations for studies using electroencephalography and magnetoencephalography

Keil et al. (2013), Psychophysiology
https://doi.org/10.1111/psyp.12147

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The End

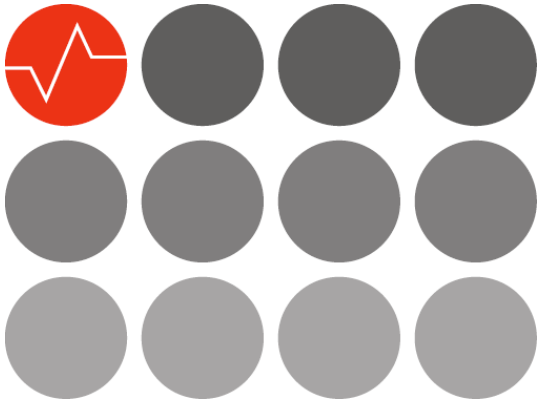
Thank you for your participation and attention.

You will receive a follow-up email with a link to the PDF slides and a video recording of the webinar.

A survey is available directly after the webinar and also via a link in the follow-up email.

We would appreciate if you have a few minutes to complete our survey.

If you have any questions about the content of this webinar or other topics around Analyzer, please contact us: **support@brainproducts.com**



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