Sleep Science Friday: In memory of Ivan Pigarev

22 October 2021

Outstanding neurophysiologist and somnologist Ivan Nikolaevich Pigarev (1941-2021), affiliated to the Kharkevich Institute for Information Transmission Problems of the Russian Academy of Sciences, who only recently celebrated his 80th birthday in full health, died on July 15, 2021 as a result of a tragic traffic accident.

Ivan was a brilliant experimental virtuoso who worked in the leading laboratories in Germany, Italy, Spain and Australia in the field of so-called "dry" neurophysiology. In the early 1990s, he also became interested in the problem of sleep and made two important discoveries in this area. In his 1994 work (Pigarev IN, 1994). Neurons of visual cortex respond to visceral stimulation during slow wave sleep. *Neuroscience*.), he was the first to show that the neurons of the primary visual cortex of the cat when it falls asleep, ceasing to respond to specific, visual stimuli, begin to be excited in response to visceral impulses coming from the intestinal tract. These studies served as the basis for Ivan's further creation of the "Visceral hypothesis of sleep."

Ivan first announced his hypothesis (later called theory) at the 12th European Sleep Research Society Congress in Florence in 1994. There I introduced Ivan to Jim Krueger and other sleep researchers who highly appreciated his work. According to Pigarev's idea, the brain is engaged in internal organs ("checking, tuning, maintenance", etc.) during slow-wave sleep. This idea was far ahead of its time and has not yet been fully accepted and assimilated by the world scientific community.

In 1997, Ivan Pigarev with his colleagues, working in Germany, published a short article about experiments on monkeys. They discovered periods of asynchronous development of slow-wave sleep in different cortical areas of the same hemisphere (Pigarev IN, et al., (1997). Evidence for asynchronous development of sleep in cortical areas. *Neuroreport*.). Subsequently, similar results were obtained by other groups of researchers in rats and led to the formation of the concept of so-called "local sleep" in terrestrial mammals, which significantly enriched the understanding of sleep mechanisms.

Ivan always looked younger than his years and until his last days kept the sharpness of his eyes and the firmness of his hand. His latest work is a small experimental masterpiece called "The Mysterious Island" (Levichkina EV, *et al.* (2021). The mysterious island: insula and its dual function in sleep and wakefulness. *Front. Syst. Neurosci.*). This paper presents a study of neurons of insula (the most inaccessible area of the temporal cortex) in the cat during the sleep-wake cycle. At the same time, Ivan did not kill his experimental animals for morphological control, but used computed tomography to clarify the location of the electrodes.

The pioneering works of Ivan Pigarev have not only scientific but also applied significance. Ivan was an unusually charming and attractive person, all his colleagues loved him very much.

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Selected Publications from Ivan Pigarev

1. Levichkina EV *et al.* (2021). The Mysterious Island: Insula and Its Dual Function in Sleep and Wakefulness. *Front Neurosci.*

2. Pigarev IN, Pigareva ML. (2020). K istorii nablyudeniya i nekotorym metodicheskim osobennostyam issledovaniya proyavlenii lokal'nogo sna [The history of observations and some methodological features of the studies on local sleep]. *Zh Nevrol Psikhiatr Im S S Korsakova.*

3. Limansky AV *et al.* (2020). Complex Visceral Coupling During Central Sleep Apnea in Cats. *Front Neurosci.*

4. Pigarev IN *et al.* (2020). Probable Mechanism of Antiepileptic Effect of the Vagus Nerve Stimulation in the Context of the Recent Results in Sleep Research. *Front Neurosci.*

5. Pigarev IN, Pigareva ML. (2018). Progress izucheniia sna v epokhu élektrofiziologii. Vistsveral'naia teoriia sna [Progress of sleep studies in the age of electrophysiology. The visceral theory of sleep]. *Zh Nevrol Psikhiatr Im S S*

6. Pigarev IN, Pigareva ML. (2018). Therapeutic Effects of Electrical Stimulation: Interpretations and Predictions Based on the Visceral Theory of Sleep. *Front*

7. Pigarev IN, Pigareva ML. (2017). Association of sleep impairments and gastrointestinal disorders in the context of the visceral theory of sleep. *J Integr Neurosci.*

8. Pigarev IN, Levichkina EV. (2016). Absolute Depth Sensitivity in Cat Primary Visual Cortex under Natural Viewing Conditions. *Front Syst Neurosci.*

9. Pigarev IN, Pigareva ML. (2015). The state of sleep and the current brain paradigm. *Front Syst Neurosci.*

10. Pigarev IN, Pigareva ML. (2014). Partial sleep in the context of augmentation of brain function. *Front Syst Neurosci.*

11. Bibikov NG, Pigarev IN. (2013). [General statistical characteristics of the background firing in cat's cortical neurons during slow-wave sleep]. *Ross Fiziol Zh Im I M Sechenova.*

12. Pigarev IN. (2013). [The visceral theory of sleep]. *Zh Vyssh Nerv Deiat Im I P Pavlova.*

13. Pigarev IN *et al.* (2012). Cortical visual areas process intestinal information during slow-wave sleep. *Neurogastroenterol Motil.*

14. Pigarev IN, Levichkina EV. (2011). Distance modulated neuronal activity in the cortical visual areas of cats. *Exp Brain Res.*

15. Pigarev IN, Pigareva ML. (2011). [The sleep and the visceral function control]. *Ross Fiziol Zh Im I M Sechenova.*

16. Pigarev IN *et al.* (2011). Visually triggered K-complexes: a study in New Zealand rabbits. *Exp Brain Res.*

17. Pigarev IN *et al.* (2008). Cortical evoked responses to magnetic stimulation of macaque's abdominal wall in sleep-wake cycle. *Acta Neurobiol Exp (Wars).*

18. Pigarev IN *et al.* (2006). Visceral signals reach visual cortex during slow wave sleep: study in monkeys. *Acta Neurobiol Exp (Wars).*

19. Vidyasagar TR, Pigarev IN. (2007). Modulation of neuronal responses in macaque primary visual cortex in a memory task. *Eur J Neurosci.*

20. Rodionova EI *et al.* (2004). Distant cortical locations of the upper and lower quadrants of the visual field represented by neurons with elongated and radially oriented receptive fields. *Exp Brain Res.*

21. Pigarev IN, Rodionova EI. (1998). Two visual areas located in the middle suprasylvian gyrus (cytoarchitectonic field 7) of the cat's cortex.

22. Pigarev IN. (1994). Neurons of visual cortex respond to visceral stimulation during slow wave sleep.

23. Pigarev IN, Rodionova EI. (1986). Nel'zyny s ne zavisimymi ot polozheniia glaz zritel'nymi retseptivnymi poliami v kaudal'nom otdele ventral'noi stenki krestovidnoi borozdy kory mozga koshki [Neurons with visual receptive fields independent of eye position in the caudal portion of the ventral wall of the cruciate sulcus of the cat cerebral cortex].

24. Pigarev IN. (1984). Novaia zritel'naia zona na nizhnei stenke krestovidnoi borozdy mozga koshek [New visual area on the inferior wall of the cruciate sulcus of the cat brain].

25. Pigarev IN. (1984). Dva tipa dvizhenii glaz pri élektricheskoi stimuliatsii rostral'noi i kaudal'noi chasteĭ medial'noi lobnoi "glazodvigatel'noi" zony koshki [2 types of eye movements during electric stimulation of the rostral and caudal portions of the medial frontal "oculomotor" zone in the cat].

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