

Curriculum vitae: Alexey Semyanov



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Russia

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Education

1996–1998	Puschchino	Pushchino State University	neuroscientist
1991–1996	Russia, Nizhny Novgorod	University of Nizhny Novgorod	biophysicist

IBCh positions

2025–to date	Head of department
2021–2025	Deputy sci-director
2018–2025	Principal research fellow
2018–2022	Head of Laboratory

Scientific societies' membership

2017-	Member of Institute of Bioorganic Chemistry academic council
2016-	Member of University of Nizhny Novgorod Dissertation Council
2014-2018	Member of University of Nizhny Novgorod academic council

Society memberships

2017-	Fellow of The Physiological Society, UK
2006-	Member, Japan Neuroscience Society
2003-	Member, Brain Research Society of Finland
2002-2017	Ordinary member, The Physiological Society, UK
1999-2002	Affiliate member, The Physiological Society, UK
1999-	Member, Society for Neuroscience, USA (ID# 100006439)

Titles

2016	Corresponding member of the Academy of Sciences
	Professor
2002	Doctor of Science (Biological sciences)

Grants and projects

2023–to date	-Эффект морфологической перестройки астроцитов на функции мозга
2021–2022	-

2020– 2022	-Влияние сокращения потребляемых калорий на нейрон-глиальные взаимодействия при старении и в модели болезни Альцгеймера
2019– 2019	-
2017– 2021	-

Publications

1. Sergeeva AD, Panova AS, Ivanova AD, Khramova YV, Morozova KI, Kotova DA, Guryleva AV, Khokhlov DD, Kelmanson IV, Vasilev AV, Kostyuk AI, **Semyanov AV**, Oleinikov VA, Belousov VV, Machikhin AS, Brazhe NA, Bilan DS (2024). Where in the tissues of *Danio rerio* is more H₂O₂ produced during acute hypoxia? *Antioxid Redox Signal* , , [10.1089/ars.2024.0563](#)
2. Kostyuk AI, Rapota DD, Morozova KI, Fedotova AA, Jappy D, **Semyanov AV**, Belousov VV, Brazhe NA, Bilan DS (2024). Modern optical approaches in redox biology: Genetically encoded sensors and Raman spectroscopy. *J Free Radic Biol Med* 217, 68–115, [10.1016/j.freeradbiomed.2024.03.010](#)
3. Christie IN, Theparambil SM, Braga A, Doronin M, Hosford PS, Brazhe A, Mascarenhas A, Nizari S, Hadjihambi A, Wells JA, Hobbs A, **Semyanov A**, Abramov AY, Angelova PR, Gourine AV (2023). Astrocytes produce nitric oxide via nitrite reduction in mitochondria to regulate cerebral blood flow during brain hypoxia. *Cell Rep* 42 (12), 113514, [10.1016/j.celrep.2023.113514](#)
4. Popov A, Brazhe N, Morozova K, Yashin K, Bychkov M, Nosova O, Sutyagina O, Brazhe A, Parshina E, Li L, Medyanik I, Korzhhevskii DE, Shenkarev Z, Lyukmanova E, Verkhatsky A, **Semyanov A** (2023). Mitochondrial malfunction and atrophy of astrocytes in the aged human cerebral cortex. *Nat Commun* 14 (14), 8380, [10.1038/s41467-023-44192-0](#)
5. Ivanova AD, Kotova DA, Khramova YV, Morozova KI, Serebryanaya DV, Bochkova ZV, Sergeeva AD, Panova AS, Katrukha IA, Moshchenko AA, Oleinikov VA, **Semyanov AV**, Belousov VV, Katrukha AG, Brazhe N, Bilan DS (2023). Redox differences between rat neonatal and adult cardiomyocytes under hypoxia. *J Free Radic Biol Med* 211, 145–157, [10.1016/j.freeradbiomed.2023.11.034](#)
6. Kotova DA, Ivanova AD, Pochechuev MS, Kelmanson IV, Khramova YV, Tiaglik A, Sudoplatov MA, Trifonova AP, Fedotova A, Morozova K, Katrukha VA, Sergeeva AD, Raevskii RI, Pestriakova MP, Solotnikov MA, Stepanov EA, Tsopina AS, Moshchenko AA, Shestopalova M, Zalygin A, Fedotov IV, Fedotov AB, Oleinikov V, Belousov VV, **Semyanov A**, Brazhe N, Zheltikov AM, Bilan DS (2023). Hyperglycemia exacerbates ischemic stroke not through increased generation of hydrogen peroxide. *J Free Radic Biol Med* 208, 153–164, [10.1016/j.freeradbiomed.2023.08.004](#)
7. Barshutina M, Doroshina N, Baizhumanov A, Nikelshparg E, Fedotova A, Popov A, **Semyanov A**, Yakubovsky D, Tselikov G, Luneva O, Kirilyuk I, Maksimov G, Volkov V, Arsenin A, Brazhe N, Novikov S (2023). SERS substrates based on rose petal replicas for the oxidative stress detection. *Appl Surf Sci* 626, , [10.1016/j.apsusc.2023.157281](#)
8. Verkhatsky A, **Semyanov A** (2023). Decline of astrocyte Ca²⁺ signalling in Alzheimer's disease: STIM1 to the rescue! *Cell Calcium* 113, 102756, [10.1016/j.ceca.2023.102756](#)
9. Lin SS, Zhou B, Chen BJ, Jiang RT, Li B, Illes P, **Semyanov A**, Tang Y, Verkhatsky A (2023). Electroacupuncture prevents astrocyte atrophy to alleviate depression. *Cell Death Dis* 14 (5), 343, [10.1038/s41419-023-05839-4](#)
10. Fedotova A, Brazhe A, Doronin M, Toptunov D, Pryazhnikov E, Khiroug L, Verkhatsky A, **Semyanov A** (2023). Dissociation Between Neuronal and Astrocytic Calcium Activity in Response to Locomotion in Mice. *Function* 4 (4), zqad019, [10.1093/function/zqad019](#)
11. (book) Verkhatsky A, **Semyanov A** (2023). Astrocytes in Ageing. *Subcell Biochem* 103, 253–277, [10.1007/978-3-031-26576-1_11](#)
12. Xiong XY, **Semyanov A**, Tang Y (2022). Restored oligodendrogenesis by fibroblast growth factor 17: molecular mechanism for rejuvenating ageing-related memory deficit. *Signal Transduct Target Ther* 7 (1), 237, [10.1038/s41392-022-01092-x](#)

13. Postnikova TY, Trofimova AM, Zakharova MV, Nosova OI, Brazhe AR, Korzhevskii DE, **Semyanov AV**, Zaitsev AV (2022). Delayed Impairment of Hippocampal Synaptic Plasticity after Pentylene-tetrazole-Induced Seizures in Young Rats. *Int J Mol Sci* 23 (21), , [10.3390/ijms232113461](https://doi.org/10.3390/ijms232113461)
14. Popov A, Brazhe N, Fedotova A, Tiaglik A, Bychkov M, Morozova K, Brazhe A, Aronov D, Lyukmanova E, Lazareva N, Li L, Ponimaskin E, Verkhatsky A, **Semyanov A** (2022). A high-fat diet changes astrocytic metabolism to promote synaptic plasticity and behavior. *Acta Physiol (Oxf)* 236 (1), e13847, [10.1111/apha.13847](https://doi.org/10.1111/apha.13847)
15. Verkhatsky A, **Semyanov A** (2022). The great astroglial metabolic revolution: Mitochondria fuel astrocyte homeostatic support and neuroprotection. *Cell Calcium* 104, 102583, [10.1016/j.ceca.2022.102583](https://doi.org/10.1016/j.ceca.2022.102583)
16. Verkhatsky A, Lazareva N, **Semyanov A** (2022). Glial decline and loss of homeostatic support rather than inflammation defines cognitive aging. *Neural Regen Res* 17 (3), 565–566, [10.4103/1673-5374.320979](https://doi.org/10.4103/1673-5374.320979)
17. Tyurikova O, Shih PY, Dembitskaya Y, Savtchenko LP, McHugh TJ, Rusakov DA, **Semyanov A** (2022). K⁺ efflux through postsynaptic NMDA receptors suppresses local astrocytic glutamate uptake. *Glia* 70 (5), 961–974, [10.1002/glia.24150](https://doi.org/10.1002/glia.24150)
18. **Semyanov A**, Verkhatsky A (2022). Inclusive Brain: From Neuronal Doctrine to the Active Milieu. *Function* 3 (2), zqab069, [10.1093/function/zqab069](https://doi.org/10.1093/function/zqab069)
19. **Semyanov A**, Verkhatsky A (2021). Astrocytic processes: from tripartite synapses to the active milieu. *Trends Neurosci* 44 (10), 781–792, [10.1016/j.tins.2021.07.006](https://doi.org/10.1016/j.tins.2021.07.006)
20. Fedotova AA, Tiaglik AB, **Semyanov AV** (2021). Effect of Diet as a Factor of Exposome on Brain Function. *J Evol Biochem Physiol* (57), 577–604, [10.1134/S0022093021030108](https://doi.org/10.1134/S0022093021030108)
21. Wang T, Ulrich H, **Semyanov A**, Illes P, Tang Y (2021). Optical control of purinergic signaling. *Purinergic Signal* 17 (3), 385–392, [10.1007/s11302-021-09799-2](https://doi.org/10.1007/s11302-021-09799-2)
22. Denisov P, Popov A, Brazhe A, Lazareva N, Verkhatsky A, **Semyanov A** (2021). Caloric restriction modifies spatiotemporal calcium dynamics in mouse hippocampal astrocytes. *BIOCHIM BIOPHYS ACTA* 1868 (7), 119034, [10.1016/j.bbamcr.2021.119034](https://doi.org/10.1016/j.bbamcr.2021.119034)
23. Dembitskaya Y, Gavrilov N, Kraev I, Doronin M, Tang Y, Li L, **Semyanov A** (2021). Attenuation of the extracellular matrix increases the number of synapses but suppresses synaptic plasticity through upregulation of SK channels. *Cell Calcium* 96, 102406, [10.1016/j.ceca.2021.102406](https://doi.org/10.1016/j.ceca.2021.102406)
24. Huang Z, Xie N, Illes P, Di Virgilio F, Ulrich H, **Semyanov A**, Verkhatsky A, Sperlagh B, Yu SG, Huang C, Tang Y (2021). From purines to purinergic signalling: molecular functions and human diseases. *Signal Transduct Target Ther* 6 (1), 162, [10.1038/s41392-021-00553-z](https://doi.org/10.1038/s41392-021-00553-z)
25. Cao X, Yin HY, Ulrich H, **Semyanov A**, Tang Y (2021). A Neural Circuit for Gut-Induced Sugar Preference. *Neurosci Bull* 37 (5), 754–756, [10.1007/s12264-021-00692-x](https://doi.org/10.1007/s12264-021-00692-x)
26. (book) Lim D, **Semyanov A**, Genazzani A, Verkhatsky A (2021). Calcium signaling in neuroglia. *Int Rev Cell Mol Biol* 362, 1–53, [10.1016/bs.ircmb.2021.01.003](https://doi.org/10.1016/bs.ircmb.2021.01.003)
27. Verkhatsky A, Illes P, Tang Y, **Semyanov A** (2021). The anti-inflammatory astrocyte revealed: the role of the microbiome in shaping brain defences. *Signal Transduct Target Ther* 6 (1), 150, [10.1038/s41392-021-00577-5](https://doi.org/10.1038/s41392-021-00577-5)
28. Popov A, Brazhe A, Denisov P, Sutyagina O, Li L, Lazareva N, Verkhatsky A, **Semyanov A** (2021). Astrocyte dystrophy in ageing brain parallels impaired synaptic plasticity. *Aging Cell* 20 (3), e13334, [10.1111/ace.13334](https://doi.org/10.1111/ace.13334)
29. Escartin C, Galea E, Lakatos A, OCallaghan JP, Petzold GC, Serrano-Pozo A, Steinhäuser C, Volterra A, Carmignoto G, Agarwal A, Allen NJ, Araque A, Barbeito L, Barzilai A, Bergles DE, Bonvento G, Butt AM, Chen WT, Cohen-Salmon M, Cunningham C, Deneen B, De Strooper B, Díaz-Castro B, Farina C, Freeman M, Gallo V, Goldman JE, Goldman SA, Götz M, Gutiérrez A, Haydon PG, Heiland DH, Hol EM, Holt MG, Iino M, Kastanenka KV, Kettenmann H, Khakh BS, Koizumi S, Lee CJ, Liddelow SA, MacVicar BA, Magistretti P, Messing A, Mishra A, Molofsky AV, Murai KK, Norris CM, Okada S, Olie SH, Oliveira JF, Panatier A, Parpura V, Pekna M, Pekny M, Pellerin L, Perea G, Pérez-Nievas BG, Pfrieger FW, Poskanzer KE, Quintana FJ, Ransohoff RM, Riquelme-Perez M, Robel S, Rose CR, Rothstein JD, Rouach N, Rowitch DH, **Semyanov A**, Sirko S, Sontheimer H, Swanson RA, Vitorica J, Wanner IB, Wood LB, Wu J, Zheng B, Zimmer ER, Zorec R, Sofroniew MV, Verkhatsky A (2021). Reactive astrocyte nomenclature, definitions, and future directions. *Nat Neurosci* 24 (3), 312–325, [10.1038/s41593-020-00783-4](https://doi.org/10.1038/s41593-020-00783-4)

30. Федотова АА, Тяглик АБ, **Семьянов АВ** (2021). Влияние диеты как фактора экспозома на работу головного мозга. *Ross Fiziol Zh Im I M Sechenova* 107 (4-5), 533–567, [10.31857/S0869813921040087](https://doi.org/10.31857/S0869813921040087)
31. McCauley JP, Petroccione MA, DBrant LY, Todd GC, Affinnih N, Wisnoski JJ, Zahid S, Shree S, Sousa AA, De Guzman RM, Migliore R, Brazhe A, Leapman RD, Khmaladze A, **Semyanov A**, Zuloaga DG, Migliore M, Scimemi A (2020). Circadian Modulation of Neurons and Astrocytes Controls Synaptic Plasticity in Hippocampal Area CA1. *Cell Rep* 33 (2), 108255, [10.1016/J.CELREP.2020.108255](https://doi.org/10.1016/J.CELREP.2020.108255)
32. Verkhatsky A, Augusto-Oliveira M, Pivoriūnas A, Popov A, Brazhe A, **Semyanov A** (2020). Astroglial asthenia and loss of function, rather than reactivity, contribute to the ageing of the brain. *Pflugers Arch Gesamte Physiol Menschen Tiere* 473 (5), 753–774, [10.1007/s00424-020-02465-3](https://doi.org/10.1007/s00424-020-02465-3)
33. Verkhatsky A, **Semyanov A**, Zorec R (2020). Physiology of Astroglial Excitability. *Function* 1 (2), zqaa016, [10.1093/function/zqaa016](https://doi.org/10.1093/function/zqaa016)
34. **Semyanov A**, Henneberger C, Agarwal A (2020). Making sense of astrocytic calcium signals — from acquisition to interpretation. *Nat Rev Neurosci* 21 (10), 551–564, [10.1038/s41583-020-0361-8](https://doi.org/10.1038/s41583-020-0361-8)
35. Ren WJ, Ulrich H, **Semyanov A**, Illes P, Tang Y (2020). TASK-3: New Target for Pain-Relief. *Neurosci Bull* 36 (8), 951–954, [10.1007/s12264-020-00516-4](https://doi.org/10.1007/s12264-020-00516-4)
36. Tyurikova O, Zheng K, Nicholson E, Timofeeva Y, **Semyanov A**, Volynski K, Rusakov DA (2020). Fluorescence lifetime imaging reveals regulation of presynaptic Ca²⁺ by glutamate uptake and mGluRs, but not somatic voltage in cortical neurons. *J Neurochem* 156 (1), 48–58, [10.1111/jnc.15094](https://doi.org/10.1111/jnc.15094)
37. Dembitskaya Y, Wu YW, **Semyanov A** (2020). Tonic GABAA conductance favors spike-timing-dependent over theta-burst-induced long-term potentiation in the hippocampus. *J Neurosci* 40 (22), 4266–4276, [10.1523/JNEUROSCI.2118-19.2020](https://doi.org/10.1523/JNEUROSCI.2118-19.2020)
38. Popov A, Denisov P, Bychkov M, Brazhe A, Lyukmanova E, Shenkarev Z, Lazareva N, Verkhatsky A, **Semyanov A** (2020). Caloric restriction triggers morphofunctional remodeling of astrocytes and enhances synaptic plasticity in the mouse hippocampus. *Cell Death Dis* 11 (3), 208, [10.1038/s41419-020-2406-3](https://doi.org/10.1038/s41419-020-2406-3)
39. Marina N, Christie IN, Korsak A, Doronin M, Brazhe A, Hosford PS, Wells JA, Sheikhabaei S, Humoud I, Paton JFR, Lythgoe MF, **Semyanov A**, Kasparov S, Gourine AV (2020). Astrocytes monitor cerebral perfusion and control systemic circulation to maintain brain blood flow. *Nat Commun* 11 (1), 131, [10.1038/s41467-019-13956-y](https://doi.org/10.1038/s41467-019-13956-y)
40. Glaser T, Andrejew R, Oliveira-Giacomelli Á, Ribeiro DE, Bonfim Marques L, Ye Q, Ren WJ, **Semyanov A**, Illes P, Tang Y, Ulrich H (2020). Purinergic Receptors in Basal Ganglia Diseases: Shared Molecular Mechanisms between Huntington's and Parkinson's Disease. *Neurosci Bull* 36 (11), 1299–1314, [10.1007/s12264-020-00582-8](https://doi.org/10.1007/s12264-020-00582-8)
41. Браже АР, Доронин МС, Попов АВ, Денисов ПА, **Семьянов АВ** (2019). Patterns of Calcium Dynamics in Brain Astrocytic Networks. *Ross Fiziol Zh Im I M Sechenova* 105 (11), 1436–1451, [10.1134/S0869813919110037](https://doi.org/10.1134/S0869813919110037)
42. Verkhatsky A, Rodrigues JJ, Pivoriunas A, Zorec R, **Semyanov A** (2019). Astroglial atrophy in Alzheimer's disease. *Pflugers Arch Gesamte Physiol Menschen Tiere* 471 (10), 1247–1261, [10.1007/s00424-019-02310-2](https://doi.org/10.1007/s00424-019-02310-2)
43. Verkhatsky A, **Semyanov A** (2019). Astroglial Ca²⁺ signals trigger pathological behaviour in optogenetic mouse. *Cell Calcium* 82, 102062, [10.1016/j.ceca.2019.102062](https://doi.org/10.1016/j.ceca.2019.102062)
44. (conference) , Brazhe AR, **Semyanov AV**, Verkhatsky AN, Denisov P (2019). High-fat (Western) diet induces morphofunctional remodeling of astrocytes in mouse hippocampus. 67 (S1), E399–E400, [10.1002/glia.23675](https://doi.org/10.1002/glia.23675)
45. **Semyanov A** (2019). Spatiotemporal pattern of calcium activity in astrocytic network. *Cell Calcium* 78, 15–25, [10.1016/j.ceca.2018.12.007](https://doi.org/10.1016/j.ceca.2018.12.007)
46. Wu YW, Gordleeva S, Tang X, Shih PY, Dembitskaya Y, **Semyanov A** (2018). Morphological profile determines the frequency of spontaneous calcium events in astrocytic processes. *Glia* 67 (2), 246–262, [10.1002/glia.23537](https://doi.org/10.1002/glia.23537)
47. Gavrillov N, Golyagina I, Brazhe A, Scimemi A, Turlapov V, **Semyanov A** (2018). Astrocytic coverage of dendritic spines, dendritic shafts, and axonal boutons in hippocampal neuropil. *Front Cell Neurosci* 12, 248, [10.3389/fncel.2018.00248](https://doi.org/10.3389/fncel.2018.00248)
48. Plata A, Lebedeva A, Denisov P, Nosova O, Postnikova TY, Pimashkin A, Brazhe A, Zaitsev AV, Rusakov DA, **Semyanov A** (2018). Astrocytic Atrophy Following Status Epilepticus Parallels Reduced Ca²⁺ Activity

- and Impaired Synaptic Plasticity in the Rat Hippocampus. *Front Mol Neurosci* 11, 215, [10.3389/fnmol.2018.00215](https://doi.org/10.3389/fnmol.2018.00215)
49. **(conference)** Kustikova VD, Krivonosov MI, Denisov PA, Zaikin AA, Ivanchenko MV, Meyerov IB, **Semyanov AV** (2018). Time-lapse imaging for calcium activity analysis in astrocytes with automatic video processing. *Opera Med Physiol* 4, 83.
 50. **(conference)** Kustikova V, Krivonosov M, Pimashkin A, Denisov P, Zaikin A, Ivanchenko M, Meyerov I, **Semyanov A** (2018). CalciumCV: Computer vision software for calcium signaling in astrocytes. *LECT NOTES COMPUT SC* 11179 LNCS (1), 168–179, [10.1007/978-3-030-11027-7_17](https://doi.org/10.1007/978-3-030-11027-7_17)
 51. Lebedeva A, Plata A, Nosova O, Tyurikova O, **Semyanov A** (2018). Activity-dependent changes in transporter and potassium currents in hippocampal astrocytes. *Brain Res Bull* 136, 37–43, [10.1016/j.brainresbull.2017.08.015](https://doi.org/10.1016/j.brainresbull.2017.08.015)
 52. Jennings A, Tyurikova O, Bard L, Zheng K, **Semyanov A**, Henneberger C, Rusakov DA (2017). Dopamine elevates and lowers astroglial Ca²⁺ through distinct pathways depending on local synaptic circuitry. *Glia* 65 (3), 447–459, [10.1002/glia.23103](https://doi.org/10.1002/glia.23103)
 53. Vedunova MV, Mishchenko TA, Mitroshina EV, Ponomareva NV, Yudintsev AV, Generalova AN, Deyev SM, Mukhina IV, **Semyanov AV**, Zvyagin AV (2016). Cytotoxic effects of upconversion nanoparticles in primary hippocampal cultures. *RSC Adv* 6 (40), 33656–33665, [10.1039/c6ra01272h](https://doi.org/10.1039/c6ra01272h)
 54. Pavlov I, Savtchenko LP, Song I, Koo J, Pimashkin A, Rusakov DA, **Semyanov A** (2014). Tonic GABA_A conductance bidirectionally controls interneuron firing pattern and synchronization in the CA3 hippocampal network. *Proc Natl Acad Sci U S A* 111 (1), 504–509, [10.1073/pnas.1308388110](https://doi.org/10.1073/pnas.1308388110)
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 56. Shih PY, Savtchenko LP, Kamasawa N, Dembitskaya Y, McHugh TJ, Rusakov DA, Shigemoto R, **Semyanov A** (2013). Retrograde Synaptic Signaling Mediated by K⁺ Efflux through Postsynaptic NMDA Receptors. *Cell Rep* 5 (4), 941–951, [10.1016/j.celrep.2013.10.026](https://doi.org/10.1016/j.celrep.2013.10.026)
 57. Włodarczyk AI, Sylantyev S, Herd MB, Kersanté F, Lambert JJ, Rusakov DA, Linthorst ACE, **Semyanov A**, Belelli D, Pavlov I, Walker MC (2013). GABA-independent GABA_A receptor openings maintain tonic currents. *J Neurosci* 33 (9), 3905–3914, [10.1523/JNEUROSCI.4193-12.2013](https://doi.org/10.1523/JNEUROSCI.4193-12.2013)
 58. Wu YW, Grebenyuk S, McHugh TJ, Rusakov DA, **Semyanov A** (2012). Backpropagating Action Potentials Enable Detection of Extrasynaptic Glutamate by NMDA Receptors. *Cell Rep* 1 (5), 495–505, [10.1016/j.celrep.2012.03.007](https://doi.org/10.1016/j.celrep.2012.03.007)
 59. Song I, Savtchenko L, **Semyanov A** (2011). Tonic excitation or inhibition is set by GABA_A conductance in hippocampal interneurons. *Nat Commun* 2 (1), 376, [10.1038/ncomms1377](https://doi.org/10.1038/ncomms1377)
 60. Kochlamazashvili G, Senkov O, Grebenyuk S, Robinson C, Xiao MF, Stummeyer K, Gerardy-Schahn R, Engel AK, Feig L, **Semyanov A**, Suppiramaniam V, Schachner M, Dityatev A (2010). Neural cell adhesion molecule-associated polysialic acid regulates synaptic plasticity and learning by restraining the signaling through GluN2B-containing NMDA receptors. *J Neurosci* 30 (11), 4171–4183, [10.1523/JNEUROSCI.5806-09.2010](https://doi.org/10.1523/JNEUROSCI.5806-09.2010)
 61. Pavlov I, Savtchenko LP, Kullmann DM, **Semyanov A**, Walker MC (2009). Outwardly rectifying tonically active GABA_A receptors in pyramidal cells modulate neuronal offset, not gain. *J Neurosci* 29 (48), 15341–15350, [10.1523/JNEUROSCI.2747-09.2009](https://doi.org/10.1523/JNEUROSCI.2747-09.2009)
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 63. Scimemi A, **Semyanov A**, Sperk G, Kullmann DM, Walker MC (2005). Multiple and plastic receptors mediate tonic GABA_A receptor currents in the hippocampus. *J Neurosci* 25 (43), 10016–10024, [10.1523/JNEUROSCI.2520-05.2005](https://doi.org/10.1523/JNEUROSCI.2520-05.2005)
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67. **Semyanov A**, Kullmann DM (2000). Modulation of GABAergic signaling among interneurons by metabotropic glutamate receptors. *Neuron* 25 (3), 663–672, [10.1016/S0896-6273\(00\)81068-5](https://doi.org/10.1016/S0896-6273(00)81068-5)