302.03

Effect of electrode morphology on the frequency spectrum of local field potentials in the rat ventral tegmental area

C. Delairesse[1] , G. Becker[2], A. Plenevaux[2], V. Seutin[1], S. Koulchitsky[1]

[1] Laboratory of Neurophysiology GIGA Neurosciences, [2] GIGA-CRC In vivo imaging, both at the University of Liège B4000 Liège, Belgium

Background

Chronic implantation is now widely used to study spike activity and local field potentials (LFP). In this work, LFPs of rat ventral tegmental area (VTA) were recorded with two different types of recording probes with different orientations.

Objective

To investigate wether the type/orientation of recording probes influences the LFP frequency spectrum

Methods

Male wistar rats were implanted either with microelectrode microwire arrays (Alpha Omega GmbH, Israel), or with silicon-based planar probes (Atlas, Neuroengineering, Belgium) at the following coordinates: 5mm posterior to bregma, 0.2mm lateral to midline, 7mm deep. In the case of the Atlas probes, some animals (n=3) were implanted with the recording side of the probe facing the lateral part of the brain and others (n=4) with the recording side oriented towards the midline. Telemetric recordings were performed using either the Multichannel° W8 or W16 system (Koulchitsky et al., 2016). Out of recordings lasting 30 minutes, we selected 10s epochs during which rats moved in a regular fashion (speed was 3.8 +/- 0.26 mm/s). Care was taken not to include episodes during wich other type of behavior occurred (such as rearing, grooming, ...). For verification of the recording area the rats were anaesthetized and perfused with 4% paraformaldehyde containing 1 % of Gadovist. The brains were removed from the skull and placed in Fomblin for MRI scanning (9.4 Tesla MRI DirectDrive VNMRS, Agilent Technologies, Palo Alto, CA).

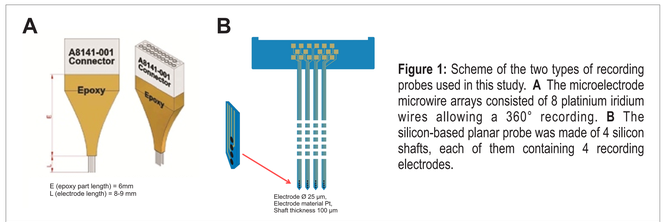

Figure 1: Scheme of the two types of recording probes used in this study. **A** The microelectrode microwire arrays consisted of 8 platinium iridium wires allowing a 360° recording. **B** The silicon-based planar probe was made of 4 silicon shafts, each of them containing 4 recording electrodes.

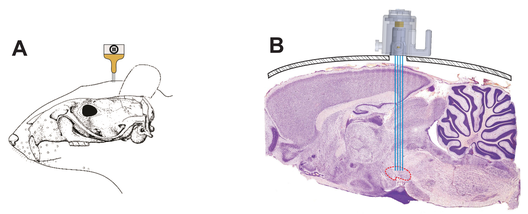

Figure 2: Scheme of implantation of **A** the microelectrode array and **B** the silicon-based planar probe

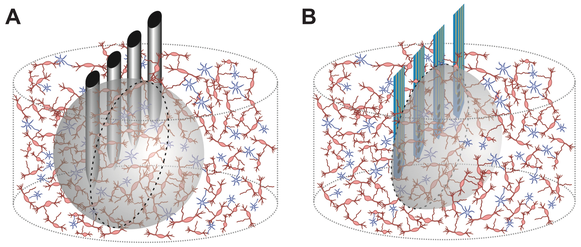

Figure 3: **A** Schematic view of 4 of the 8 electrodes of the microwire array. This configuration allows the recording of 360° as depicted by the grey sphere. **B** Schematic view of the planar probe. The electrodes are located on one face of the probe, presumably allowing the recording of 180°. The recorded area is shown by the grey half-sphere

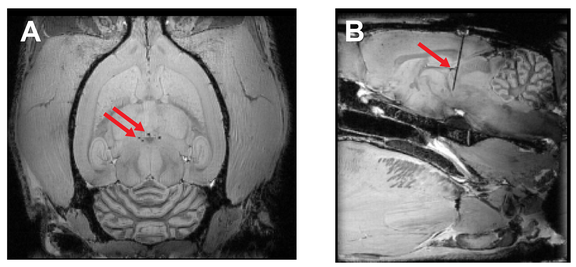

Figure 5: MRI pictures of a brain implanted with a planar probe**.** **A** Transverse plane. The red arrows show the tracks of the shafts. **B** Sagittal plane. The red arrow shows the track of one shaft. For technical reasons the shaft does not seem to reach the VTA in this plane.

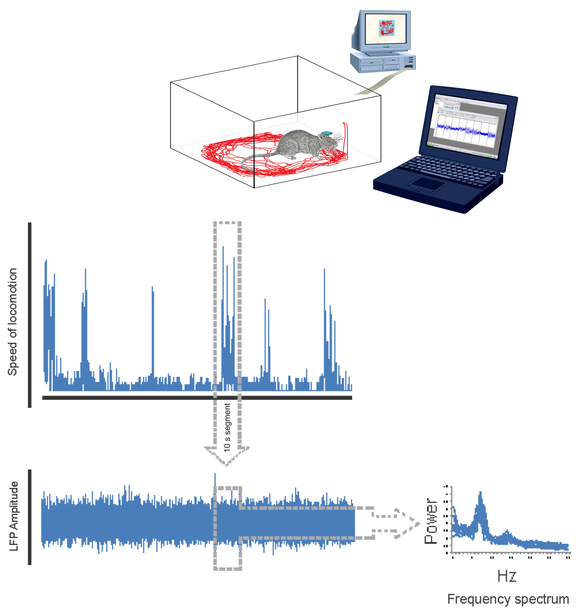

Figure 4: Scheme of set-up and data analysis. The upper panel shows the tracking (in red) of the animal when it was recorded in the arena. A 10 s period during which the animal was moving was chosen. The corresponding LFP segment was used to create the frequency spectrum. LFP frequency spectra were built using the MATLAB FieldTrip toolbox (Oostenveld et al., 2011)

Results

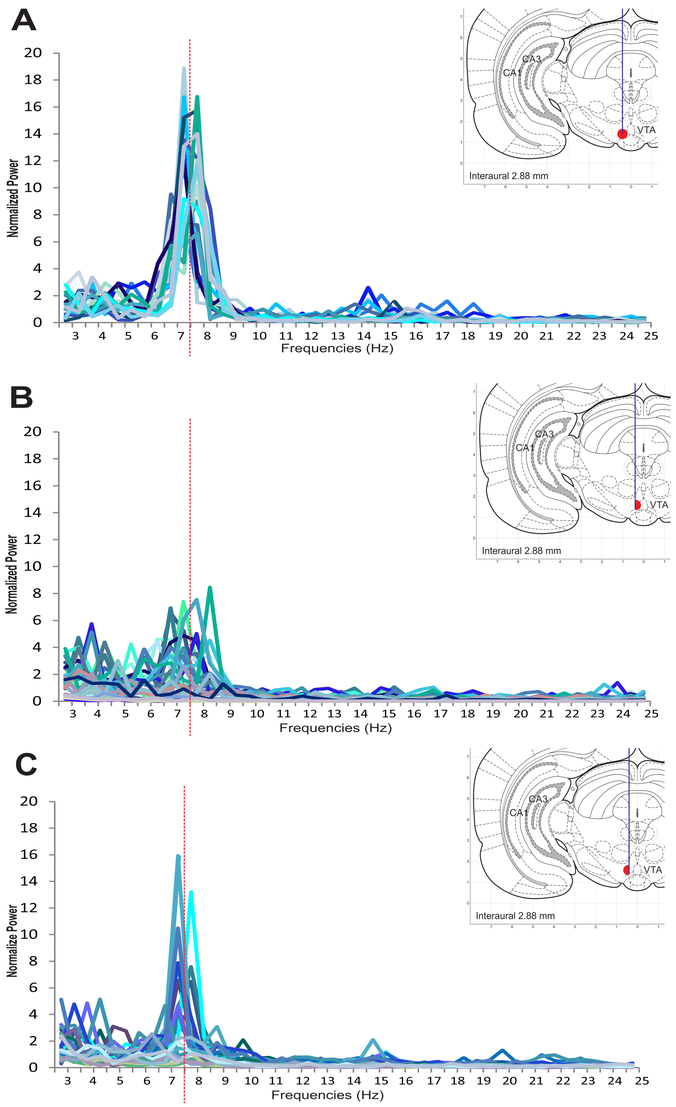

Figure 6:

A Frequency spectrum of the LFP recorded with the microelctrode array (n=5 rats and 16 epochs). The red dashed line indicates the frequency at which the peak occurs.

B Frequency spectrum of the LFP recorded with the planar probe when facing the midline (n=4 rats and 25 epochs).

C Frequency spectrum of the LFP recorded with the planar probe facing the lateral parts of the brain (n=3 rats and 25 epochs).

Recordings of the rat VTA LFP with electrodes of different morphology clearly give frequency spectra with different caracteristics. While with the micorelectrode array (A) we observed a clear peak in the theta range (around 7,5 Hz), recordings using the ATLAS probes display a more variable signal with additional peaks that appear in the lower frequencies. A peak in the theta range is clearly observed when the neural probe is oriented towards the lateral part of the midbrain. However, the theta peak is blunted when using probes facing the midline.

Conclusion

In the VTA, LFP signals recorded with multielectrode arrays of different geometries yield qualitatively very different results. Whereas a theta peak is clearly observed with 360° sensing electrodes and laterally facing electrodes, it is much less present with midline facing electrodes.

We see 2 possible explanations for these differences:

1) The differential neurochemical nature of neurones in the medial versus the lateral VTA (wih more DA neurones in the lateral VTA and more non-DA neurones in the medial VTA)

2) If the theta rythm originates from elsewhere in the brain, its invasion of the VTA could be sensed differencially by electrode of opposite orientation

Aknowledgment: This work was supported by grant T.0015.13 from the “Fonds National de la Recherche Scientifique” (FNRS) (Belgium) (to VS and CD) and grant P7/10 from the Belgian Science Policy (Interuniversity Attraction Poles program grant) (to VS)