Подходы к исследованию электрофизиологических сигналов мозга человека и их биомедицинские применения

ИЛИ

чем физики могут помочь медикам

Алексей Седов

ФИЦ ХФ РАН - 2023

План доклада

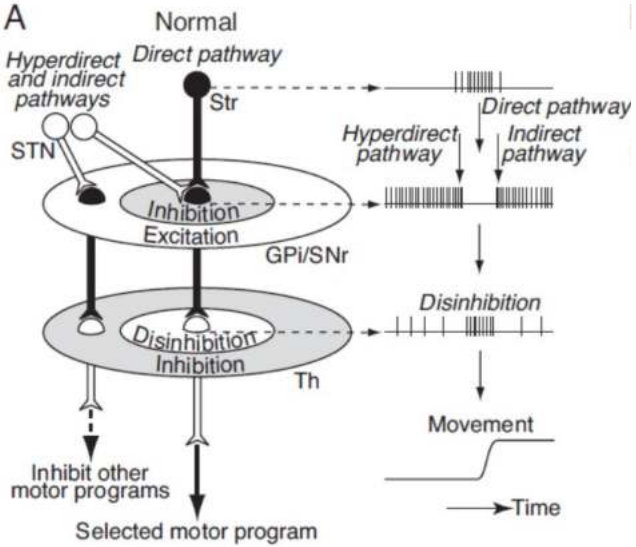
- Объект исследования – пациенты с двигательными нарушениями
- Метод стимуляции глубинных структур мозга
- Получение и анализ электрофизиологических данных
- Некоторые результаты исследования мозга
- Перспективные направления развития

Объект исследования- пациенты с болезнью Паркинсона и дистонией

Гиперкинезы (дистония)

Гипокинезы (болезнь Паркинсона)

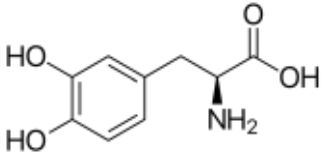
Модель двигательных нарушений

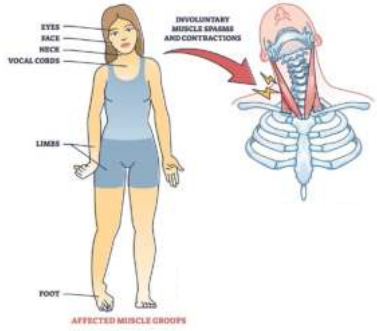


Консервативное лечение

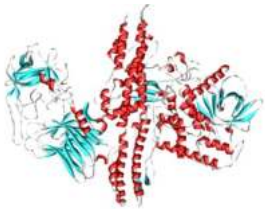
Болезнь Паркинсона

Леводопа





Мышечная дистония



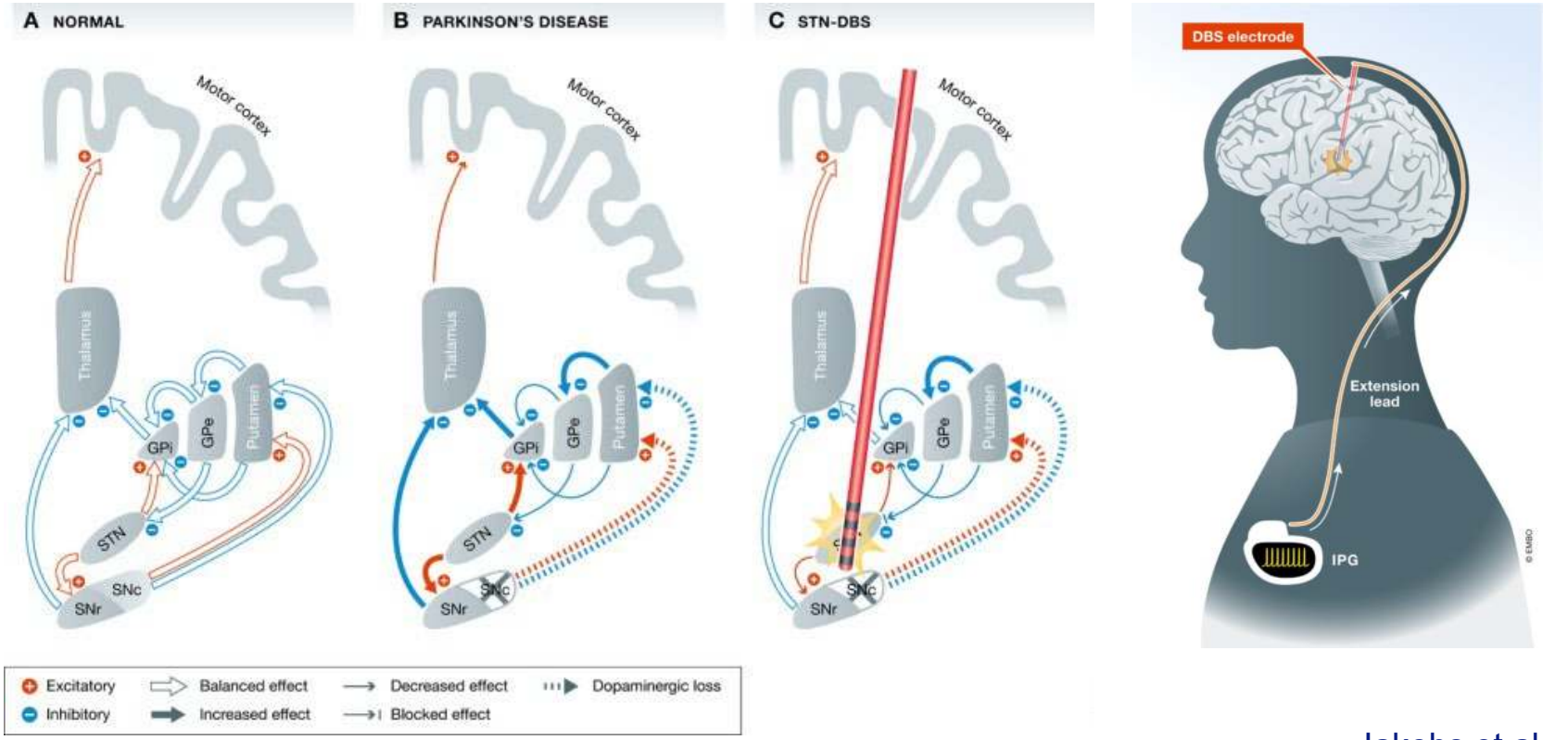
Внутримышечные инъекции ботулотоксина

Побочные эффекты от лекарства

До L-DOPA

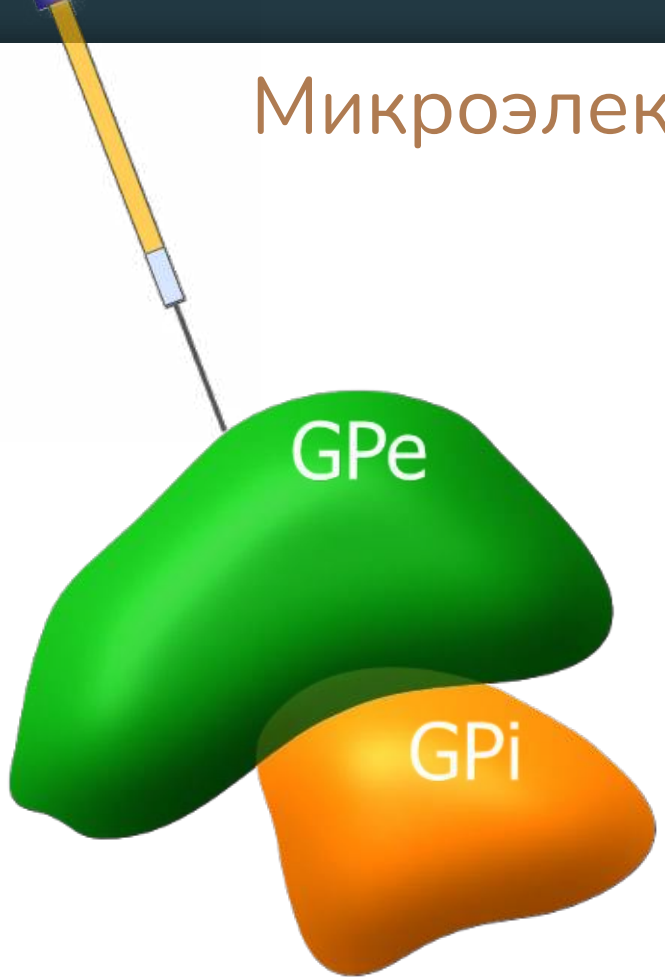
После L-DOPA

Стимуляция глубинных структур мозга (DBS)



Jakobs et al., 2019

Микроэлектродная регистрация



Интраоперационная стимуляция

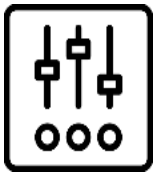
Треморная активность

Эффект от DBS

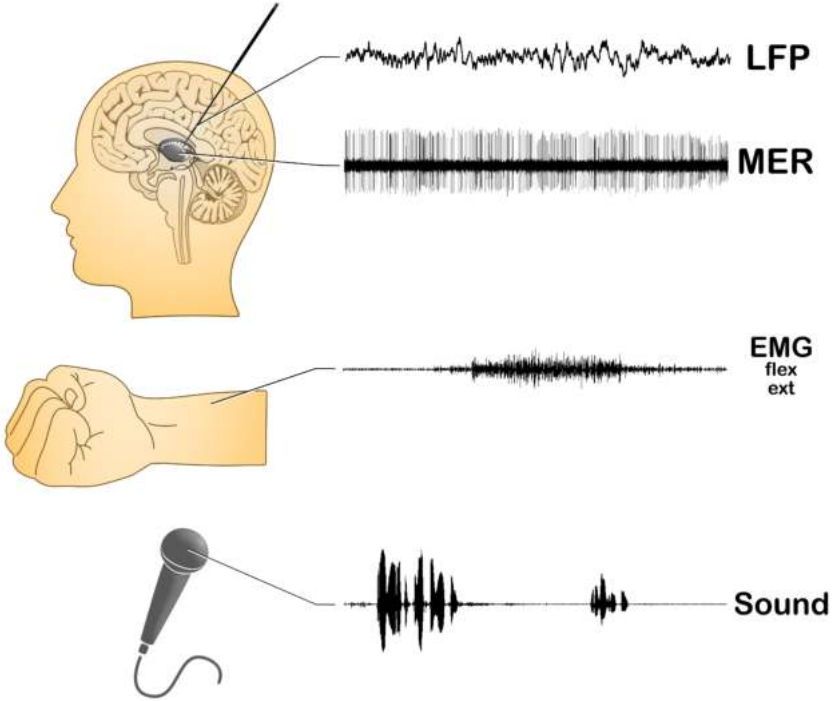
Получение и анализ электрофизиологических данных

Определение хирургической мишени → Операция → **Постоперационная регистрация** → Настройка программы стимуляции

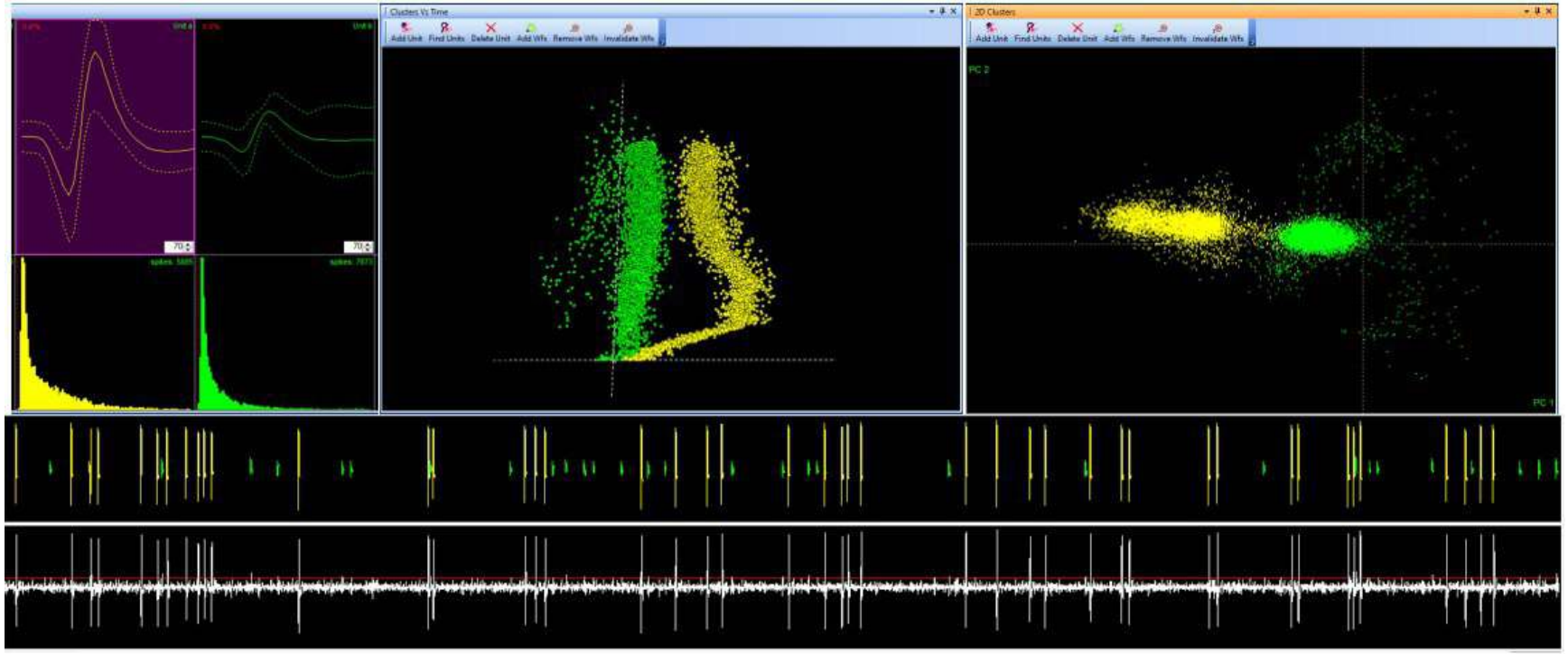
Интраоперационная регистрация



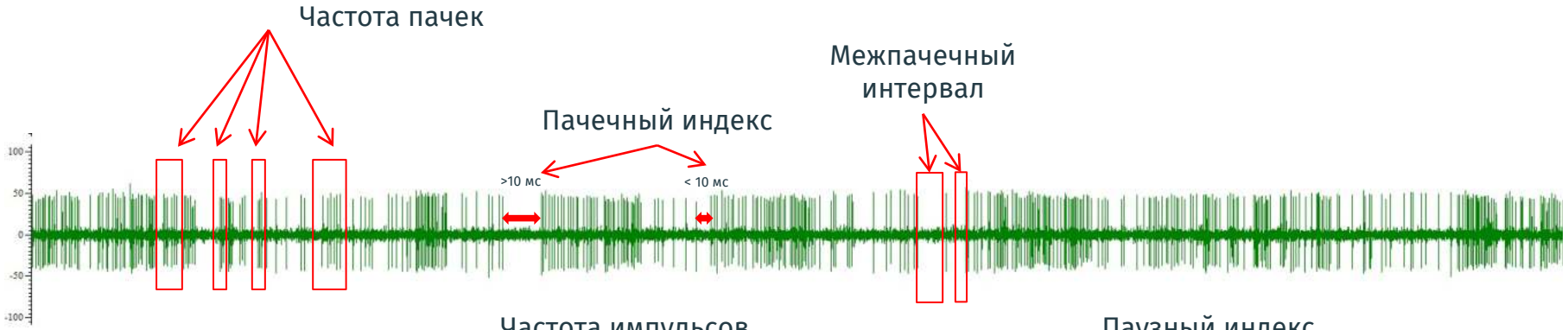
Интраоперационная регистрация данных

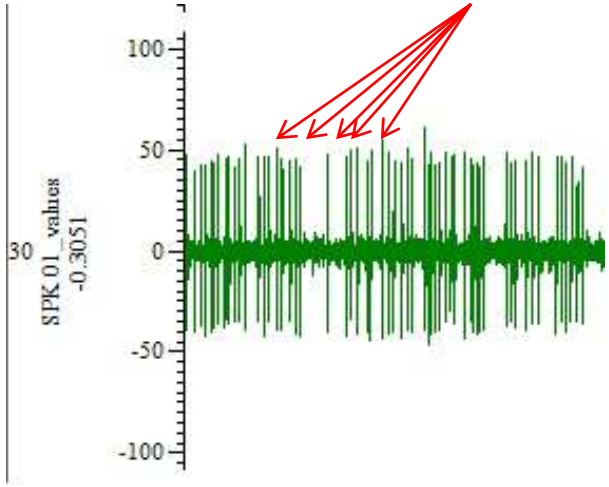


Сортировка спайков



Анализ одиночной нейронной активности





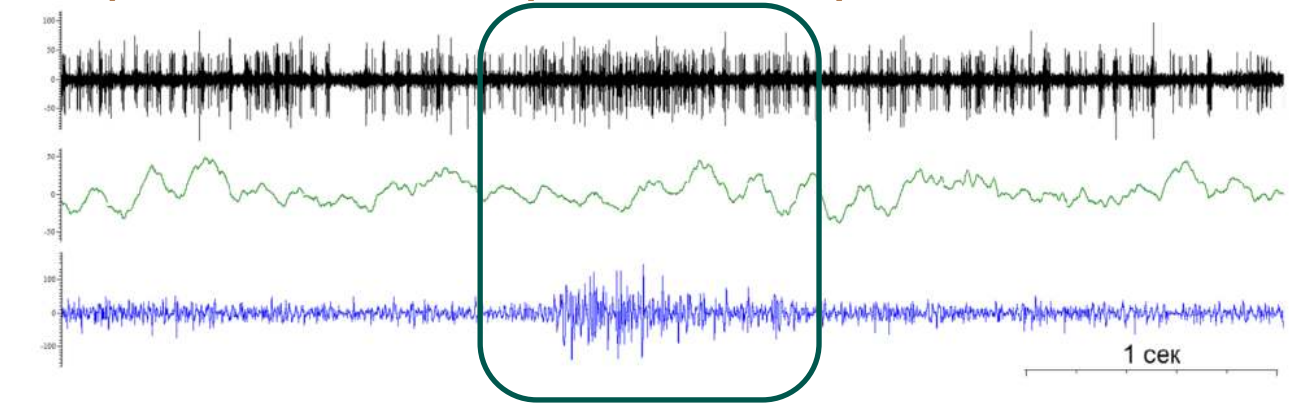
A new approach for estimation of spiketrain patterns in basal ganglia

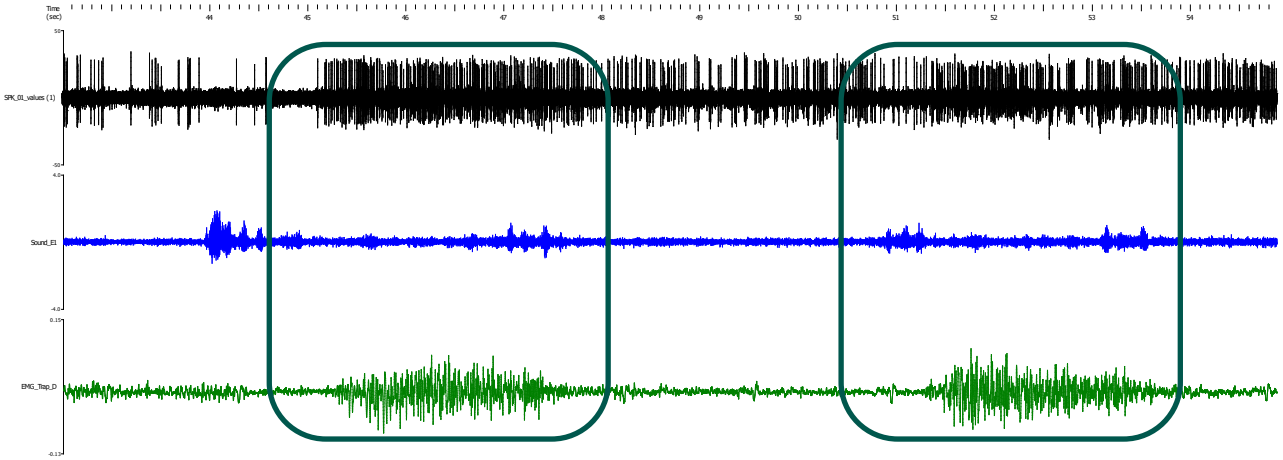
Vladislav Myrov [1], Alexey Sedov [2], Alexey Tomskiy [3], Ludmila Myrova [4], Elena Belova [5]

Affiliations + expand

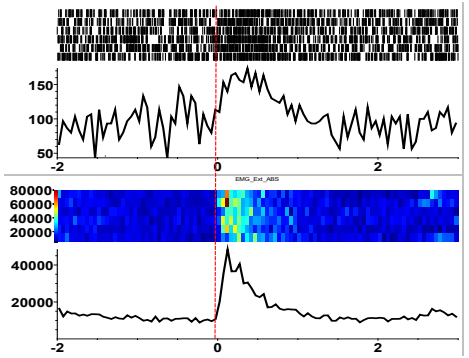
PMID: 31325991 DOI: 10.1016/bs.pbr.2019.04.039

Изучение нейронных реакций

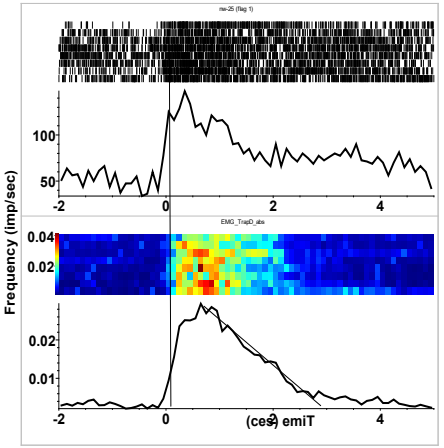




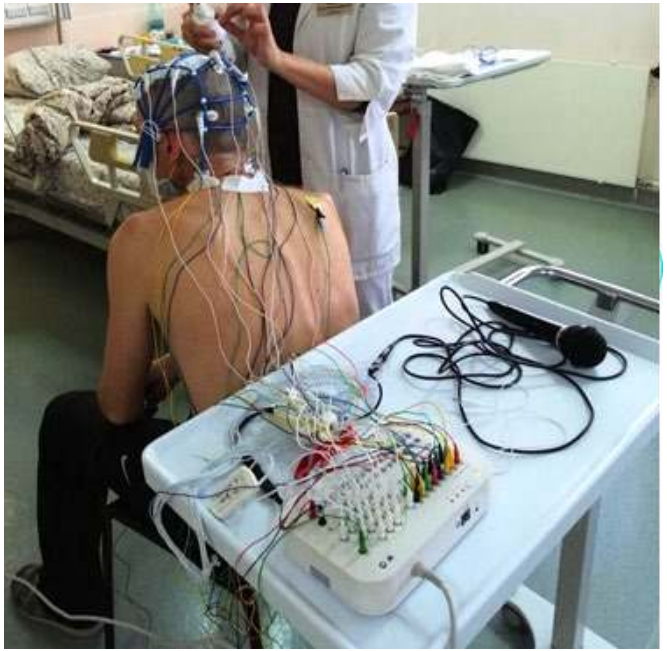
Периивентная гистограмма

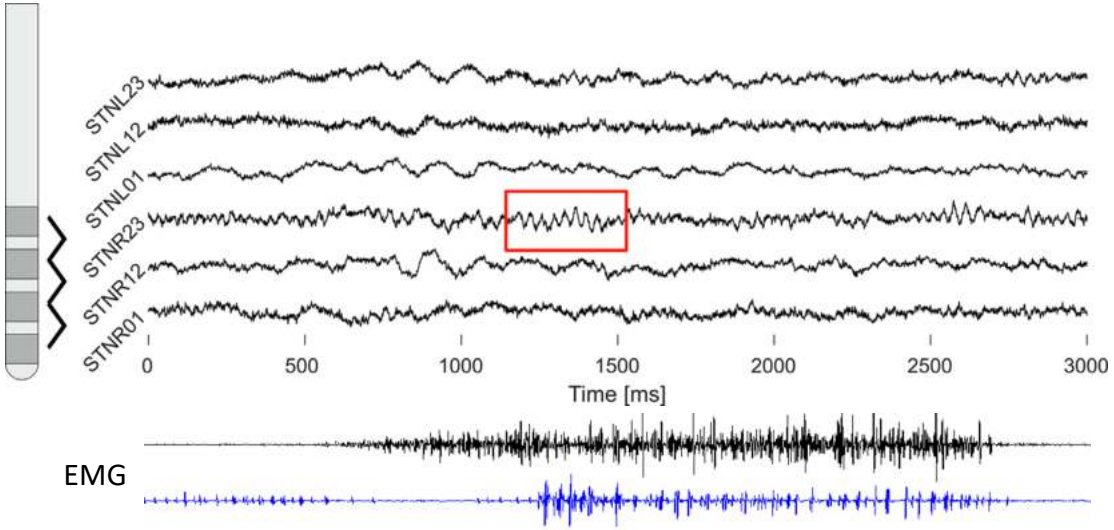


Perievent Rasters, reference = PPP, bin = 100 ms

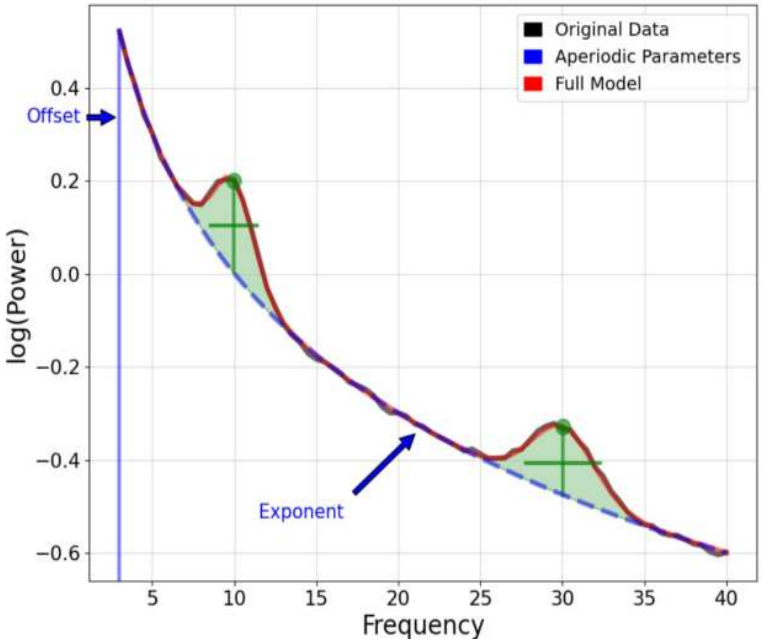


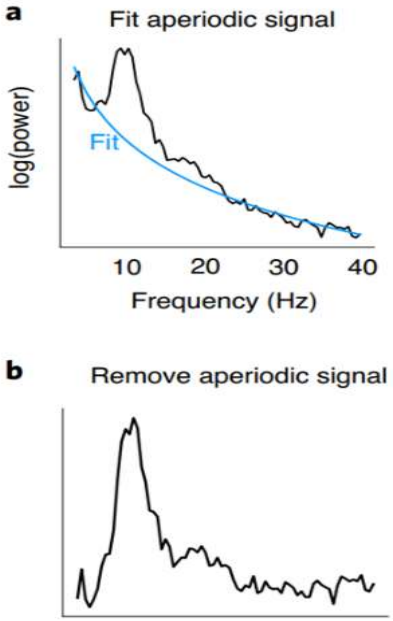
Постоперационная регистрация LFP и ЭЭГ





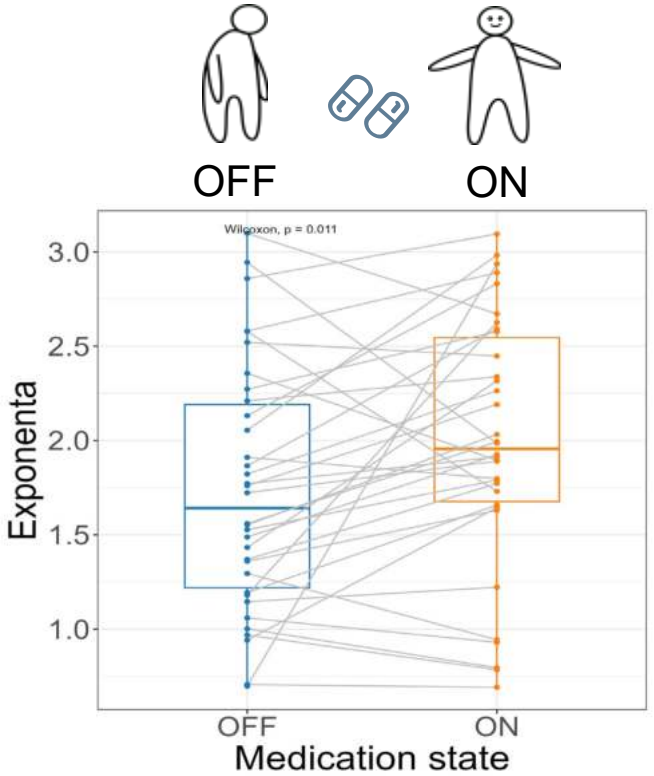
Вычисление периодических и апериодических компонент спектра (FOOOF)

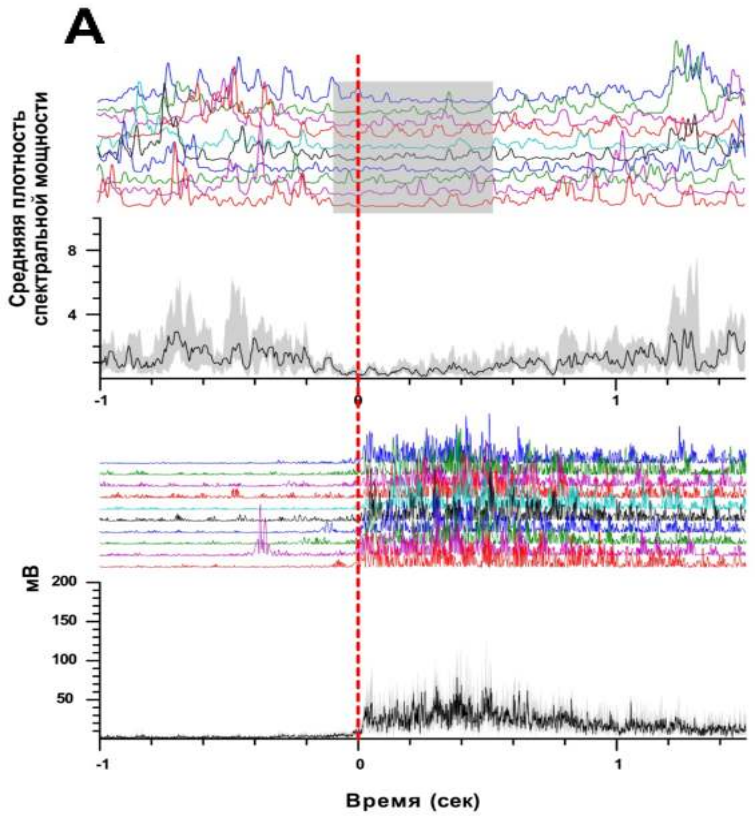




(Donoghue et al., 2020)

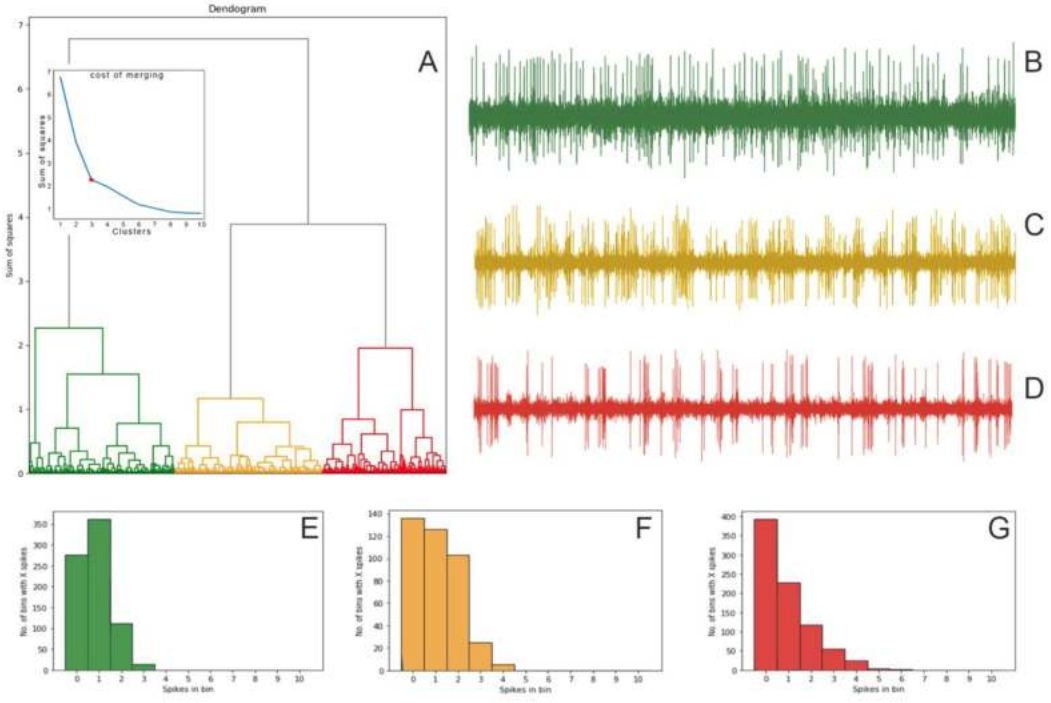
Пример анализа периодических и апериодических компонент





Некоторые результаты наших исследований

Паттерны нейронной активности



Journal of Neuroscience Methods 311 (2019) 164–169

Contents lists available at ScienceDirect

Journal of Neuroscience Methods

journal homepage: www.elsevier.com/locate/jneumeth

Neural activity clusterization for estimation of firing pattern

Vladislav Myrov[a,*], Alexey Sedov[b,c], Elena Belova[b]

[a] Saint Petersburg Academic University, Saint Petersburg, Russia
[b] Semenov Institute of Chemical Physics, Moscow, Russia
[c] Moscow Institute of Physics and Technology, Moscow, Russia

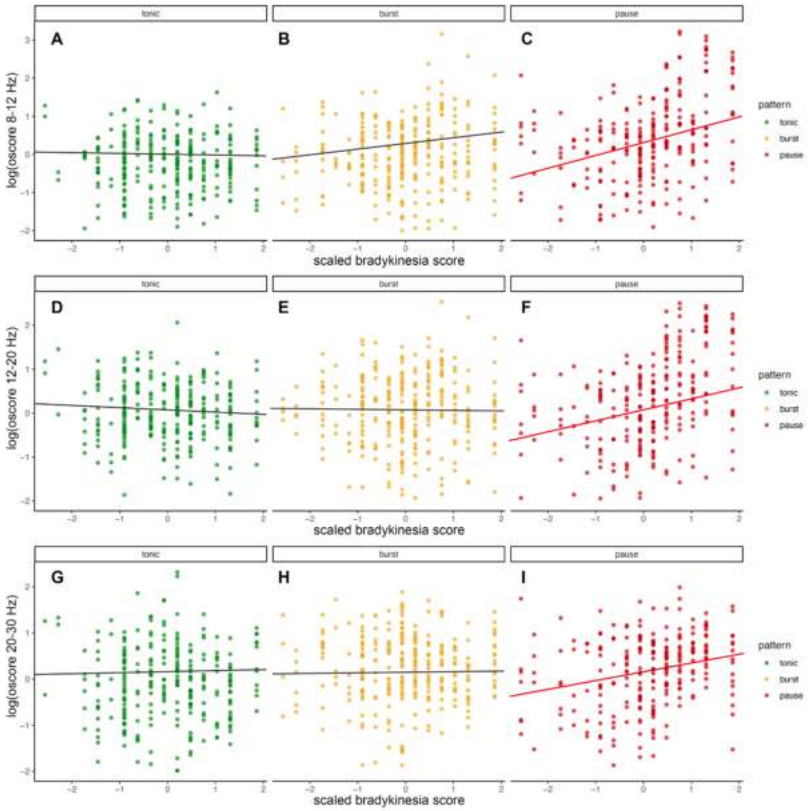
CHAPTER 25

A new approach for estimation of spiketrain patterns in basal ganglia

Vladislav Myrov[a], Alexey Sedov[b,*], Alexey Tomskiy[c], Ludmila Myrova[d], Elena Belova[b]

[a]Saint Petersburg Academic University, Saint Petersburg, Russia
[b]Semenov Institute of Chemical Physics, Moscow, Russia
[c]N.N. Burdenko National Scientific and Practical Center for Neurosurgery, Moscow, Russia
[d]Moscow Scientific Research Institute of Radio Engineering, Moscow, Russia
*Corresponding author: Tel.: +7-903-579-5024, e-mail address: AlexeyS.Sedov@gmail.com

Активность паузных нейронов коррелирует с брадикинезией



Experimental Neurology 356 (2022) 114155

Contents lists available at ScienceDirect

Experimental Neurology

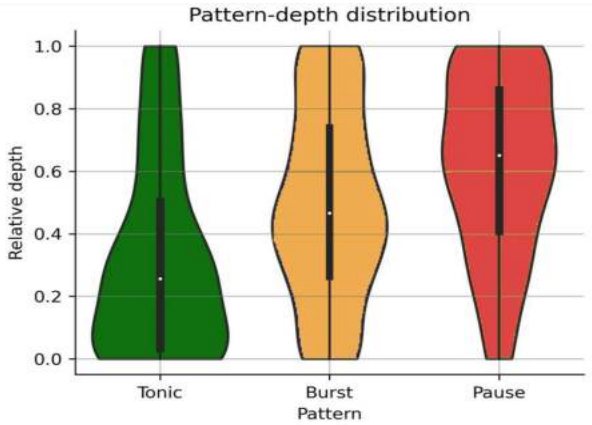
journal homepage: www.elsevier.com/locate/yexnr

Research paper

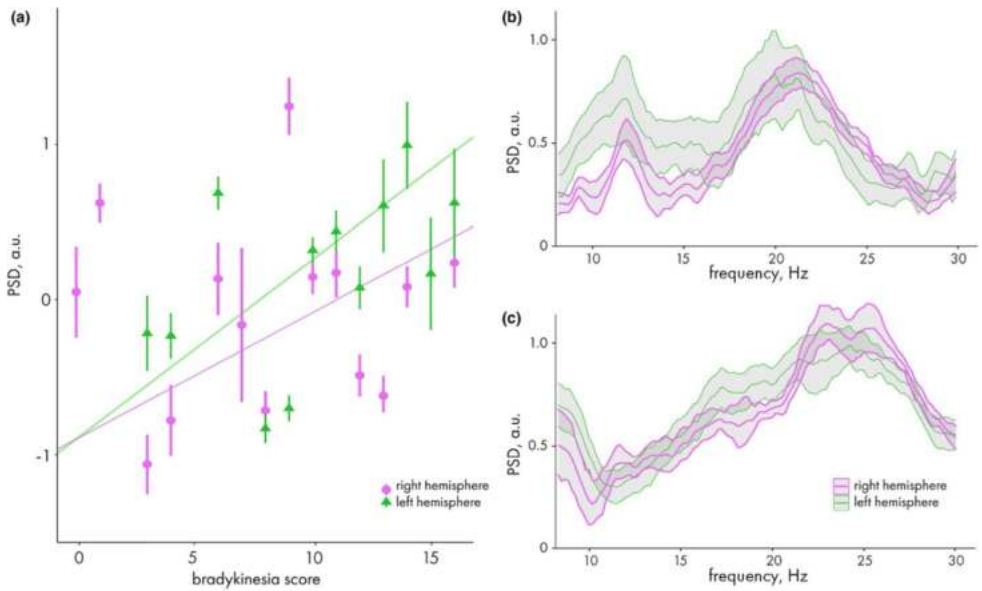
Oscillations of pause-burst neurons in the STN correlate with the severity of motor signs in Parkinson's disease

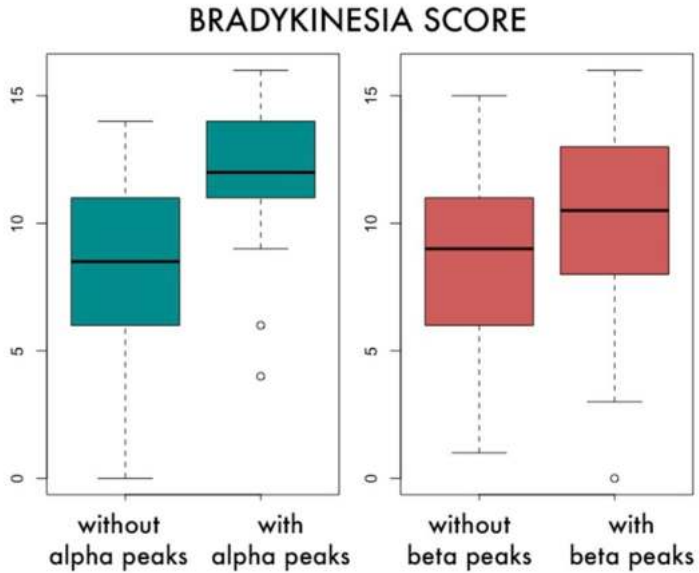
Elena M. Belova [a,*], Veronika I. Filyushkina [a], Indiko Dzhalagoniia [a], Anna A. Gamaleya [b], Alexey A. Tomskiy [b], Wolf-Julian Neumann [c], Alexey Sedov [a]

[a] Semenov Institute of Chemical Physics RAS, Moscow, Russia
[b] N. N. Burdenko National Medical Research Center of Neurosurgery, Moscow, Russia
[c] Charité - Universitätsmedizin Berlin, Berlin, Germany



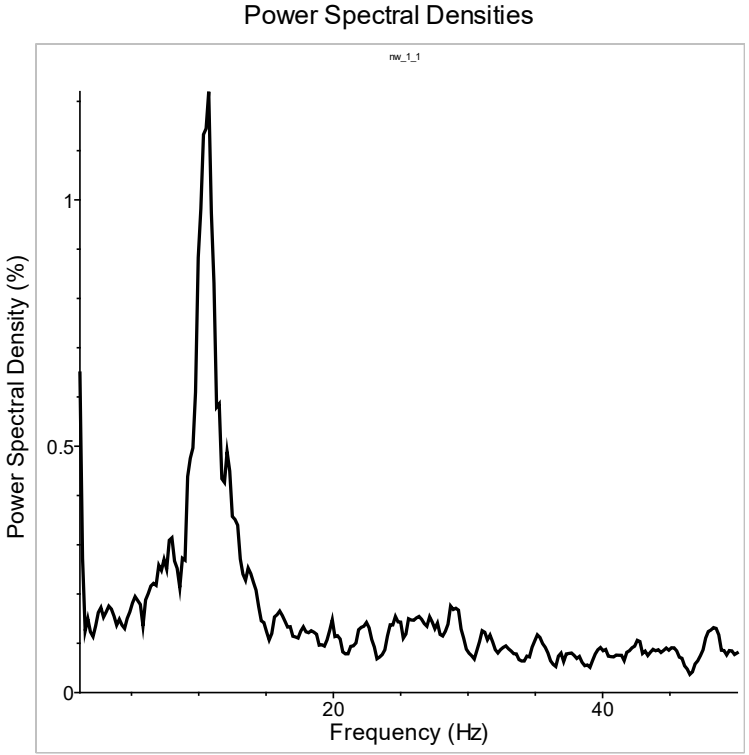
Альфа активность субталамического ядра



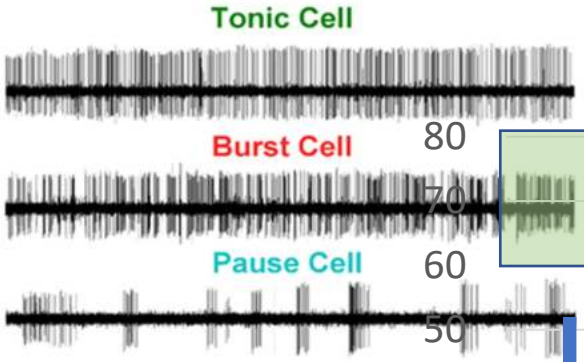


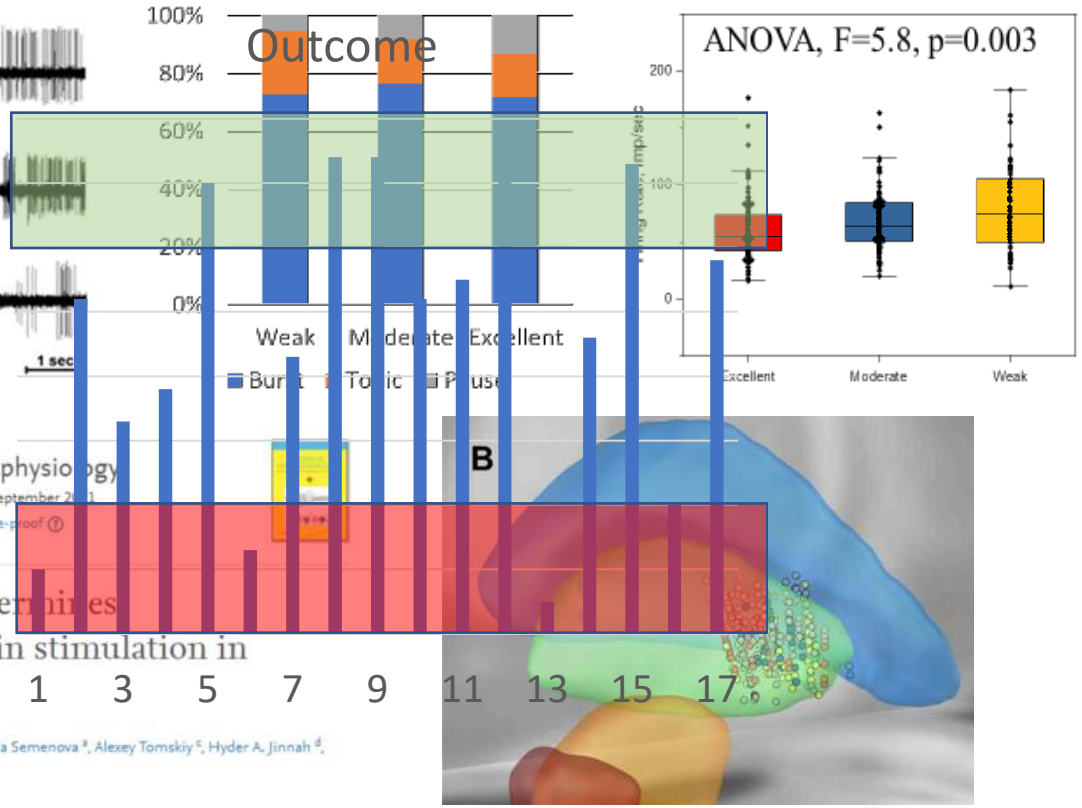
In some patients we observed alpha peak additional to beta peak

Источник альфа активности



Эффективность DBS при цервикальной дистонии





ELSEVIER

Clinical Neurophysiology

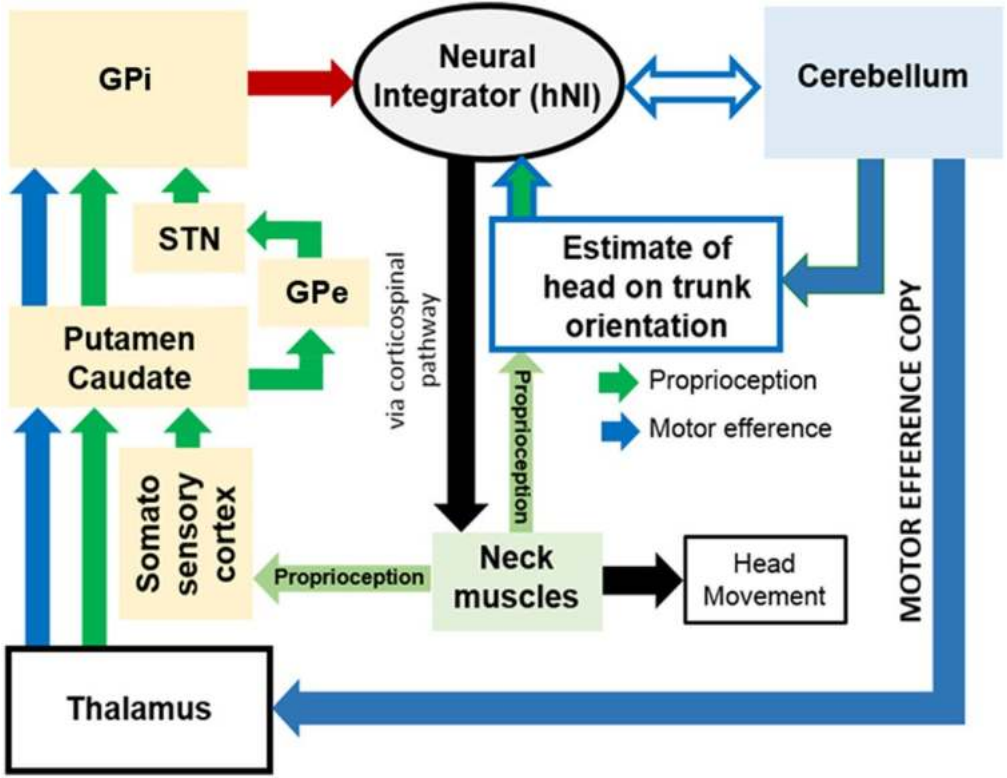
Available online 7 September 2021

In Press, Journal Pre-proof

Pallidal neuron activity determines responsiveness to deep brain stimulation in cervical dystonia

Alexey Sedov [a, b], Valentin Popov [a, c], Anna Gamaleya [c], Ulia Semenova [a], Alexey Tomskiy [c], Hyder A. Jinnah [d], Aasef G. Shaikh [a, f, g]

Интегративная модель цервикальной дистонии



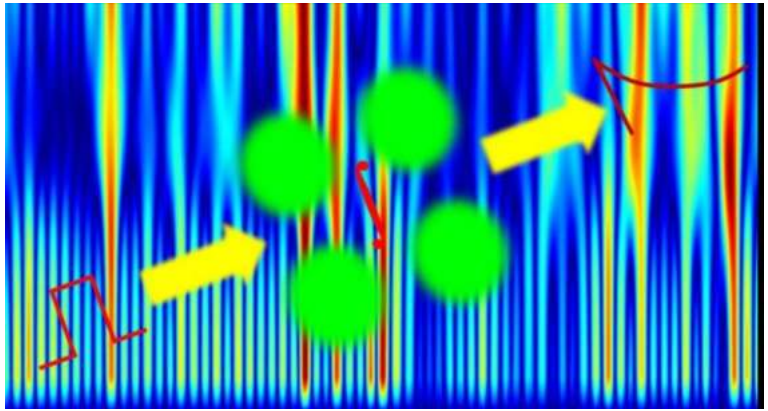
doi:10.1093/brain/aww141 BRAIN 2016: 139; 2590–2599 | 2590

BRAIN
A JOURNAL OF NEUROLOGY

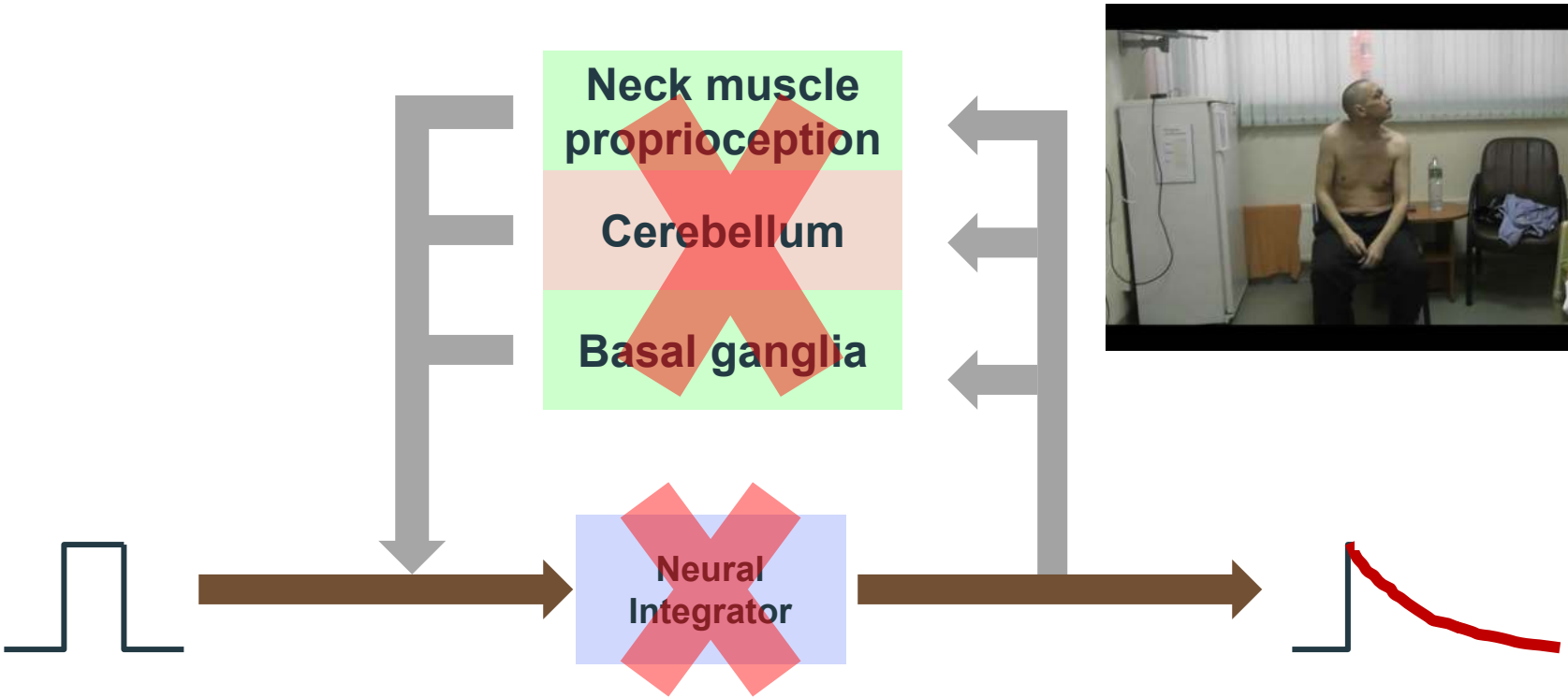
UPDATE

Cervical dystonia: a neural integrator disorder

Aasef G. Shaikh,[1,2] David S. Zee,[3] J. Douglas Crawford[4] and Hyder A. Jinnah[5]



Нейронный интегратор



Поиск подтверждения новой модели

RESEARCH ARTICLE

Physiology of Midbrain Head Movement Neurons in Cervical Dystonia

Alexey Sedov, PhD,[1,2] Valentin Popov, PhD,[1,3] Vladimir Shabalov, MD,[3] Svetlana Raeva, PhD,[1] H. A. Jinnah, MD, PhD,[4] and Aasef G. Shaikh, MD, PhD[4,5,6,7*]

[1]Semenov Institute of Chemical Physics, Russian Academy of Sciences, Moscow, Russia
[2]Moscow Institute of Physics and Te
[3]Burdenko Scientific Research Neurosur
[4]Department of Neurology, Emory Uni
[5]Department of Neurology, Case Western Res
[6]Neurological Institute, University Hospitals Clevela
[7]Neurology Service and Daroff-DellOsso Ocular Motility Laboratory, Lo

ABSTRACT: Background: Early theories for cervical dystonia, as promoted by Hassler, emphasized the role of the midbrain interstitial nucleus of Cajal. Focus then shifted to the basal ganglia, and it was further supported with the success of deep brain stimulation. Contemporary theories suggested the role of the cerebellum, but even more recent hypotheses renewed interest in the midbrain. Although the pretectum was visited on several occasions, we still do not know about the physiology of midbrain neurons in cervical dystonia.

...im was not to address specific hypothesis, but to make an accurate lesion providing optimal relief from ...ystonia. © 2017 International Parkinson and Movement Disorder Society

Key Words: head tremor; interstitial nucleus of Cajal; dystonic tremor

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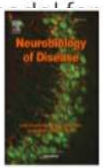
Neurobiology of Disease

journal homepage: www.elsevier.com/locate/ynbdi



The role of pallidum in the neural integrator model of cervical dystonia

Alexey Sedov[a,b], Svetlana Usova[a], Ulia Semenova[a], Anna Ga
J. Douglas Crawford[d], Brian Corneil[e], H.A. Jinnah[f], Aasef G

CHAPTER 20

Implications of asymmetric neural activity patterns in the basal ganglia outflow in the integrative neural network ...cervical dystonia

...[a,*], Ulia Semenova[a], Svetlana Usova[a], Alexey Tomskiy[b], Douglas Crawford[c], Hyder A. Jinnah[d], Aasef G. Shaikh[e,f,g]

...of Chemical Physics, Russian Academy of Sciences, Moscow, Russia
...al Scientific and Practical Center for Neurosurgery, Moscow, Russia
[c]York University, Toronto, ON, Canada
...and Human Genetics, Emory University, Atlanta, GA, United States
...gy, Case Western Reserve University, Cleveland, OH, United States
...Consortium Center and Neurology Service, Louis Stokes Cleveland VA Medical Center, Cleveland, OH, United States
...logical Institute, University Hospitals, Cleveland, OH, United States
...author: +7-903-5795024 e-mail address: alexeys.sedov@gmail.com

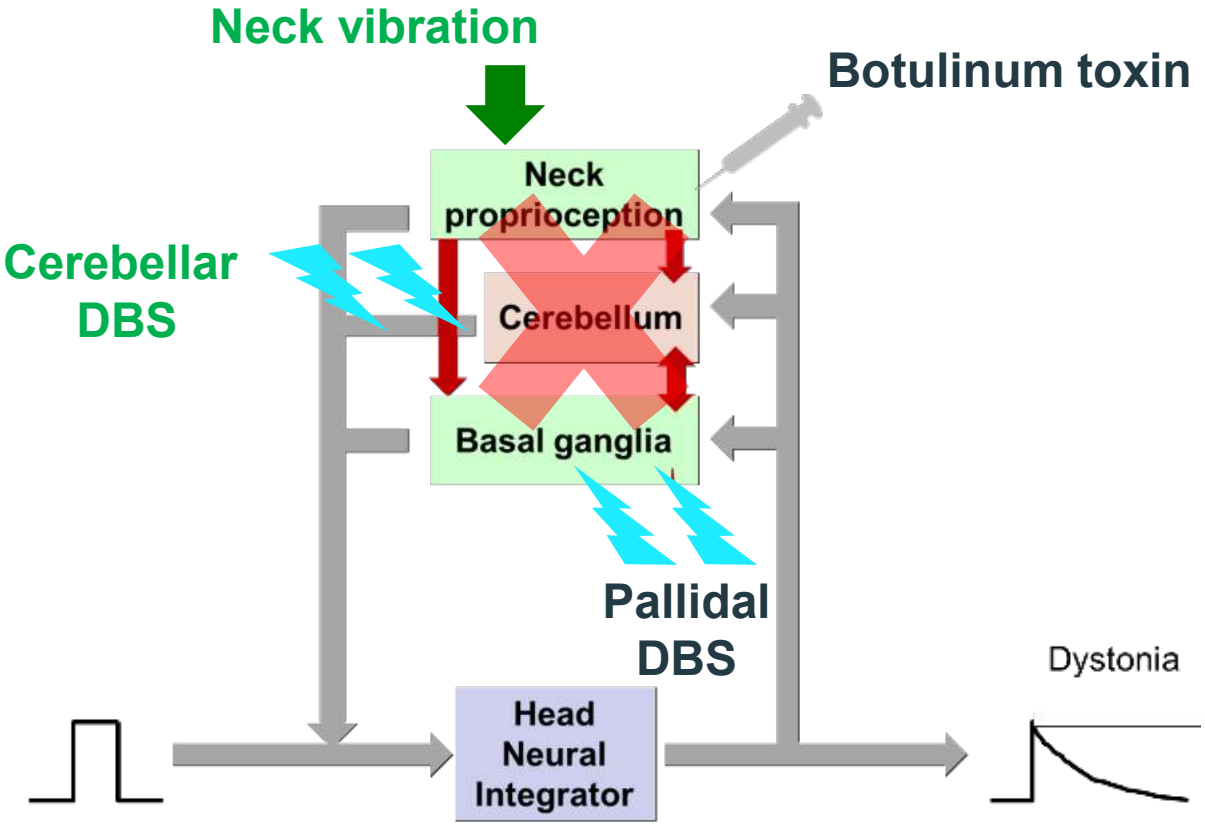
RESEARCH ARTICLE

Proprioceptive Modulation of Pallidal Physiology in Cervical Dystonia

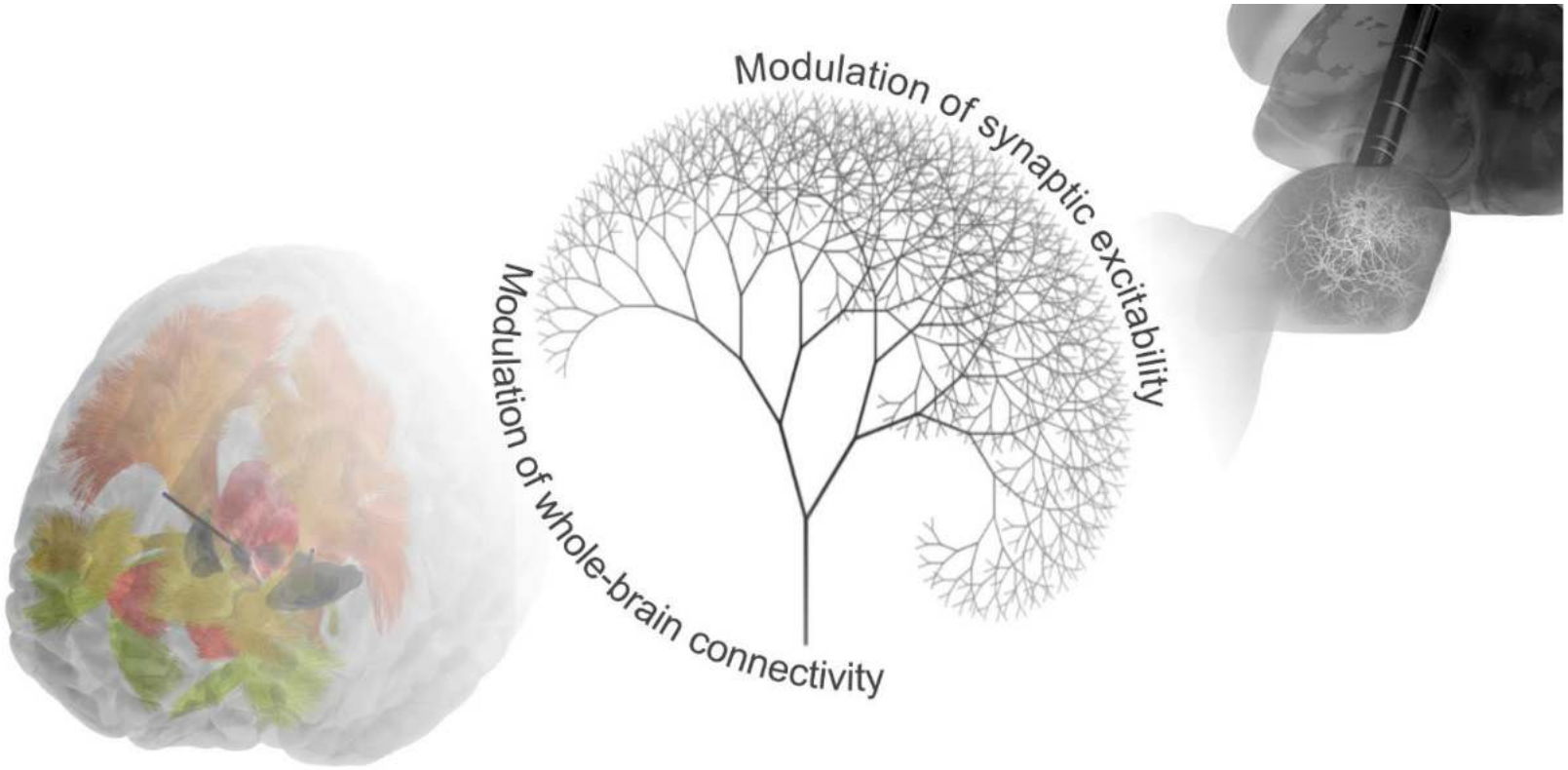
Alexey Sedov, PhD,[1,2] Prajakta Joshi, MS,[3] Ulia Semenova, MSc,[1] Svetlana Usova, PhD,[1] Svetlana Asriyants, MD,[1,4] Anna Gamaleya, MD,[4] Alexey Tomskiy, MD, PhD,[4] Hyder A. Jinnah, MD, PhD,[5] and Aasef G. Shaikh, MD, PhD[3,6,7,8*]

[1]N.N. Semenov Federal Research Center for Chemical Physics, Russian Academy of Sciences, Moscow, Russia
[2]Moscow Institute of Physics and Technology, Dolgoprudny, Moscow Region, Russia
[3]Department of Biomedical Engineering, Case Western Reserve University, Cleveland, Ohio, USA
[4]Burdenko National Scientific and Practical Center for Neurosurgery, Moscow, Russia
[5]Department of Neurology, Pediatrics, and Genetics, Emory University, Atlanta, Georgia, USA
[6]Department of Neurology, Case Western Reserve University, Cleveland, Ohio, USA
[7]Neurological Institute, University Hospitals, Cleveland, Ohio, USA
[8]Neurology Service, Louis Stokes Cleveland VA Medical Center, Cleveland, Ohio, USA

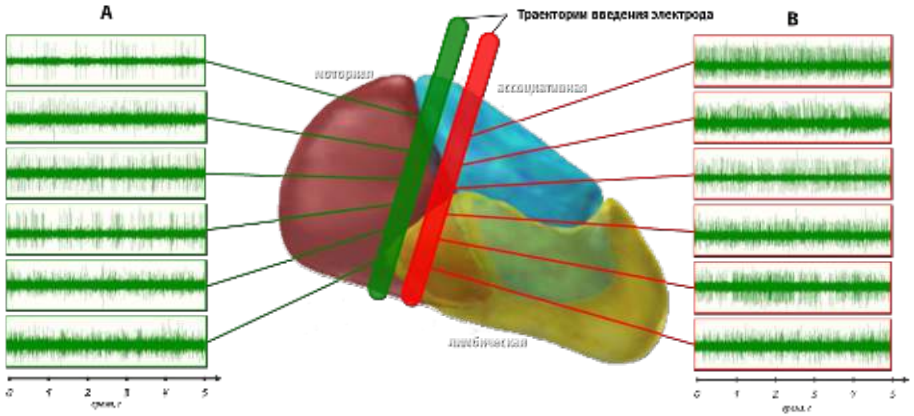
Home messages



Перспективные направления развития

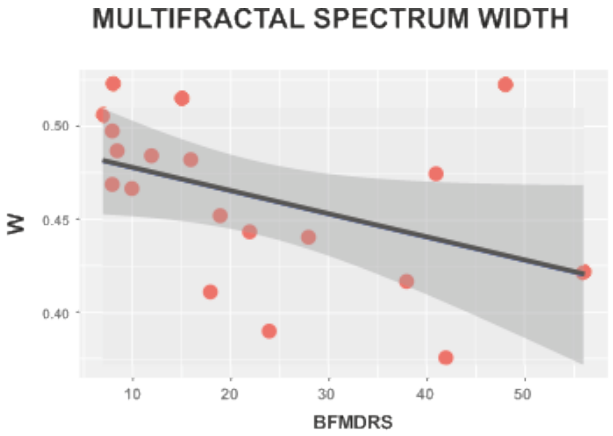


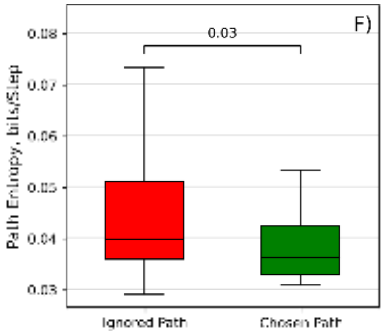
Поиск новых нелинейных предикторов

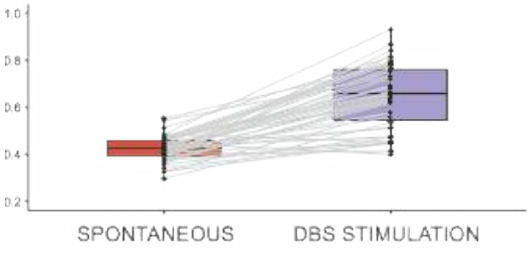


Заметный клинический эффект

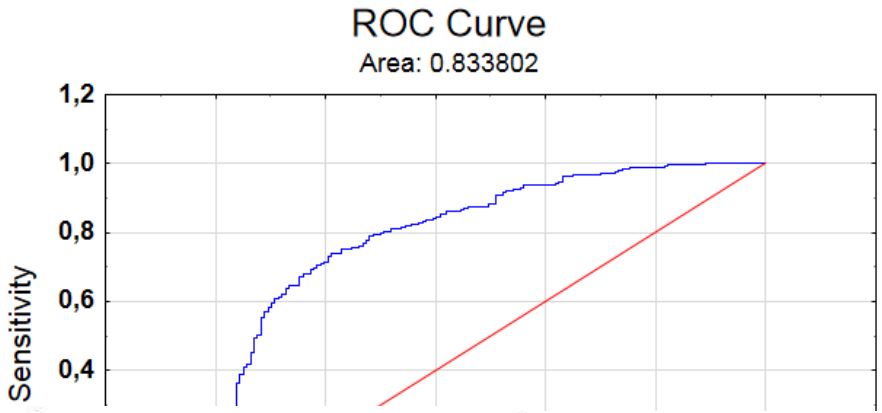
Слабый клинический эффект/нет эффекта

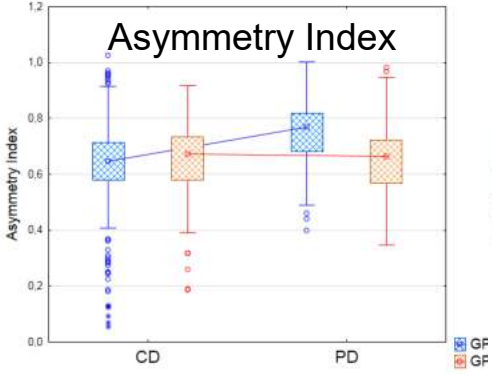


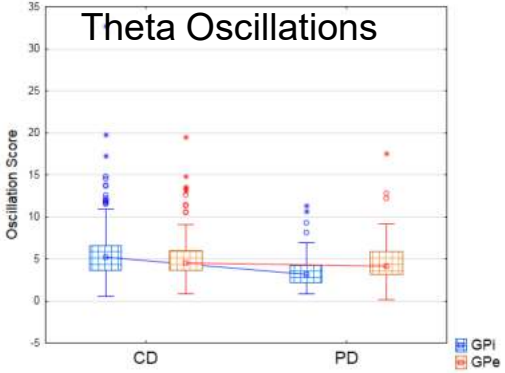




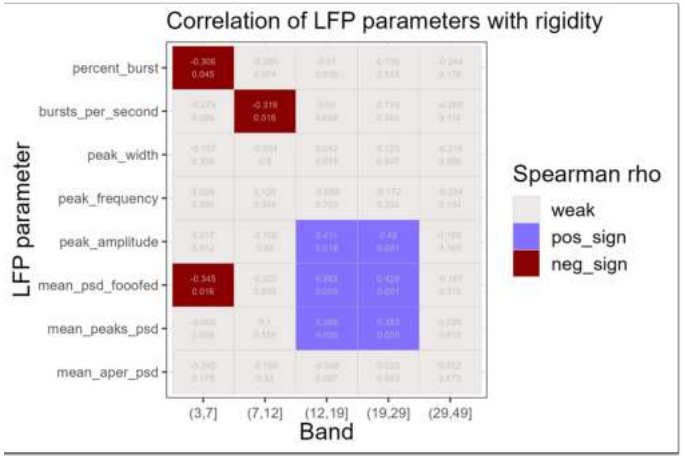
Многофакторные модели







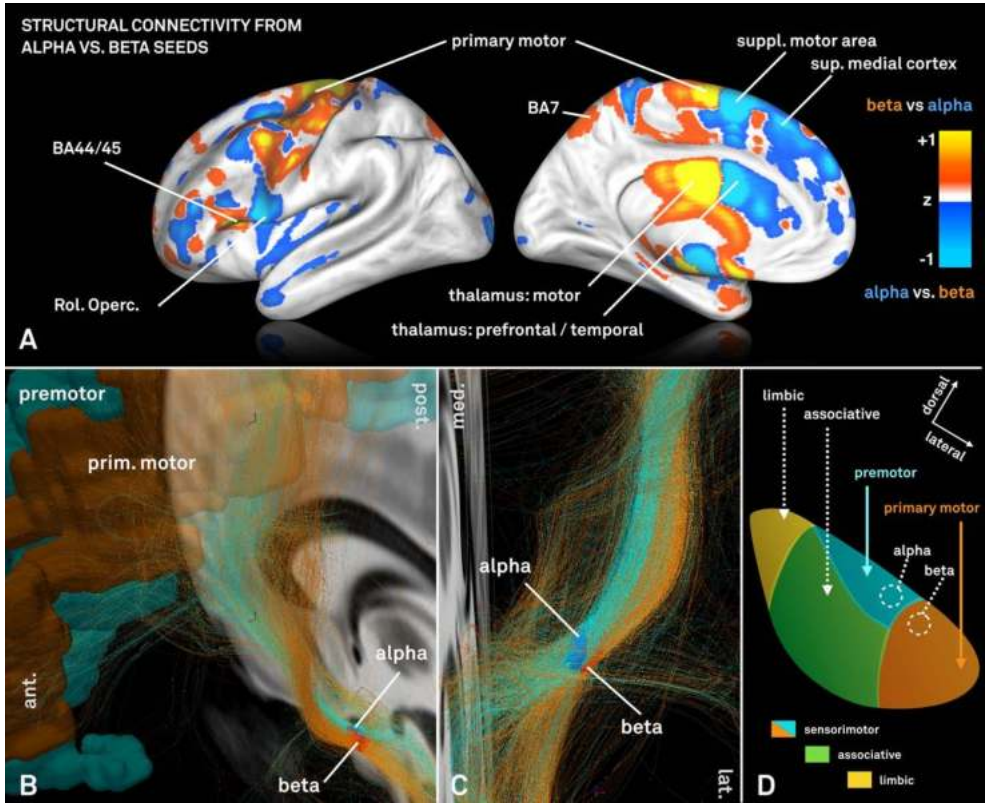
Матрица корреляций параметров сигнала с симптомом

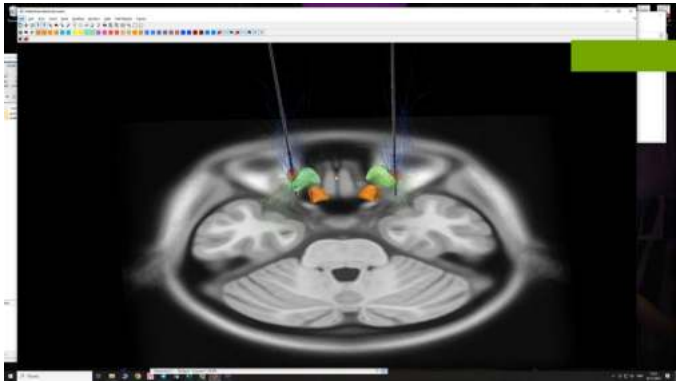


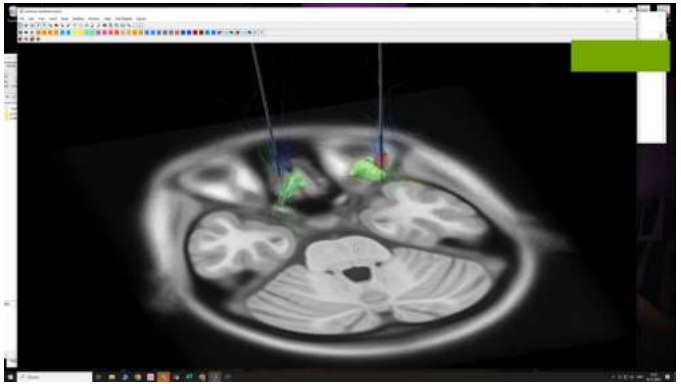
С ригидностью коррелирует не один, а несколько параметров в разных частотных диапазонах!

Бордовый – значимые отрицательные корреляции,
фиолетовый – значимые положительные

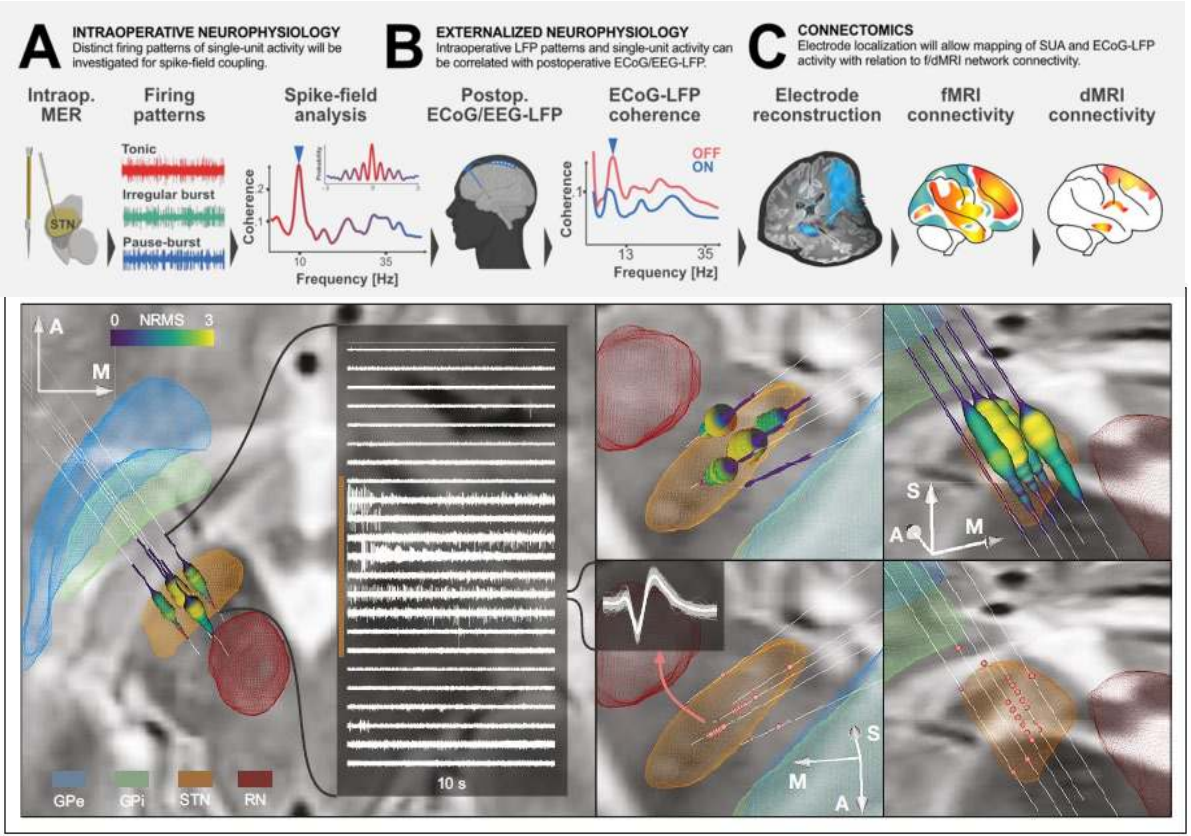
Функциональная и анатомическая коннективность







От микро- до макроуровня



Наша команда

Basic Scientists










Clinical Scientists