Neuronal generator patterns of olfactory event-related potentials (OERP) in schizophrenia

Jürgen Kayser 1,2, Craig E. Tenke 1,2, Dolores Malaspina 3, Christopher J. Kroppmann 1, Jennifer D. Schaller 1, Andrew Depta 1, Nathan A. Gates 1, Roberto B. Gil 2,4, Gerard E. Bruder 1,2

1 Division of Cognitive Neuroscience, New York State Psychiatric Institute, New York, NY; 2 Department of Psychiatry, College of Physicians and Surgeons, Columbia University, New York, NY; 3 Department of Psychiatry, New York University School of Medicine, New York, NY; 4 Division of Translational Imaging, New York State Psychiatric Institute, New York, NY

Abstract

Deficits in odor threshold sensitivity, discrimination and identification are common olfactory symptoms, presumably originating from brain structures also linked to cognitive and emotional disturbances. However, the neurophysiological processes underlying olfactory dysfunction in schizophrenia have only been studied by Turetsky et al (2003) who found reduced N1 and P2 amplitudes. Methods: Nose-referenced 30-channel ERPs were recorded from 32 schizophrenic and 32 healthy control (n=18 male) during odor detection tasks. Hydrogen sulfide (H2S) stimuli (200 ms duration) at concentrations of 50% and 100% were presented to the left or right nostril by a continuous inhalation (volume 0.5L; 0.25 s). Time of odor stimulation was not cued. Subjects indicated whether they perceived a low or high odor intensity. To identify and measure neuronal generator patterns underlying ERPs, unrestricted Varimax-PCA was performed on their reference-free current source densities (spherical splines).

Results: Patients' behavioral performance was on par with that for healthy controls for high (73.5%) and low (41.1%) odor concentrations. Patients showed similar olfactory ERP and CSD waveforms compared to controls, but their N1 sink (200 ms, bilateral frontotemporal maximum) and P2 source (615 ms, mid-pial maximum) amplitudes were smaller. However, both groups had greater N1 sinks and P2 sources for low odor intensities. Concluding, ERP amplitude reductions to H2S stimuli in schizophrenia appear to reflect reduced activity of bilateral orbitofrontal, midline frontopolar, and parietal regions.

Fig. 2: Grand average OERP waveforms for controls and patients at 31 sites using a 31-channel electrode cap. The H2S stimulus (200 ms) was presented to the left or right nostril by a continuous inhalation (volume 0.5L; 0.25 s). Time of odor stimulation was not cued. Subjects indicated whether they perceived a low or high odor intensity. To identify and measure neuronal generator patterns underlying ERPs, unrestricted Varimax-PCA was performed on their reference-free current source densities (spherical splines).

Surface Potentials

Fig. 3: Direct comparison of ERP waveforms in healthy adults and schizophrenic patients. A) For high intensity stimuli, both groups had distinct bilateral fronto-temporal H1 sinks (approximate peak latencies 260 ms at Cz) and P2 source potentials (520 ms at Pz). For low intensity stimuli, H1 sinks and P2 source amplitudes were reduced and their peak latencies were delayed. B) Compared to healthy adults, N1 sinks and P2 source appear to be reduced in schizophrenic patients. However, both groups showed comparable intensity-related effects on both CSD components.

Current Source Densities

References

Kayser J, Tenke CE (2003). Optimizing PCA methodology for ERP component definition and measurement of appropriate ERP components (e.g., specific time windows for peak or component analysis) to ERP research, which usually affect component interpretation (e.g., polarity, topography, generator) and statistical analysis of the ERP components of interest.

