Probability to Detect an N2pc ERP Component in Individual EEG Datasets

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Abstract Submission

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Introduction:

The N2pc event-related potential (ERP) is key to understand when and how human visuo-spatial attention is allocated to target objects. Its amplitude usually amounts to less than 2 μV (Eimer and Kiss, 2007; Kiss, Van Velzen and Eimer, 2008; Woodman, Arita and Luck, 2009). Unless one uses exact replications of standard search designs showing clear N2pcs, the design of novel variants is delicate, because not finding an N2pc may be due to a flaw in the design itself or to an unfortunate choice of the subjects recruited. After all, it is well-established that subject's efficiency in attention deployment to targets is characterized by high inter-individual variability (Feldmann-Wüstefeld et al., 2017).
Under these circumstances, an analytical solution to establish - a priori - the minimum number of trials necessary to probe the individual predisposition to show an N2pc would be welcome.
In this work, we investigated N2/N2pc data in the frequency domain with the aim of identifying indices of the presence of an N2pc response.

Methods:

Nineteen participants performed a standard visual search task whilst recording their EEG at a sampling frequency of 500 Hz. Data were standardly preprocessed by applying filtering (0.1-30 Hz), segmentation into sweeps (from -600 to 1000 ms time locked to the visual array onset) and ocular artifacts removal. Analyses were focused on electrodes P7 and P8. Four subjects, having less than 25 sweeps per condition, were discarded.
N2pc was computed for each participant by subtracting the ipsilateral (IL) from the contralateral (CL) activity. Subsequently, the spectrogram of the N2pc and of the related CL and IL activities was computed on the entire time span of the ERP. The absolute power of the α/β/δ/θ frequency bands was computed in the N2 time range only (210-310 ms). Powers at each band were correlated with the N2pc mean amplitude while varying the number of averaged sweeps and their position inside the total recording (either at the beginning, in the middle or at the end).

Results:

When averaging at least 40 sweeps (20 per target side) for each subject (mean±std = 92±43 for IL data, 93±41 for CL) the amplitude of N2pc was significantly correlated with powers in each frequency band and this pattern of correlations was also independent on the temporal stint of the acquisition. Using only 20 or 10 sweeps, the correlation between N2pc and powers was reduced or abated in α and β bands only (Table 1).
The results are also suggestive of the presence of a distinguishable threshold based on the δ and θ power that could be used to discriminate the presence of an N2pc response. Higher power values were indeed obtained for participants showing high amplitude N2pcs, while a power of about 0 μV^2/Hz was obtained for participants showing little to no N2pc, even when averaging all the available sweeps (Fig. 1). This pattern of results was also observed distinctive when CL and IL activities were directly compared. α and δ powers of CL & IL average signals resulted comparable when the amplitude of the N2pc was little to nil, while they differed substantially when high-amplitude N2pcs were observed (Fig. 1).

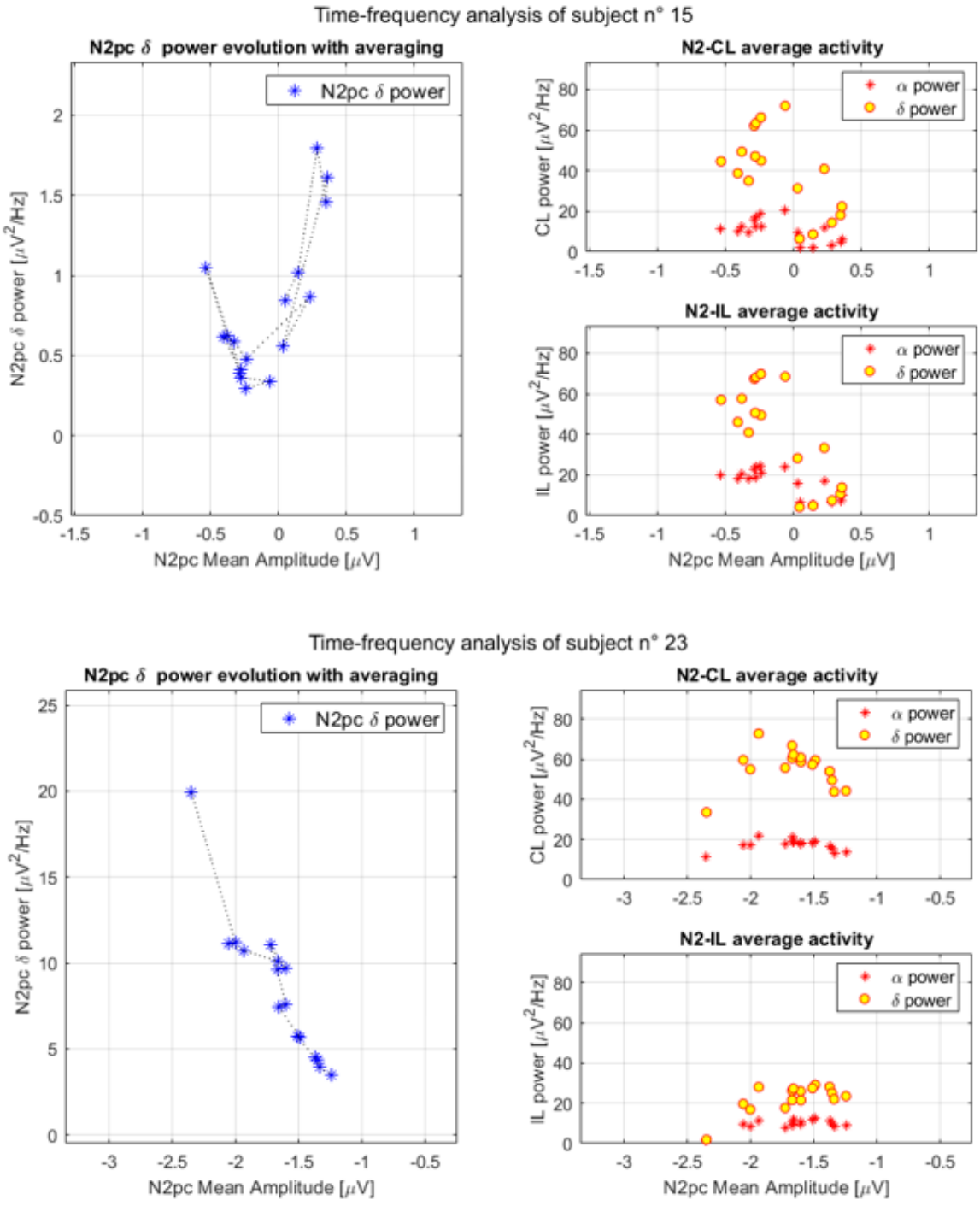
PEARSON CORRELATION COEFFICIENT, PCC

	Total n° of sweeps and position in the recording							
f-band	All	First 40	First 20	First 10	Central 40	Central 20	Final 40	Final 20
α	-0.92	-0.90	-0.61	-0.58	-0.75	-0.82	-0.94	-0.81
β	-0.80	-0.78	0.34	0.42	-0.68	-0.59	-0.54	-0.05
δ	-0.95	-0.94	-0.91	-0.92	-0.81	-0.87	-0.95	-0.92
θ	-0.94	-0.93	-0.85	-0.88	-0.79	-0.86	-0.95	-0.91

·Table 1. Correlation between power in each frequency band and N2pc mean amplitude.

Conclusions:

Results of this preliminary investigation seem to highlight that time-frequency domain indices, particularly the δ and θ power in the N2 time range, might be key features to be fed into a classifier able to discriminate whether a specific participant will show or not a stable N2pc by using only the first 40 sweeps. These results open up new interesting scenarios, whereby piloting of novel search variants could be performed on participants with a predisposition to show an N2pc, thus reducing time and costs. Other interesting applications could be in studies investigating the factors responsible of N2pc variability across participants and conditions, or to classify participants in different groups, e.g., depending on efficiency in attention deployment, directly during the experiment, thus reducing the variability of the sample.



·Figure 1. N2/N2pc time-frequency analysis of two representative subjects of the dataset.

Modeling and Analysis Methods:

EEG/MEG Modeling and Analysis [1]
Methods Development

Perception, Attention and Motor Behavior:

Attention: Visual [2]

Keywords:

Data analysis
Electroencephaolography (EEG)
Other - Time-Frequency Analysis, N2pc, Event-Related Potentials

[1|2]Indicates the priority used for review

My abstract is being submitted as a Software Demonstration.

No

Please indicate below if your study was a "resting state" or "task-activation" study.

Task-activation

Healthy subjects only or patients (note that patient studies may also involve healthy subjects):

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Was any human subjects research approved by the relevant Institutional Review Board or ethics panel? NOTE: Any human subjects studies without IRB approval will be automatically rejected.

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Not applicable

Please indicate which methods were used in your research:

EEG/ERP

Provide references using author date format

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