Variable time delay between sound onset and magnetic cortical response to word*

Vvedensky V.L. /vvedensky@imp.kiae.ru/, Korshakov A.V.

Kurchatov Institute, Moscow, Russia

Magnetic responses to word can be seen on many sensors of the Elekta Neuromag system over left and right temporal cortex. There is hardly a direct connection from the ear to any of these sites. The time needed to reach the target area depends on the actual route the neural pulses travel before they activate cortical generators of current producing magnetic signal. This time can provide valuable information on the sequence of events during word perception. However, it is difficult to determine this time since both the uttered word and the cortical response are extended in time for hundreds of milliseconds. We observed in our experiments, that the waveforms of the average signal, accumulated during 120 presentations of any word are particularly robust and can be compared with every signal recorded during running presentation of the word as shown in Fig.1. We calculate cross-correlation of instantaneous amplitudes of the average and the running signals, and do it with different time shifts as shown in Fig.2. The approach is similar to the one used in [1]. We see that the majority of runs with high correlation with average display evident peak though often with considerable time shift. One run with such shift is shown in Fig.1.

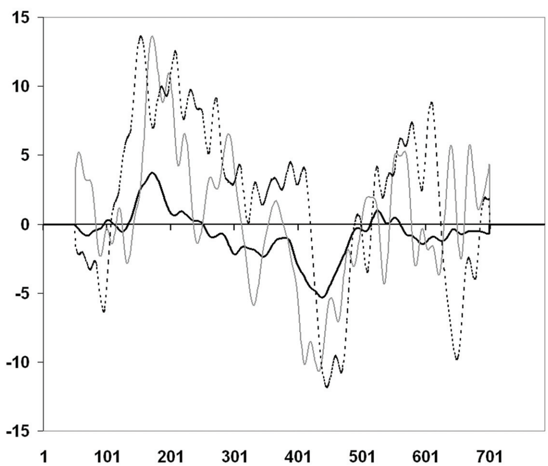

Fig.1. Maximum amplitude magnetic response to Russian word BROSAY over right temporal cortex. The signal is 40 Hz low-pass filtered. Black curve: average signal for 120 utterances of the word. Gray curve: actual record during single word presentation, which correlates most with the average signal. Dotted curve: another record with high correlation with the average, though with 30 ms time delay. Vertical scale in fT/cm is common for all curves. Horizontal scale is in milliseconds after word onset. Word lasts for about 450 ms.

* Supported by Russian Foundation of Basic Research, grants 11-07-00637-a and 11-04-12086-ofi_m.

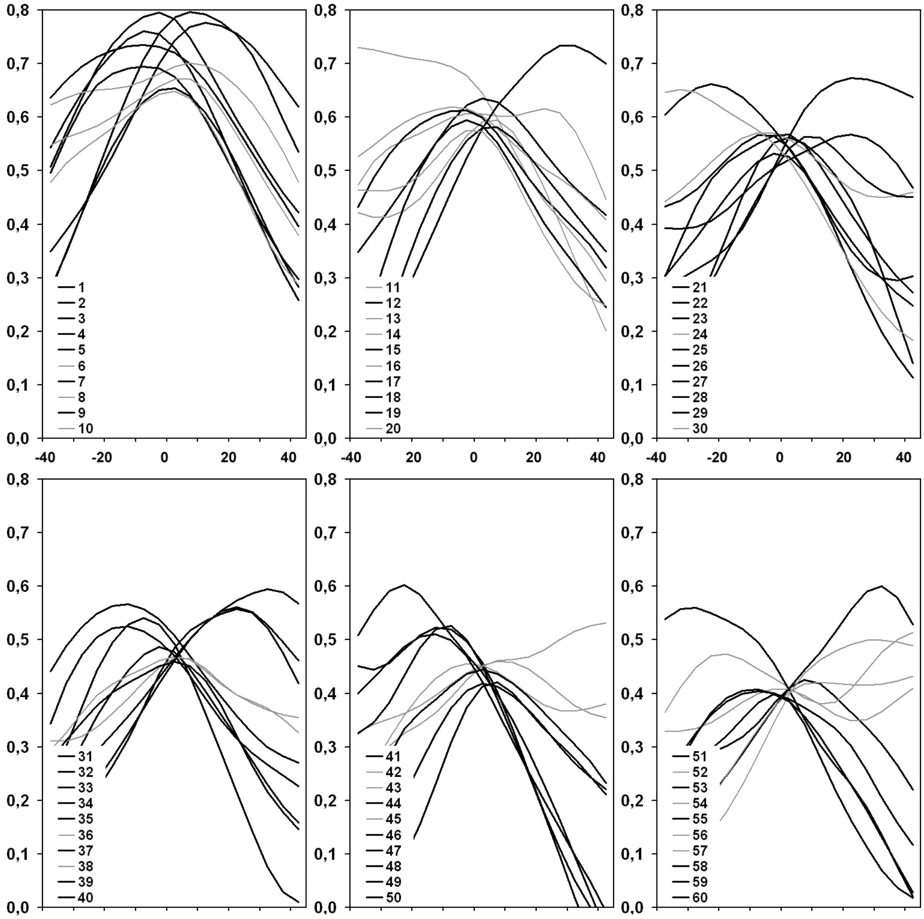

Fig.2. Correlation (vertical scale) between actual time course of the magnetic gradient for 60 different presentations of the word BROSAY and the average signal shown in Fig.1. Each curve is calculated adding variable time shift to the averaged signal. This shift is indicated on the horizontal scale in milliseconds. Black lines of parabolic shape indicate runs, where actual time course is congruent to the averaged signal, though sometimes with considerable time shift as shown in Fig.1. The runs indicated by the gray lines imply more complex waveform, deviating much from the average signal.

We observe considerable trial-to-trial variability of magnetic responses to word for different words and different subjects and nevertheless quite robust average signals can be obtained. This variability is both in the amplitude of the signal associated with the word perception and in the time lag. This is the interval between the onset of sound coming into the ear and the beginning of the characteristic waveform, recorded as the magnetic response to word. The scatter of time lags is considerable, up to 60 ms. This means that the actual waveform of the response is rigid and can be shifted in time that much without distortion. This variability provides valuable information on the role which “background” activity (permanently present in the records during the experiment) plays in the shaping of cortical responses to words.

We are grateful to Prof. T.Stroganova, A.Butorina and A.Nikolayeva for providing us with the reliable experimental data.

Referens

1. Adhikari A, Sigurdsson T, Topiwala MA, Gordon JA. Cross-correlation of instantaneous amplitudes of field potential oscillations: a straightforward method to estimate the directionality and lag between brain areas. J Neurosci Methods. 2010 Aug 30;191(2):191-200.

Локализация зон головного мозга, связанных с лексико-семантической и синтаксической обработкой предложений русского языка*

Березуцкая Ю. Н. /onthehay@mail.ru/, Печенкова Е.В., Мершина Е.А.

Московский государственный университет им. М.В. Ломоносова, Москва, Россия

В литературе не существует единого мнения о том, возможно ли выделить специфические мозговые механизмы лексико-семантической и синтаксической обработки языка. С одной стороны, как данные, полученные при анализе локальных поражений мозга, так и методами нейровизуализации, указывают на наличие подобной специфики. В связи с синтаксической обработкой в литературе упоминаются активация левого полушария в области треугольной и оперкулярной частей нижней лобной извилины и задней трети верхней височной извилины (BA 44, 45, 22 – поля, связанные с классическими зонами Брока и Вернике), в передней части височной доли (BA 38) [4], в средневисочной извилине (BA 21), среднелобной извилине (BA 9) и других зонах (BA 5, 6, 23, 24, 35, 37, 39, 40, 47) [3]. В связи с лексико-семантической обработкой указываются задняя и нижняя часть височной доли (BA 37), предположительно, обеспечивающая хранение информации в семантической памяти, а также орбитальная часть нижнелобной извилины (BA 47), предположительно, обеспечивающая контроль над процессом кодирования и извлечения информации [2, 4].

С другой стороны, существуют свидетельства против функциональной специализации речевых зон в отношении лексической семантики и синтаксиса. Так, согласно результатам факторного фМРТ-эксперимента, проведенного Э. Федоренко с коллегами [1] на материале английского языка, изменение указанных аспектов предложений приводит к различиям в активации мозга в пределах одних и тех же зон.

* Исследование поддержано грантами РФФИ № 10-07-00670-а и № 12-06-00268.