Auditory Event Related Potentials during Masking Experiments

Jacques Paty, Eugène Fernand Loubelo, Jean Berthomieu, Bernard Claverie

4th International Conference on Cognitive Neurosciences
I.C.O.N.IV - Dourdan (France) - June 14-19 - 1987

AUDITORY EVENT RELATED POTENTIALS DURING MASKING EXPERIMENTS

J. PATY, E. LOUBELLO, J. BERTHOMIEU, B.CLAVERIE

Groupe de Psychophysiologie Cognitive. Laboratoire de Médecine Expérimentale
- Université BORDEAUX II - 146,rue Léo-Saignat - 33076 BORDEAUX CEDEX (FRANCE).

The masking effect consists of a decrease in a sound perception - called "sonie" in psychophysics (7) during the simultaneous hearing of a second sound, of the same intensity at an adjacent near lower frequency.

Previously certain peripheral aspects of masking have been studied, at the cochlear or at the brain stem levels (1,4) which are often discussed in terms of characteristic frequency of auditory neuronal discharges, or in terms of "bicochlear interactions" (3). Therefore central mechanisms may be involved, as suggested by some authors. For example : there are certain behavioral changes under natural conditions, higher phonatory frequency in crowds, or definite hearing preferences during dichotic listening. We have studied the effects of partial proactive auditory masking in man on E.P. to differenciate between central and peripheric mechanisms which may be involved in masking, and to verify the peripheral input control processes. Moreover, topographic specificities must to be appreciated, because we have previously reported such changes as related to subjective disturbances by intense impulse noises (9).

An operational hypothesis may be assumed as follows: Homogenous deterioration of Evoked potentials may reflect a peripheral locus for action, or a global noisy disturbance at the brain level. A dissociation between homolateral and heterolateral masking, or selective changes of E.P., may reflect central antagonistic and/or compensatory reactions to the noise disturbance, with an increase of attentional processes.

METHOD

12 normal right-handed male volunteer (23 to 39 years old) non paid subjects with audiometrically normal audition were examined. Test stimuli (burst tones of 72 dB S.P.L., 44 ms duration) at 1,5 to 3 s I.S.I, were randomly delivered to each ear. After habituation and control, a continuous masking noise was presented to the left or the right ear in blocks of 3 minutes at the same 72 dB. The Subjects were instructed simply to listen to the signal test, without any specific task in order to avoid systematic influences of individual attentional learning strategies. There were 2 recording sessions for each subject, one with a 250 Hz test and the other with a 1000 Hz test. We choose a masking noise frequency 20 % lower than the test (200 Hz or 800 Hz), frequencies that are well documented in the litterature (6).
An E.E.G. was recorded at C3,C4,T3,T4 with a nasion reference which has been previously described (11). The Evoked Potentials were averaged and superaveraged with respect to each test condition (about 25 sweep samples for each individual E.P.), using a signal analyzer (PLURIMAT S Intertechnic, interconnected with a PDP 11-34 computer), and each negative or positive peak, whose amplitude was more than 0.33 µV, was measured on a scale from P0 (50 ms) to P3 (350 ms) latencies and these latencies and amplitudes were then subjected to a two-way variance analysis using BMDP programs. Examples of superaveraged curves are shown in the diagrams.
The results of test lateralization (right or left ear), and of homolatéral or heterolateral masking (on the same side or on the opposite side of the test) were compared, taking into account the differences between Central and Temporal E.P.s (ipsilateral or controlateral to the test side). Only significant data at the 0.001 level (latencies) or at the 0.05 level (amplitudes) will be further discussed.

RESULTS

A - Under neutral conditions (control without mask) we may observe 4 points:

1 - N1 amplitude is higher with right stimulation, while the P2 wave is greater with the left stimulus.

2 - There is an interhemispheric assymetry among responses, which are greater on the controlateral derivations, and even more important on the right derivations.

3 - There are topographical differences with higher N0,P1 waves on the Temporal than on the Central derivations.

4 - There are some changes in wave development according to the stimulus frequency: at the 1000 Hz test stimulus the N0 wave is higher than at 250, and at 250 Hz the wave is higher on Temporal than on Central derivations.

B - Homolateral masking

1 - There are significantly increased P0,N0,P1,N2 latencies on the ipsi- or the controlateral Temporal derivations (delay greater than 40 ms), also the N1,P1,N2 amplitudes are decreased, while P2 and P3 are increased.

2 - The N1 components of responses to the left stimulus are less affected than those to the right ones (mainly on the controlateral responses) and there is an increase of the P2 and P3 waves.

3 - The only topographical differences between Central and Temporal derivations is on the N0 wave.

4 - At 1000 Hz there are more important E.P. deterioration, which are more notable on N1 and P2 components, then on N0 components.

C - Heterolateral masking

1 - There are increased latencies (P0,N0,P1,N1) and increased amplitudes (N1,P1) with the 250 Hz test.

2 - This increase is more important in Central than in Temporal derivations with significant differences between neutral and homolateral masking conditions.

3 - Important changes are only observed with left stimulations. With right stimulus, no significant differences between neutral and masking do appear.

4 - With the 1000 Hz stimulus changes of N1,P2 amplitudes are more notable than at 250 Hz; moreover these are particularly evident on the right hemisphere.

CONCLUSIONS

1 - Masking differentially affects the various auditory E.P. N0,N1,P2,P3 wave components. These observations support the assumption of the heterogeneity of the N1 wave (N1a,N1b,N1c components)(10). Similarly the topographical differencies we have observed on Temporal and Central derivations are in accord with the generally-accepted views on brain generators of N1 (10,13) and Ta-Tb components (12).

2 - Our data, concerning ERP's deterioration on some components during masking, are more in agreement with the existence of a "noisy disturbance at a central level" than with a "competition at a peripheral level". But some of our data, mainly with controlateral masking effect, suggest that masking enhancement of NO,P2,P3 waves is an indicator of brain activation, or of a sustained attentional set (5), which may be automatically triggered by input information.

3 - Cerebral assymetry is clearly involved in responses to sounds and masking effects. As previously reported, E.P. amplitudes are higher on the right hemisphere (controlateral to the left test stimulus)(2,8). But this assymetry appears more clearly in conditions where the left masking effects are lower than the right, and where heterolateral left masking facilitates the right ear responses. This assymetry is more notable with a 250 Hz stimulus, than with a 1000 Hz. These data suggest that there may well be a physiological control (or inhibition) of the left ear, which may be supressed by right masking. This final hypothetisis might be effectively studied in the context of a bilateral masking experiment.

ACKNOWLEDGEMENTS: This work was supported by a grant from the French Environment ministery (contract 85-256).We are grateful for the stimulating discussions of this topics with our colleagues J.M. ARAN, D.FELDMAN, T.PICTON.

REFERENCES

1 - ANANTHANARYAN,A.K.,GERKEN,G.M.;(1987);Response enhancement and reduction of the auditory brainstem response in a forward masking paradigm;Electroenceph. Clin.Neurophysiol.; 66; 427-437.

2 - ANDREASSI,J.L.,DE SIMONE,J.J.,FRIEND M.A.,GROTA,P.A.,(1975),Hemispheric amplitude assymmetries in the auditory evoked potential with monaural and binaural stimulation.Physiol. Psychol.,3,160-171.

3 - BOTTE,M.,CAVE,C.,(1979);Donnees psychoacoustiques et mecanismes du systeme auditif peripherique; in LEGOUIX, J.P., (Ed.), "Les recepteurs cochleaires: structure et fonctionnement,G.A.L.F., Lannion (France),191-194.

4 - BOEZEMAN,E.H.,KAPTEYN,T.S.,VISSER,S.L.,SNEL A.M.,(1983),Effect of controlateral and ipsilateral masking of acoustic stimulation on the latencies of auditory evoked potentials from cochlea and brain stem; Electroenceph. Clin. Neurophysiol.,55,710-713.

5 - BROADBENT,D.E.,(1970),Stimulus set and response set: Two kinds of selective attention.in MOSTOFSKY (Ed.)"Attention contemporary theories analysis";Mc GRAW-HILL (New-York),51-60.

6 - CAVE,C.,CHOCHOLLE,R.,(1974),Effet de la frequence sur la sonie des sons brefs: comparaisons entre deux frequences proches: 500 Hz et 1000 Hz.;C.R. Soc. Biol.,Vol.2,170,310-314.

7 - CHOCHOLLE,R.,GREENBAUM,H.B.,(1966),La sonie des sons partiellement masques.;J. Psychol.,Vol. 4,385-414.

8 - McCALLUM,W.W.,CURRY,S.H.,(1980),The form and distribution of auditory evoked potentials and CNVs when stimuli and responses are lateralized.in H.H. KORNHUBER and L.DEECKE (Eds.) "Motivation, Motor and Sensory Processes of the Brain: Electrical Potentials,Behavior and Clinical Use."Progress in Brain Research, Vol.54. Elsevier(Amsterdam),767-775.

9 - PATY,J.,CLAVERIE,B.,DELIAC,Ph.,BERTHOMIEU,J.;(1986),ERP Indicators of Objective and Subjective Disturbances Caused by Noise Impulses. In W.C. MAC CALLUM, R.ZAPPOLI and F. DENOTH (Eds.),"Cerebral Psychophysiology: Studies in Event-Related Potentials",Electroencephal. and Clinical Neurophysiol.,40-42.

10 - PERRAULT,N.,PICTON,T.W.,(1984),Event-related potentials recorded from the scalp and naso-pharynx:I - N1 and P2. Electroenceph. Clin. Neurophysiol. 59, 177-194.

11 - VAUGHAN,H.G.,RITTER,W.,(1970),The sources of auditory evoked responses recorded from the human scalp.Electroencephal. Clin. Neurophysiol.,28,309-367.

12 -WOLPAW,J.R.,PENRY,J.K.,(1975),A temporal component of the auditory evoked response.Electroenceph. clin.Neurophysiol.,39:609-620.

13 - WOOD,C.C.,WOLPAW,J.R.,(1982),Scalp distribution of human auditory evoked potentials.II.Evidence for multiple sources and involvment of auditory cortex.Electroenceph. clin. Neurophysiol.,54,25-38.