NEURAL CORRELATES OF VIGILANCE TASKS: A SINGLE SWEEP ERP ANALYSIS IN NORMAL PERFORMANCE

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INTRODUCTION

➔Vigilance tasks are defined as tasks in which rarely and unpredictably occurring targets have to be discriminated from frequently and predictably occurring non-targets (Koegela et al., 1992).

➔Typically, detection of low frequency presentation of targets demands vigilance resources.

➔Parasuraman (1985) observed a N100 component in reaction to targets and a P300 related to non-targets.

➔Coull et al. (1991) revealed a right lateralized vigilance network that includes frontal and superior parietal regions.

➔When people concurrently perform two tasks that both require a choice of response, the time taken to complete one or both tasks is typically longer than it is when the same tasks is performed alone (Welford, 1980).

A common experimental dual-task paradigm involves two stimuli in rapid succession that both require an independent speeded response (Pashler, 1993).

➔P300 seems to provide an index of allocation of cognitive processing resources in complex or multiple component tasks (Nash & Fernandez, 1996). Specifically, in a dual-task P300 is diminished for the second task when it is preceded by a stimulus that itself elicits P300.

AIMS

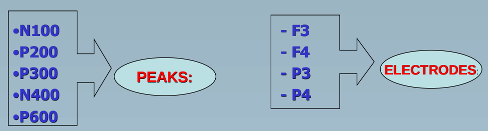
➔ The aim of the present study is to examine the neural activity associated with the performance of vigilance tasks varying in the frequency of target presentation, while performing an ongoing task (vigilance dual task).

ELECTROPHYSIOLOGICAL RECORDING

•Subjects wore an Electrocap of 19 tin electrodes located according to the International System 10-20 (Jaspers,1958).

•Signals were amplified with a Neuroscan Syn Amp: gain of 500 and filter= 0.05 and 100.00 Hz.

•ERPs analysis epochs: interval activity of 100 ms of pre-stimulus and 800 ms post-stimulus & baseline = 100 ms of pre-stimulus activity.



METHODS

a. PARTICIPANTS

Fifty four subjects participated to a cognitive experiment of 488 stimuli. They were divided as follows:

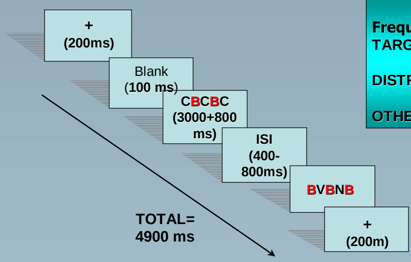
b. PROCEDURE

Subjects performed a vigilance dual-task:

Ongoing task : they had to press one of two keys, according to the identity or difference of the second and fourth letters (DFDFD OR DFDGD)

Vigilancedual task: they had to press the space bar when target "B" appeared in the second and/or fourth positon (SBSBS or SBSDS).

⬥Subjects were assigned to three frequency conditions, based on the target presentation.



Frequency	LOW	MEDIUM	HIGH
TARGET *B*:	16	112	224
DISTRACTORS *B*:	144	144	144
OTHER STIMULI:	328	232	120

RESULTS

ELECTROPHSIOLOGICAL ANALYSIS

•Peaks and latencies

For all the sites ERPs components were defined as maximal negative o positive peaks: N1 (70-120 ms), P2 (150-250 ms), P3 (250-350 ms), N4 (350-450 ms), P6 (550-800).

•Amplitudes on time-windows of 100 ms.

•The statistical analyses showed significant differences in sites' activations and peaks' latencies but not through frequency conditions. The only difference was in the posterior parietal right site **P4** ($F_{(2,15)}$= 4,120; p= .037), which shows a positive amplitude in a tardive interval (P600) in the medium condition. Bonferroni post-hoc *t* -test revealed a difference between the low and the medium conditions.

BEHAVIORAL DATA

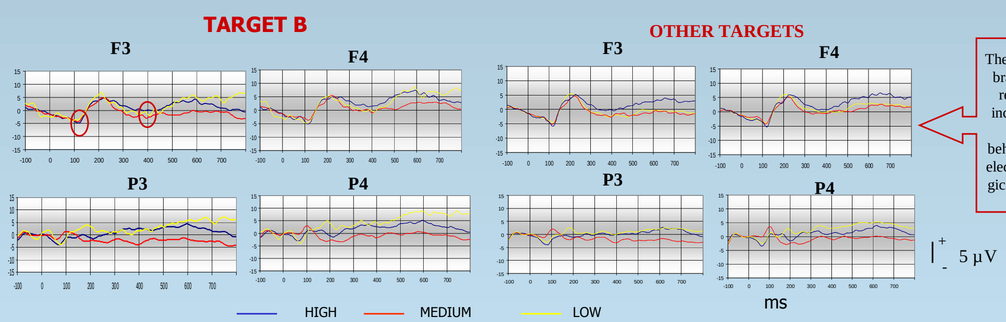
•Response time in the high, medium and low frequency conditions were compared in a two-way analysis design.

• A repeated measures ANOVA was conducted, with one between-groups factor (FREQUENCY: low, medium and high) and ONE within-groups factor (TARGET:B/noB).

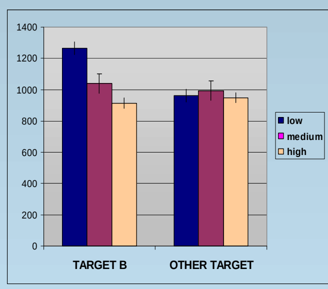
•Main effect of frequency ($F_{(2,51)}$ =3,554; p= .036) ⟶ LOW > HIGH

•Main effect of B target ($F_{(2,51)}$ =21,313; p= .000)

•Interaction frequency/target ($F_{(2,51)}$ =20,267; p= .000)

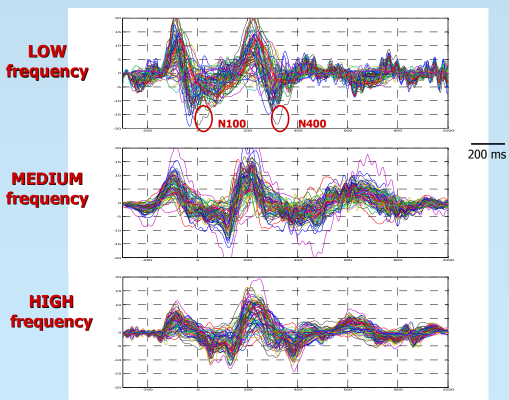


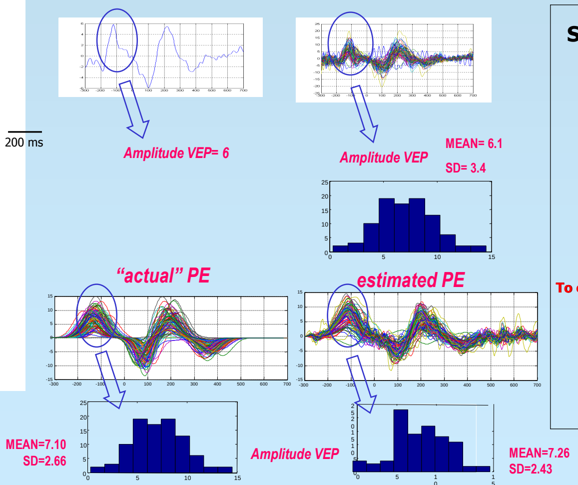
The analyses of brain activity relieved an incongruence between behavioral and electrophysiological measures



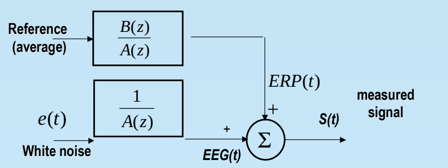
Since the standard conventional averaging (CA) technique for the measurement of ERPs will not be sufficient to the scope, a new algorithms and software (allowing the measurement of ERP also for a low number of sweeps) have been developed:

TARGET B e.g. F3 analyzed by ARX model

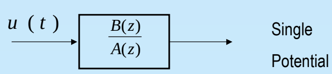




SINGLE SWEEP ESTIMATION BASED ON ARX MODEL (Cerutti et al, 1998)



To each ERP there are specific parameters of the model associated to, estimated through an identification process.



CONCLUSIONS

➔Behavioral data reflect the vigilance performance observed in literature (Pasheler, 1993).

➔The traditional averaging reveals a significant activation of the right posterior parietal site, which might reflect Posner & Petersen's Attentional Posterior System network (1990).

➔The application of the ARX mathematical model to cognitive ERPs analysis will allow the detection of N100 and N400 components.

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