Presentation Effect on auditory event related potentials N1 latencies

D.Cugy[1,2]

1. EFSN CHU-Pellegrin, Place Amelie Raba Léon, 33076 Bordeaux cédex
2. Laboratoire d'Imagerie Moleculaire et Fonctionnelle ERT CNRS 5543, Université Victor Ségalen, Bordeaux, France

Courriers :

Dr Didier Cugy,
Laboratoire d'Imagerie Moleculaire et Fonctionnelle
ERT CNRS 5543, Université Victor Ségalen,
146 rue Léo Saignat
33076 Bordeaux cédex, France

e-mail :
didier.cugy@neuf.fr

Abstract :

We studied the potentials evoked in response to a tonal stimulation at the frequency of 125Hz and 1000Hz presented in a unilateral way at the level of the right ear and left ear according to three different paradigms: first consisting in using a random pseudo continuation maximum length (lm-Sequence) covering the duration of the presentation of the stimuli ; in the second the stimuli are presented in a sequential way (p-sequence) ; in the third they consist of a succession of blocks of 31 second composed of a continuation of the m-sequence type. In a synthetic way, it appears that the variation observed between the N1 wave for the stimuli with 125Hz and 1000Hz is maximum when the stimulus is presented at the level of the left ear in a sequential way (p-sequence) and is minimal when the presentation is carried out on the level of the left ear according to a maximum sequence (m-sequence). The variation measured in the N1 wave is of the same level (30-50 ms) when the stimulus is presented at the level of the right ear.

keywords

Auditive evoked potential

m-sequences

N1 Latency

p-sequences

Introduction :

The evoked potentials in response to stimulation tonal are characterized by a particular effect lateralization and variations of latency wave N1 in connection with the frequency of stimulation [1, 3].

However, the temporary differences observed are low thus limiting the value of this observation with regard to the overall duration of the phenomena observed and the inter-individual variability that may exist. The accentuation of these differences could help improve their discriminatory nature and can be lead to routine clinical applications.

The work above implement a paradigm characterized by a binaural associated with a random variable frequency stimuli. We are interested in the impact of experimental paradigm regarding the modalities of presentation evoked potentials in response to stimulation tone at a frequency of 125Hz and 1000Hz presented successively at the right ear and the left ear.

The stimuli are usually presented randomly in order to limit the effects of learning. We make the assumption that this is the minimization of self-correlation of the sequence of presentation of stimuli that can limit the effect of learning.

In the context of this hypothesis we chose to implement stimulus sequences determined by sequences maximum length of m-type sequences [2] and compare them with stimulation determined on a periodic basis (PSEQ). In practical terms, the stimuli are presented in three different paradigms: the first to use a suite of pseudo-random maximum length (lm-sequence or LMSEQ) covering the duration of the presentation of stimuli, in the second stimuli are presented sequentially (p-sequence or PSEQ), in the third they consist of a series of blocks with a duration of 31 seconds consist of a suite of m-type sequence or MSEQ.

Equipment and method:

a) Topics: 4 male subjects aged between 25 and 55 years, right, without hearing loss. The subjects were informed of experimental procedures and gave their consent prior to the completion of recordings. The experimental protocol was submitted to MPC Bordeaux and accepted.

b) Chain of stimulation: stimuli are synthesized by software through a micro-computer Apple iBook. The stimuli are made up of sinusoidal signals at a frequency of 125Hz (F125) and 1000Hz (F1000). A signal is transmitted in phase with the beginning of the stimulus through a box interface to the acquisition chain EEG. The calculation of m-sequence is done by software according to the algorithm Galois [6]. Each paradigm is controlled by calculating the autocorrelation (fig1). The stimuli are presented through transducers (neuroscan) at the hearing conducted right and left.

c) Characteristics of stimuli: The range of stimuli is adjusted to be presented with an intensity level 70dbSPL. The duration of the stimulus is to 400ms. The inter-stimulus interval is set to a period of 600ms. The stimuli are presented at a rate of 1 per second.

d) Acquisition and signal processing: The EEG signal is recuilli through 64 electrodes placed on the scalp using a helmet Easy-Cap (Easy-cap Germany). The signal is referenced in relation to the lobe of the left ear. The positioning of electrodes is measured using the system polemus (and saved). The digital signal is received through the acquisition chain Neuroscan on 64 lines at a frequency of 1000Hz. The data are then analyzed using software Edict of the company Neuroscan after filtering digital low pass 30Hz. The evoked potentials are calculated by averaging about 150 responses by type of stimulus. A baseline for a period of 200ms before the stimulus is used as a benchmark for evaluating the amplitude. The potentials are analyzed individually and

after super-averaging responses gathered for the four subjects. The discrepancy between the methods of presentation is calculated by inter-correlation. The error time on the super-averaging is estimated from the calculation of inter-correlation between the super-averaged signal and its various components.

Results:

The aspect and the amplitude of the different components of the response evoked is broadly in line with what was described to stimuli the same type. After averaging the super-N1 component is observed 170ms after the stimulus, the N2 component in a 270ms FZ.

Effect of the frequency of stimulation:

The culmination of the wave N1 is shorter stimulus for the F1000 (162 ms) compared to that of stimulus F125 (191 ms).

Effect of paradigm:

It is not highlighted significant differences depending on whether the stimuli are presented according to a paradigm type sequence or m-lm-type sequence. Thereafter comparisons will be made between the paradigms of m-type sequence and p-sequence.

In the case of a pseudo-random sequence of m-type sequence (Table 1), the culmination of the N1 wave is more brief stimulus for the F125 (150 ms) compared to the stimulus F1000 (176 ms) when the Stimulus is presented in the left ear. When the stimulus is presented in the right ear, latency wave N1 is shorter stimulus for the F1000 (164 ms) compared to that measured for the stimulus F125 (202 ms). In the case of a p-type sequence differences are found when the stimulus is presented to the left with a culmination of the wave N1 more brief signal for the F1000 (131 ms) than for the signal F125 (197 ms) .

Effect of the frequency of stimulation:

The culmination of the wave N1 is shorter stimulus for the F1000 (162 ms) compared to that of stimulus F125 (191 ms).

Effect of paradigm:

It is not highlighted significant differences depending on whether the stimuli are presented according to a paradigm type sequence or m-lm-type sequence. Thereafter comparisons will be made between the paradigms of m-type sequence and p-sequence.

In the case of a pseudo-random sequence of m-type sequence (Table 1), the culmination of the N1 wave is more brief stimulus for the F125 (150 ms) compared to the stimulus F1000 (176 ms) when the Stimulus is presented in the left ear. When the stimulus is presented in the right ear, latency wave N1 is shorter stimulus for the F1000 (164 ms) compared to that measured for the stimulus F125 (202 ms). In the case of a p-type sequence differences are found when the stimulus is presented to the left with a culmination of the wave N1 more brief signal for the F1000 (131 ms) than for the signal F125 (197 ms) .

Effect of lateralization:

The main differences are highlighted at the culmination of the N1 wave measured with deadlines for frequencies F1000 and F125 much greater when the stimulus is presented at the left ear (F1000: 131 ms, F125: 197 ms, 66 ms delta) over the right ear (F1000: 179 ms, F125: 218 ms, 40 ms delta).

It is found an effect in relation to the type of paradigm (lm-sequence, m-sequence, p-sequence), lateralization of the stimulus and frequency of stimulus.

The calculation of inter-correlation (tab.2.) Shows a maximization of the gap between the responses evoked when the stimulus is presented at the left ear of sequentially (-70 ms, r2 0.73) And is minimal when the presentation is made at the left ear in a sequence maximum (10 ms, r2 0.81). The difference in calculated responses is similar (-30 ms, -50 ms) when the stimulus is presented in the right ear.

Discussion:

The main observation of this work involves the discovery of a significant difference in the responses evoked (N1, cross-correlation) depending on the frequency of stimulus and in connection with the lateralization and the type of sequence used (m -séquence/p-séquence) fig.3

The observed difference between the latency of the wave N1 depending on the frequency (29 ms) without taking into account the type of presentation is similar to that made evident by Roberts & Poeppel [4] with stimuli presented at the right ear (30 ms).

The culmination times measured in terms of the lateralization at the presentation in a sequence of m-type sequence are more quickly when the presentation is done right over left. The gap is similar to that found by Salajegheh & al [5] (between 5 and 10ms). Similarly, the gap between the latencies in relation to stimuli F125 and F1000 is similar (25 ms).

Regarding the method of presentation, use a sequence of maximum length of m-type sequence present in a presentation Gaussian minimize the advantage and make independent phase of self-correlation in connection with the sequence stimulation on the other hand to be reproducible and can deduct the transfer function of the treatment being studied.

The joint use of these methods of presentation shows the interest of help maximize the differences between the responses observed in a controlled manner. The discrepancies observed up to a hundred milliseconds, which is relevant for other methods of study of responses including functional MRI.

In practical terms, the highlight significant differences in the responses evoked by type of paradigm m-séquence/p-séquence, suggests the use of such tests as objective indicator of processes involved in memory.

Bibliographie :

(1) Crottaz-Herbette S., RagotR. (2000). Perception of complex sounds : N1 latency codes pitch and topography codes spectra,. Clinical Neurophysiologyt 111 (2000) 1759-1766

(2) Golomb S.W. (1982). Shift Register Sequences. Aegean Park Press, Laguna Hills, CA.

(3) Ragot R., Lepaul-Ercole Renaud (1996). Brain potentials as objective indexes of auditory pitch extraction from harmonics, NeuroReport 7(4) ; 905-909.

(4) Roberts, T.P.L. and Poeppel, D (1996). Latency of auditory evoked M100 as a function of tone frequency. NeuroReport 7(6): 1138-1140.

(5) Salajegheh A, Link A, Elster C, Burghoff M, Sander TH, Trahms L, Poeppel D (2004) Systematic latency variation of the auditory evoked M100: from average to single-trial data. NeuroImage 23: 288-295

(6) William H., Saul A. Teulkolsky, Flannery B.P. Numerical Recipies in C. Cambridge University Press, 1992

TABLEAUX

Cz	Présentation oreille Gauche		Présentation oreille droite	
	F125N	F1000N	NF125	NF1000
MSEQ	150 ms	176 ms	202 ms	164 ms
PSEQ	197 ms	131 ms	214 ms	178 ms

Tableau 1 – effet de la fréquence de stimulation et de latéralisation sur la culmination de N1

	Délai (ms)	r^2
m-séquence F125N-F1000N	10	0,81
p-séquence F125N-F1000N	-70	0,73
m-séquence NF125-NF1000	-50	0,94
p-séquence NF125-NF1000	-30	0,85

Tableau 2 – décalage (en ms) et coefficient d'inter-corrélation calculés entre le premier et le second stimulus dans les modalités de présentations m-séquence p-séquence à gauche et à droite.

FIGURES

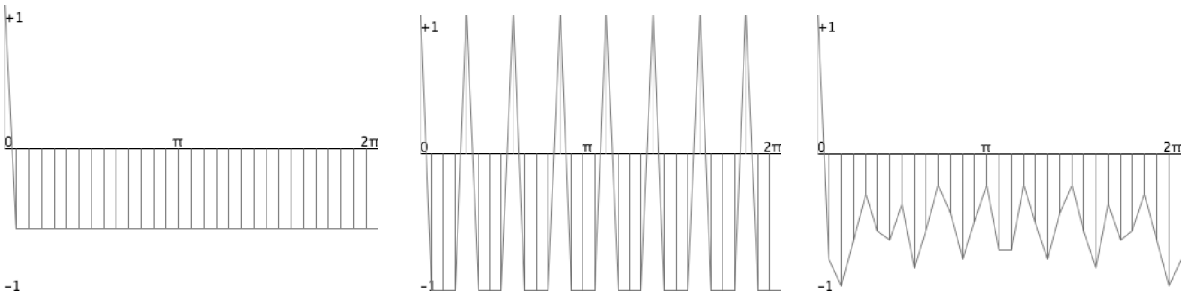

Figure 1 : De gauche à droite, graphe d'autocorrélation m-séquence, p-séquence, séquence aléatoire Gaussienne

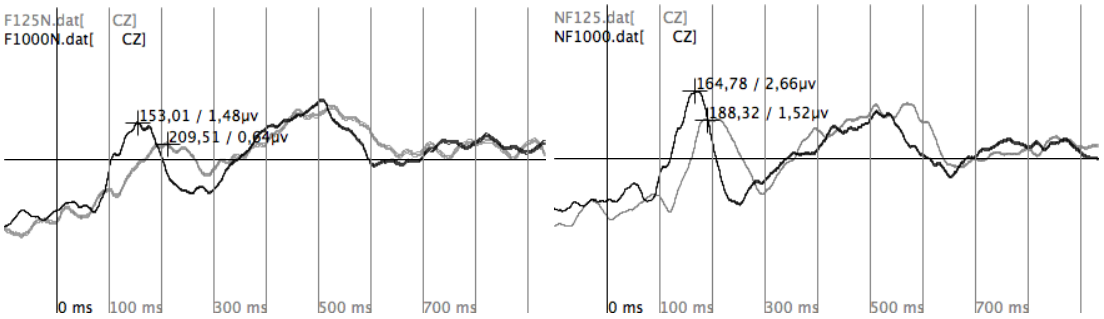

Figure 2 : potentiels évoqués en Cz supermoyennés selon la latéralisation et la fréquence de stimulation.

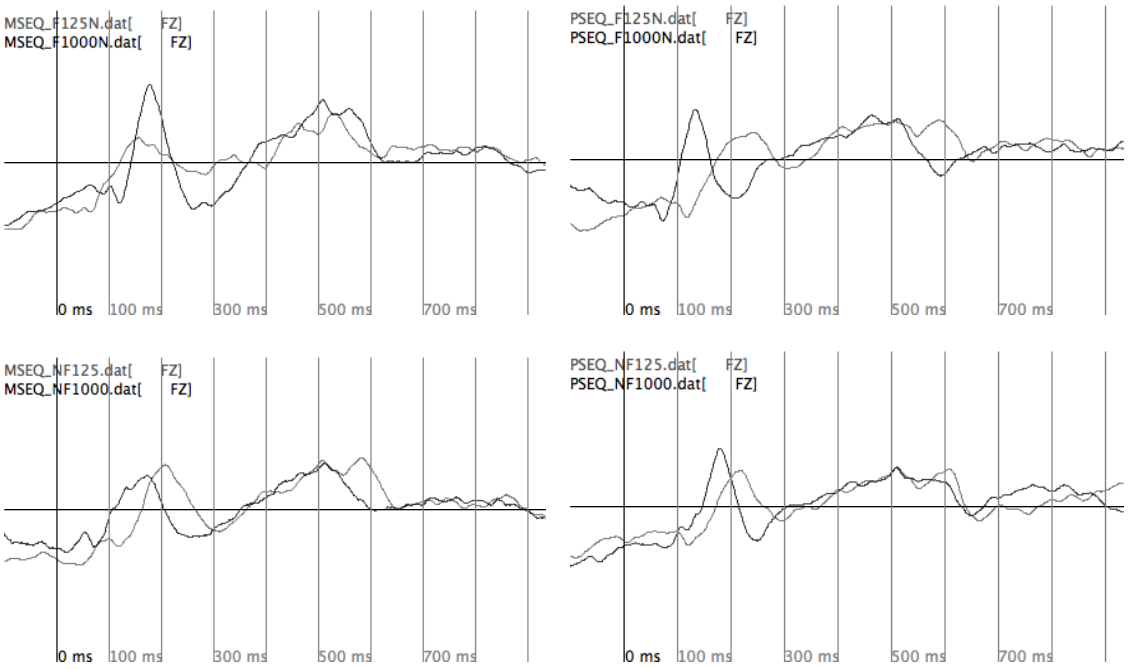

Figure 3 : potentiel évoqué en FZ selon le paradigme (MSEQ/PSEQ) et la latéralisation. F125N : 125Hz à gauche, F1000N : 1000Hz à gauche, NF125 : 125Hz à droite, NF1000 : 1000Hz à droite.