LIST OF NEUROSCIENCE TECHNIQUES TO STUDY BRAIN ACTIVITY IN VIVO

After the LLM Screening, it is necessary to merge **both Step 2** and **Step 3** into a single list, again screening for the techniques that fit the established criteria and also looking for duplicates. All the while creating a properly structured list, and also already tagging if they are Invasive [**I**] or non-invasive [**NI**], techniques which are minimally invasive (for instance, require only a contrast injection or isotope) are tagged as [**I***].

New additions while performing the merge of both Step 2 and 3 and checking on selected papers were added to the list, but are pointed at the end as additions and where did they come from (tagged as "**§**").

Note: some items are listed due to their importance but are not counted as they can be seen as advancements or specific approaches within the same technique.

Any feedback is more than welcomed at ricardojunior@unistra.fr

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1. ELECTROMAGNETIC

Microscopic Resolutions

Intracellular or Juxtacellular

1.1. Patch-Clamp [**I**] (1)
https://doi.org/10.1007/978-1-0716-0818-0_1
https://doi.org/10.3390/s21041448
1.2. Sharp Electrode Intracellular Recordings [**I**] (2)
https://doi.org/10.1016/S0165-0270(03)00126-2
1.3. Juxtacellular Recording and Labeling [**I**] (3)
https://doi.org/10.1016/j.jneumeth.2006.02.004
https://doi.org/10.1038/nprot.2014.161

Extracellular

1.4. Tungsten Microelectrodes [**I**] (4)
https://doi.org/10.3389/fnins.2021.691788
1.5. Stereotrodes [**I**] (5)
https://doi.org/10.1016/0165-0270(83)90097-3
https://doi.org/10.1016/j.jneumeth.2013.11.013
1.6. Tetrodes [**I**] (6)
https://doi.org/10.1016/S0165-0270(02)00092-4
1.7. Multielectrode Arrays [**I**]
    1.7.1. Michigan Probes [**I**] (7)
    https://doi.org/10.1109/10.7273
    https://doi.org/10.1016/j.heares.2008.01.010

1.7.2. Utah Arrays [**I**] (8)
https://doi.org/10.1016/S0013-4694(96)95176-0
1.7.3. Floating Microelectrode Arrays [**I**] (9)
https://doi.org/10.1016/j.jneumeth.2006.09.005
1.8. Neuropixels [**I**] (10)
https://doi.org/10.1016/j.conb.2018.01.009
1.9. CMOS-Integrated Neural Probes [**I**] (11)
https://doi.org/10.1126/sciadv.adf9524
https://doi.org/10.1016/j.snr.2024.100206
1.10. Fishbone Nanowire Arrays [**I**] (12)
https://doi.org/10.1002/adma.202504171
1.11. Nitrogen-Vacancy Diamond Sensors [**I**] (13)
https://doi.org/10.1073/pnas.1601513113
https://doi.org/10.1038/s41598-023-39539-y

 # Middle Term Resolutions and Multimodal Approaches
1.12. Flexible Bioelectronic Neural Interfaces [**I**] (14)
https://doi.org/10.1038/s41563-020-0679-7
1.13. Optotetrodes [**I**] (15)
https://doi.org/10.1038/nn.2992
1.14. Transparent Graphene Microelectrodes Arrays [**I**] (16)
https://doi.org/10.1038/s41467-018-04457-5
1.15. Electrical Impedance Tomography [**NI/I**] (17)
https://link.springer.com/article/10.1186/s40779-022-00370-7
https://doi.org/10.1016/j.neuroimage.2019.05.023
https://doi.org/10.1006/nimg.2000.0698

 # Macroscopic Resolutions
1.16. Electroencephalography [**NI**] (18)
https://doi.org/10.1038/nrn3241
https://doi.org/10.1016/j.ijpsycho.2015.05.004
1.17. Electrocorticogram [**NI**] (19)
https://doi.org/10.1038/nrn3241
1.17.1. Micro Electrocorticogram [**I**] (20)
https://doi.org/10.1038/s41378-023-00597-x
1.18. Magnetoencephalography [**NI**]
https://doi.org/10.1038/nrn3241
https://doi.org/10.3390/brainsci12060788
1.18.1 SQUID (the typical one) [**NI**] (21)
1.18.2. Optically Pumped Magnetometer MEG (OPM-MEG) [**NI**] (22)
https://doi.org/10.1038/s41398-024-03047-y
1.19. Stentrodes [**I**] (23)
https://doi.org/10.1038/nbt.3428
https://doi.org/10.1016/j.jneumeth.2025.110471
https://doi.org/10.1126/science.adh3916
1.20. Stereoelectroencephalography [**I**] (24)
https://doi.org/10.1097/wnp.0000000000000249
https://doi.org/10.1016/j.seizure.2019.01.021

1.21. Deep Brain Stimulation **[I]** (25)
https://doi.org/10.3389/fpsyt.2023.1080260
https://doi.org/10.1016/j.neurom.2022.01.017
1.22. Neural Dust **[I]** (26)
https://doi.org/10.1016/j.conb.2017.12.010
https://doi.org/10.3389/fnins.2021.599549

2. MOLECULES SENSING

Microdialysis and Push-Pull Perfusion
2.1. Microdialysis **[I]** (27)
https://doi.org/10.1021/acsami.2c02740
https://doi.org/10.1039/C4AN01974A
2.2. Push-pull Perfusion **[I]** (28)
https://doi.org/10.1021/acsami.2c02740
https://pubs.acs.org/doi/10.1021/acs.analchem.8b02468
Note: both 2.1. and 2.2. can be associated with the following techniques
2.3. + High Performance Liquid Chromatography **[I]** (29)
https://doi.org/10.1021/ac4023605
2.4. + Column Liquid Chromatography **[I]** (30)
https://doi.org/10.1021/acsami.2c02740
2.5. + Capillary Electrophoresis **[I]** (31)
https://doi.org/10.1016/j.jneumeth.2004.03.025
2.6. + Mass Spectrometry **[I]** (32)
https://doi.org/10.1016/j.jpba.2005.07.025
https://doi.org/10.1208/s12248-017-0114-4
2.7. + Electrochemical Workstation **[I]** (33)
https://doi.org/10.1021/acs.nanolett.2c00289

Carbon Fiber Microelectrodes
2.8. Voltammetry **[I]** (34)
https://doi.org/10.1021/acsami.2c02740
https://doi.org/10.1016/j.neubiorev.2005.02.003
https://doi.org/10.1523/JNEUROSCI.14-01-00442.1994
- 2.8.1. Differential Pulse Voltammetry
- 2.8.2. Cyclic Voltammetry
- 2.8.3. Fast-Scan Cyclic Voltammetry
  https://doi.org/10.1016/0306-4522(88)90255-2
  https://doi.org/10.1039/C9AN01925A

2.9. Amperometry **[I]** (35)
https://doi.org/10.1021/acsami.2c02740
- 2.9.1. High-Speed Chronoamperometry
  https://doi.org/10.3390/cells11152454

2.10. Liquid-Liquid Interface Microsensors **[I]** (36)
https://doi.org/10.1021/acssensors.1c00978
https://doi.org/10.1021/ac504151e

Indirect Sensing

2.11. Enzyme-Based sensors [**I**] (37)
https://doi.org/10.1111/j.1471-4159.2006.03673.x
https://doi.org/10.1021/ac403250w
2.12. Aptamer-based sensors [**I**] (38)
https://doi.org/10.1021/acsptsci.4c00579
2.13. Molecularly Imprinted Polymers Sensors [**I**] (39)
https://doi.org/10.1016/j.snb.2011.07.052
https://doi.org/10.1016/j.trac.2018.08.002

 # Other sensing techniques
2.14. Electron Paramagnetic Resonance (EPR) Oximetry [**I**] (40)
https://doi.org/10.1007/s12013-017-0798-1
https://doi.org/10.4103/2045-9912.202911
2.15. Hydrogen Clearance CBF Measurement [**I**] (41)
https://doi.org/10.1038/jcbfm.1986.83

3. POSITRON EMISSION TOMOGRAPHY
3.1. Total-Body PET Imaging [**I***] (42)
https://doi.org/10.1259/bjr.20220357
https://doi.org/10.2967/jnumed.119.231845
https://doi.org/10.1007/s00259-022-06057-4
3.2. Metabolic Tracing with Short-Lived Isotopes (Dynamic PET) [**I***] (43)
https://doi.org/10.1002/acn3.51546R
https://doi.org/10.1007/s00259-023-06542-4
3.3. μ-opioid Receptor PET ([^{11}C]carfentanil) [**I***] (44)
https://doi.org/10.1007/s00259-024-06746-2
3.4. Dopamine D2/D3 Receptor Occupancy PET [**I***] (45)
https://doi.org/10.1038/s42003-022-03434-5
https://doi.org/10.1177/0271678X231210128
3.5. Cerebral Metabolic Rate of Oxygen (CMRO2) PET [**I***] (46)
https://doi.org/10.1016/j.neuroimage.2020.117136
https://doi.org/10.2967/jnumed.120.260521
3.6. GABA-A Receptor PET ([^{18}F]flumazenil) [**I***] (47)
https://doi.org/10.3390/ph16030417
3.7. Serotonin Transporter PET ([^{11}C]DASB) [**I***] (48)
https://doi.org/10.3390/ijms26010252
3.8. Oxygen-15 Water PET ([^{15}O]H_2O PET) [**I***] (49)
https://doi.org/10.1053/j.semnuclmed.2023.08.002
https://doi.org/10.1016/j.neuroimage.2013.11.044

4. NON-FLUORESCENCE OPTICAL TECHNIQUES

 # Infrared
4.1. Thermal Infrared Imaging / Thermoencephaloscopy [**NI**] (50)
https://doi.org/10.1038/srep17471
https://doi.org/10.1016/S0301-0082(98)00038-0
https://doi.org/10.1111/psyp.12243
4.2. Functional Near-Infrared Spectroscopy [**NI**] (51)

https://doi.org/10.1111/nyas.13948

4.2.1. Time-Domain Near-Infrared Spectroscopy (TD-NIRS) [**NI**] (52)
https://doi.org/10.1038/s41598-024-68555-9
https://doi.org/10.1117/1.JBO.27.7.074710 *
https://doi.org/10.1117/1.NPh.10.1.013504 *

4.2.2. Functional Diffuse Optical Tomography (fDOT) [**NI**] (53)
https://doi.org/10.3390/s25072040 *
https://doi.org/10.1038/s41598-025-85858-7
https://doi.org/10.1117/1.NPh.6.3.035007

4.3. Diffuse Correlation Spectroscopy [**NI**] (54)
https://doi.org/10.1016/j.neuroimage.2013.06.017
https://doi.org/10.1007/s12028-018-0573-1

 # Intrinsic Signals

4.4. Optical Intrinsic Signal [**I**] (55)
https://doi.org/10.1117/1.NPh.10.2.020601
https://doi.org/10.1016/j.xpro.2021.100779 *
https://doi.org/10.1038/324361a0
https://doi.org/10.1146/annurev.ne.08.030185.001403

4.4.1. Hyperspectral Imaging of Intrinsic Signals (56)
https://doi.org/10.1117/1.NPh.2.4.045003
https://doi.org/10.1007/978-3-319-91287-5_3

4.5. Laser Speckle Contrast Imaging [**I**] (57)
https://doi.org/10.1117/1.NPh.10.2.020601
https://doi.org/10.1097/00004647-200103000-00002

4.6. Spatial Frequency Domain Imaging [**I**] (58)
https://doi.org/10.1117/1.NPh.10.2.020601
https://doi.org/10.1117/1.3088140
https://doi.org/10.1117/1.NPh.8.2.025001

4.6.1. Structured Illumination Diffuse Optical Tomography [**NI**] (59)
https://doi.org/10.1117/1.NPh.4.2.021102

4.7. Laser Doppler Flowmetry [**I**] (60)
https://doi.org/10.1111/micc.12884
https://doi.org/10.1002/lpor.202401016 *
https://doi.org/10.1007/s12028-017-0472-x

4.8. Optical Coherence Tomography [**I/NI**] (61)
https://doi.org/10.1126/science.1957169
https://doi.org/10.1016/j.jneumeth.2008.11.026

4.8.1. Speckle-Modulated Optical Coherence Tomography (OCT) [**I**] (62)
https://doi.org/10.1038/ncomms15845
https://doi.org/10.1063/5.0278271
https://doi.org/10.1093/cercor/bhac388

4.8.2. Doppler Optical Coherence Tomography (D-OCT) [**I**] (63)
https://doi.org/10.1364/BOE.5.003217
https://doi.org/10.1021/acsphotonics.4c00856

4.8.3. Visible Light Optical Coherence Tomography (vis-OCT) [**I**] (64)

https://doi.org/10.1364/BOE.6.003941
https://doi.org/10.1364/BOE.6.001429
https://doi.org/10.1117/1.JBO.22.12.121707

5. ULTRASOUND AND PHOTOACOUSTICS

Ultrasound (Purely)

5.1. Transcranial Doppler [**NI**] (65)
https://doi.org/10.33549/physiolres.935413
https://doi.org/10.1186/s41984-021-00114-0
https://doi.org/10.1159/000103113

5.2. Functional Ultrasound (fUS) Imaging [**NI/I**] (66)
https://doi.org/10.1016/j.cobme.2021.100286
https://doi.org/10.1146/annurev-neuro-111020-100706
https://doi.org/10.1016/j.neuroscience.2021.03.005
https://doi.org/10.1038/nmeth.1641

5.2.1. Microbubble-Enhanced fUS (Contrast-Enhanced fUS) [**I**] (67)
https://doi.org/10.1016/j.neuroimage.2015.09.037
https://doi.org/10.1016/j.cobme.2021.100286

5.2.2. Functional Ultrasound Microscopy (68)
https://doi.org/10.1038/s41592-022-01549-5

Photoacoustic

5.3. Photoacoustic Imaging (PAI) [**I/NI**] (69)
https://doi.org/10.1016/j.pacs.2019.05.001
https://doi.org/10.1063/1.2195024
https://doi.org/10.3109/13813450312331337649

5.3.1. Photoacoustic Computed Tomography (PACT) [**I/NI**] (70)
https://doi.org/10.1038/nbt839
https://doi.org/10.1002/jbio.201700024
https://doi.org/10.1364/BOE.423707

5.3.2. Functional Photoacoustic Microscopy (fPAM) [**I**] (71)
https://doi.org/10.1038/s41377-022-00836-2
https://doi.org/10.1016/j.neuroimage.2021.118260

5.4 Voltage-Sensitive Photoacoustic Imaging [**I**] (72)
https://doi.org/10.1002/lpor.202400165

6. MAGNETIC RESONANCE IMAGING

Hemodynamic

6.1. Blood Oxygen Dependent Levels (BOLD) [**NI**] (73)
https://doi.org/10.1073/pnas.87.24.9868
https://doi.org/10.1038/jcbfm.2012.23
https://doi.org/10.1016/j.tins.2024.12.010
https://doi.org/10.1002/nbm.70076
https://doi.org/10.1523/JNEUROSCI.23-10-03963.2003

6.1.1. Functional Connectivity MRI (fcMRI) [**NI**]

https://doi.org/10.1016/j.neuroimage.2023.120249
https://doi.org/10.1038/s42003-023-05629-w
6.1.2. Resting-State fMRI (rs-fMRI) [**NI**]
https://doi.org/10.1002/jmri.28894
6.2. Arterial Spin Labeling [**NI**] (74)
https://doi.org/10.1002/mrm.1910230106 (first)
https://doi.org/10.1002/mrm.29381 *
https://doi.org/10.1073/pnas.89.1.212
6.2.1. Continuous Arterial Spin Labeling (CASL) [**NI**]
https://doi.org/10.3389/fradi.2022.929533
6.2.2. Pulsed Arterial Spin Labeling (PASL) [**NI**]
https://doi.org/10.3389/fradi.2022.929533
6.3. Vascular-Space-Occupancy (VASO) [**NI**] (75)
https://doi.org/10.1002/mrm.10519
https://doi.org/10.1016/j.neuroimage.2021.118868
6.3.1. VASO and Perfusion (VAPER) [**NI**] (76)
https://doi.org/10.1016/j.neuroimage.2019.116358
https://doi.org/10.1162/imag_a_00140
6.4. Laminar fMRI [**NI**]
https://doi.org/10.1016/j.neuroimage.2017.02.063
https://doi.org/10.1093/psyrad/kkae027
https://doi.org/10.1016/j.cobme.2021.100288
https://doi.org/10.1016/j.neuroimage.2017.07.004
6.5. Exogenous Labeling [**I**]
https://doi.org/10.3348/kjr.2014.15.5.554
6.5.1. Dynamic Susceptibility Contrast (DSC)-MRI [**NI/I**] (77)
https://doi.org/10.1038/jcbfm.2010.4
https://doi.org/10.1007/s10334-009-0190-2
https://doi.org/10.1038/s41598-024-58086-8 [**NI**]
6.5.2. Dynamic Contrast-Enhanced (DCE)-MR [**I**] (78)
http://www.ajnr.org/content/27/7/1467
https://doi.org/10.2174/1874440001105010090
https://doi.org/10.7554/eLife.89611.4
6.6. Susceptibility-Weighted Imaging (SWI) [**NI**] (79)
https://doi.org/10.1016/j.neuroimage.2012.01.020
https://doi.org/10.1016/j.neuroimage.2007.11.046
6.7. Intravoxel Incoherent Motion (IVIM) MRI [**NI**] (80)
https://doi.org/10.1371/journal.pone.0117706
https://doi.org/10.1002/nbm.3780
https://doi.org/10.1016/j.neuroimage.2017.12.062
6.8. Phase-Contrast MRI [**NI**] (81)
https://doi.org/10.1148/rg.2020190039
https://doi.org/10.1186/s40809-016-0019-0
6.8.1. Displacement Spectrum (DiSpect) Imaging (82)
https://doi.org/10.1002/mrm.28882

 # Non Hemodynamic
6.9. Functional Magnetic Resonance Spectroscopy [**NI**] (83)

https://doi.org/10.1016/j.neuroimage.2023.120194
https://doi.org/10.1177/0271678X221076570
https://doi.org/10.1002/nbm.4314

6.9.1. ^{31}P MRS [**NI**]
https://doi.org/10.1002/nbm.70043

6.9.2. ^{13}C MRS [**I**]
https://doi.org/10.1007/s11064-022-03538-8
https://doi.org/10.1038/s41598-019-38981-1

6.10. Functional Quantitative Susceptibility Mapping (fQSM) [**NI**] (84)
https://doi.org/10.1016/j.neuroimage.2021.117924

6.11. ^{23}Na Sodium MRI [**NI**] (85)
https://doi.org/10.1016/j.neuroimage.2018.09.071
https://archive.ismrm.org/2025/2503_bFbEoFQ1W.html

6.12. Hyperpolarized ^{13}C Metabolic MRI [**I**] (86)
https://doi.org/10.1073/pnas.1613345114
https://doi.org/10.1016/j.neuroimage.2022.119284

6.13. Chemical Exchange Saturation Transfer (CEST) fMRI [**NI**] (87)
https://doi.org/10.1038/s41598-019-40986-9
https://doi.org/10.1002/jmri.27850

6.14. Magnetic Resonance Elastography (MRE) [**NI**] (88)
https://doi.org/10.3389/fbioe.2021.666456
https://archive.ismrm.org/2014/0871.html

6.15. Apparent Diffusion Coefficient fMRI [**NI**] (89)
https://doi.org/10.1038/s42003-025-07889-0
https://doi.org/10.1038/s41467-025-60357-5
https://doi.org/10.3389/fnhum.2013.00817

6.16. Molecular fMRI [**I**] (90)
https://doi.org/10.1016/j.jneumeth.2021.109372

7. LABELED OPTICAL TECHNIQUES

 # Indicators and Sensors
https://doi.org/10.1146/annurev-anchem-061522-044819

7.1. Calcium Indicators [**I**]
https://doi.org/10.1111/j.1476-5381.2010.00988.x
https://www.sciencedirect.com/science/article/pii/S0092867421014458

7.1.1. Calcium Indicator Dyes (Ratiometric / Nonratiometric) [**I**] (91)
https://doi.org/10.1073/pnas.1507110112
https://doi.org/10.1016/S0143-4160(98)90085-9

7.1.2. Genetically Encoded Calcium Indicators (GECIs) [**I**] (92)
https://doi.org/10.1016/j.neures.2020.05.013 (GCaMP variants)

7.2. Voltage Indicators [**I**]
https://doi.org/10.3390/colorants3040025 (General)

7.2.1. Voltage-Sensitive Dye Imaging (VSDI) (Ratiometric / Nonratiometric) [**I**] (93)
https://www.sciencedirect.com/science/article/pii/S100184172030783X
https://onlinelibrary.wiley.com/doi/full/10.1002/lpor.202400165

7.2.2. Genetically Encoded Voltage Indicators (GEVIs) [**I**] (94)
https://link.springer.com/chapter/10.1007/978-981-15-8763-4_12

7.6.2. Genetically Encoded Lactate Sensors **[I]**
https://doi.org/10.1038/s41467-025-64484-x
7.6.3. Genetically Encoded Nitric Oxide Sensors (geNOps) **[I]**
https://doi.org/10.1016/j.celrep.2023.113514

 # Microscopy Modalities
7.7. One-Photon Imaging (Miniscope / Widefield) **[I]** (99)
https://doi.org/10.1016/j.conb.2011.12.002
https://doi.org/10.1016/j.cell.2022.02.017
7.8. Two-Photon Microscopy **[I]** (100)
https://doi.org/10.1016/j.conb.2011.12.002
https://doi.org/10.1016/j.cell.2022.02.017
7.9. Three-Photon Microscopy **[I]** (101)
https://doi.org/10.1038/s41583-025-00937-y
https://doi.org/10.1038/s42003-025-08079-8
7.10. Fiber Photometry **[I]** (102)
https://doi.org/10.1080/15476278.2025.2489667
7.11. Mesoscopic Calcium Imaging (Widefield, not Miniscope) **[I]** (103)
https://doi.org/10.3390/biology11111601
https://doi.org/10.3389/fnins.2023.1210199
https://doi.org/10.1371/journal.pone.0185759
7.12. Light-Sheet Fluorescence Microscopy (LSFM) **[I]** (104)
https://doi.org/10.1038/nmeth.2434
https://doi.org/10.1016/j.jneumeth.2018.07.011
https://doi.org/10.1016/j.conb.2018.03.007
https://doi.org/10.1146/annurev-neuro-070918-050357
7.13. Swept Confocally-Aligned Planar Excitation (SCAPE) Microscopy **[I]** (105)
https://doi.org/10.1038/nphoton.2014.323
https://doi.org/10.1038/s41587-020-0628-7
7.14. Adaptive Optics for In Vivo Neural Imaging **[I]** (106)
https://doi.org/10.3389/fnins.2022.880859
https://doi.org/10.3389/fnins.2023.1188614
7.15. Oblique Plane Microscopy (OPM) **[I]** (107)
https://doi.org/10.1038/s41467-023-43741-x
7.16. Multifocal/Multibeam Two-Photon Microscopy **[I]** (108)
https://doi.org/10.1364/BOE.9.003678
https://doi.org/10.3389/fncel.2019.00039
https://doi.org/10.1364/BOE.514826
7.17. Line-Scanning Temporal Focusing Microscopy (mosTF) **[I]** (109)
https://doi.org/10.1038/s41598-024-57208-6
https://doi.org/10.1364/BOE.9.005654
7.18. Light Field Microscopy **[I]** (110)
https://doi.org/10.1016/j.jneumeth.2021.109083
7.19. Fluorescence Lifetime Imaging Microscopy (FLIM) **[I]** (111)
https://doi.org/10.1364/OPTICA.426870
https://doi.org/10.1038/s41598-020-77737-0
7.20. Total Internal Reflection Fluorescence (TIRF) Microscopy **[I]** (112)
https://doi.org/10.1021/acsnano.3c04489

7.21. Random Access Microscopy **[I]** (113)
https://doi.org/10.1038/nmeth.4033
https://iopscience.iop.org/article/10.1088/2515-7647/ad2e0d
7.22. Multispectral Optoacoustic Tomography (MSOT) **[I]** (114)
https://doi.org/10.1016/j.pacs.2021.100285
7.23.Bioluminescent Voltage Imaging (e.g., LOTUS-V) **[I]** (115)
https://doi.org/10.1038/s41598-019-43897-x
https://doi.org/10.1117/1.nph.11.2.024203
7.24 Digital Holographic Microscopy **[I]** (116)
https://doi.org/10.1038/s41467-023-36889-z
https://doi.org/10.1016/j.conb.2018.03.006

8. INTERFERENCE TECHNIQUES
https://doi.org/10.3389/fnbeh.2021.820017

 # Electrical Stimulation
8.1. Cortical Stimulation **[I]** (117)
https://doi.org/10.1016/j.yebeh.2009.03.001 (1870)
8.2. Microstimulation **[I]** (118)
https://doi.org/10.1038/s41551-024-01299-z
https://doi.org/10.1002/adhm.202100119
    8.2.1 Supracortical Microstimulation **[I]**
    https://doi.org/10.1146/annurev-bioeng-103023-072855
8.3. Temporal Interference Simulation [**NI**] (119)
https://doi.org/10.3389/fnhum.2023.1266753
https://doi.org/10.1016/j.cell.2017.05.024
https://doi.org/10.1109/EMBC46164.2021.9629968
8.4. Transcranial Electrical Stimulation [**NI**]
https://doi.org/10.3390/biomedicines10102333
https://doi.org/10.1371/journal.pbio.3001973
    8.4.1. Transcranial Direct Current Stimulation (tDCS) [**NI**] (120)
    https://doi.org/10.3389/fnhum.2025.1640565
    8.4.2. Transcranial Alternating Current Stimulation (tACS) [**NI**] (121)
    https://doi.org/10.3389/fnhum.2025.1640565
    8.4.3. Transcranial Random Noise Stimulation (RNS) [**NI**] (122)
    https://doi.org/10.1038/s41598-019-51553-7
    https://doi.org/10.3389/fncel.2017.00162
8.5. Transcranial Magnetic Stimulation [**NI**] (123)
https://doi.org/10.1007/s12264-021-00781-x
https://doi.org/10.1146/annurev-psych-081120-013144
    8.5.1. Deep Transcranial Magnetic Stimulation (dTMS) [**NI**] (124)
    https://doi.org/10.5498/wjp.v13.i9.607
    https://doi.org/10.1016/j.jneumeth.2021.109261
    https://doi.org/10.1016/j.jneumeth.2020.108709
    https://doi.org/10.1523/ENEURO.0163-17.2018
8.6. Peripheric Nerve Stimulation **[I]**
    8.6.1. Galvanic Vestibular Stimulation (GVS) **[I]** (125)

https://doi.org/10.1152/jn.00035.2019
https://doi.org/10.3389/fneur.2012.00117
https://doi.org/10.1016/0006-8993(82)90990-8 (1982)
https://doi.org/10.1016/j.brainresbull.2004.07.008
8.6.2. Trigeminal Nerve Stimulation (TNS) [**I**] (126)
https://doi.org/10.1186/s42234-023-00128-z
https://doi.org/10.3171/jns.2002.97.5.1179
https://doi.org/10.1007/s00221-018-5338-8
8.6.3. Vagus Nerve Stimulation (VNS) [**I**] (127)
https://doi.org/10.1093/cercor/bhab158
https://doi.org/10.3390/brainsci12091137

 # Optogenetics and Optogenetics-Like
https://doi.org/10.1002/advs.202413817
8.7. Optogenetics [**I**] (128)
https://doi.org/10.1017/S0033583523000033
https://doi.org/10.3389/fncel.2021.778900
https://doi.org/10.1007/978-981-15-8763-4
8.7.1. Channelrhodopsin-2 (ChR2)
8.7.2. Halorhodopsin (NpHR)
8.7.3. Archaerhodopsin (Arch)
8.7.4. Anion-conducting channelrhodopsins (ACRs)
8.7.5. Photoswitchable Voltage-Gated Ion Channels
8.7.6. Photoswitchable Ligand-Gated Ion Channels
8.7.7. Optical Switch Protein Conjugates
8.7.8. Holographic Optogenetic Stimulation [**I**] (129)
https://doi.org/10.1038/s41593-021-00902-9
https://doi.org/10.1523/JNEUROSCI.1785-18.2018
8.7.9. X-ray Optogenetics [**NI**/I] (130)
https://doi.org/10.1038/s41467-021-24717-1
8.8. Chemogenetics [**I**] (131)
https://doi.org/10.1177/10738584221134587
https://doi.org/10.1002/glia.24390
https://doi.org/10.1523/JNEUROSCI.0625-23.2023
https://doi.org/10.1038/s41593-020-0661-3
8.9. Mechano/Sonogenetics [**NI**] (132)
https://doi.org/10.1016/j.brs.2022.09.002
https://doi.org/10.1002/anie.202317112
8.10. Magnetogenetics [**NI**] (133)
https://doi.org/10.15252/embj.201797177
https://doi.org/10.1186/s12951-024-02616-z
https://doi.org/10.1038/s41565-024-01694-2
https://doi.org/10.1038/s41467-021-25837-4
https://doi.org/10.7554/eLife.27069
https://doi.org/10.1038/s41563-022-01281-7
8.11. Thermogenetics [**NI/I**] (134)
https://doi.org/10.1002/advs.202413817
8.12. Upconversion Nanoparticle-Based Neural Imaging [**I**] (135)

https://doi.org/10.1126/science.aaq1144
https://doi.org/10.1016/j.biomaterials.2017.07.017

Other Interference Techniques
8.12. Cortical Cooling [**I**] (136)
https://doi.org/10.3389/fnsys.2011.00053
https://doi.org/10.1016/0006-8993(77)90734-X
8.13. Lidocaine Inactivation [**I**] (137)
https://doi.org/10.1016/S0165-0270(97)02229-2
8.14. Muscimol Inactivation [**I**] (138)
https://doi.org/10.1016/j.jneumeth.2008.01.033
8.15. Transcranial Focused Ultrasound [**NI**] (139)
https://doi.org/10.3389/fnhum.2021.749162
https://doi.org/10.1371/journal.pone.0288654
https://doi.org/10.1007/s13534-024-00369-0
8.15.1. Focused Ultrasound Blood–Brain Barrier Opening (FUS-BBBO) [**NI**] (140)
https://doi.org/10.1002%2Fmds.101
https://doi.org/10.1148/radiol.14140245
https://doi.org/10.1093/brain/awab460
https://doi.org/10.1038/s41598-018-25904-9
8.16. Optoacoustic Neuromodulation [**I**] (141)
https://doi.org/10.1038/s41467-020-14706-1
8.17. Infrared Neural Stimulation [**NI/I**] (142)
https://doi.org/10.1073/pnas.2015685118
https://doi.org/10.1038/s41598-021-89163-x
https://doi.org/10.1016/j.brs.2023.01.1678
8.18. Transcranial Photobiomodulation (tPBM) [**NI**] (143)
https://doi.org/10.1038/s41598-019-42693-x
https://doi.org/10.1126/sciadv.abq3211
https://doi.org/10.1364/BOE.402047
8.19 Photothermal Neuromodulation (non-genetic) [**I**] (144)
https://doi.org/10.1002/admi.202400873
https://doi.org/10.1021/acsnano.4c01037
8.20. Iontronic microfluidic probes / microfluidic interconnection [**I**] (145)
https://doi.org/10.1038/s41378-021-00295-6
https://doi.org/10.1002/smll.202410906
8.21. Neuromodulation via Magnetic Nanodiscs [**I**] (146)
https://doi.org/10.1038/s41565-024-01798-9
https://doi.org/10.3389/fnhum.2025.1489940
8.22. Terahertz Neural Control [**NI**] (147)
https://doi.org/10.7554/eLife.97444.3
DOI: 10.4103/NRR.NRR-D-23-00872

9. MISCELLANEOUS TECHNIQUES
(or they are a mix/interface of the above or not encompassed by the above classification)
9.1. Thermal Diffusion Flowmetry [**I**] (148)
https://doi.org/10.1089/neu.2018.6309
9.2. Magnetic Particle Imaging (MPI) [**I**] (149)

https://doi.org/10.18416%2FIJMPI.2020.2009009
https://doi.org/10.1016/j.neuroimage.2018.05.004
9.3. Near-Infrared Fluorescence Imaging of Hemodynamics **[I]** (150)
https://doi.org/10.1371/journal.pone.0048383
9.4. Second Harmonic Generation (SHG) Microscopy **[I]** (151)
https://doi.org/10.1073/pnas.1004748107 *(pivotal, not brain)*
https://doi.org/10.1021/acsphotonics.9b01749 (brain dynamics)

ADDITIONS:
1. Diffuse Correlation Spectroscopy
from https://doi.org/10.1111/micc.12884
2. Laminar Functional Magnetic Resonance Imaging
from https://doi.org/10.1093/psyrad/kkae027
3. Phase-Contrast Based Approaches MRI
from https://doi.org/10.1002/mrm.28882
4. Thermal Diffusion Flowmetry
https://doi.org/10.1089/neu.2018.6309
from https://doi.org/10.1111/micc.12884

EXCLUDED after recheck:
1. Deep Label-Free Microscopy (DLFM)
https://doi.org/10.1038/nm.3495 (after rechecking its time frames)
2. Microvascular Volumetric Pulsatility Mapping
https://doi.org/10.1038/s44161-025-00722-1
https://doi.org/10.3389/fnagi.2025.1486775
https://doi.org/10.1177/0271678X20980652
(the literature does not show functional studies to the moment)
3. Magnetic Resonance Fingerprinting (MRF)
https://doi.org/10.1002/jmri.29812 (It is not a technique per se, but more a “pipeline” optimization method. EXTREMELY interesting and useful, but here excluded)
