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Reporting Summary

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Statistical parameters

When statistical analyses are reported, confirm that the following items are present in the relevant location (e.g. figure legend, table legend, main text, or Methods section).

n/a	Confirmed	
☐	☒	The exact sample size (n) for each experimental group/condition, given as a discrete number and unit of measurement
☐	☒	An indication of whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
☐	☒	The statistical test(s) used AND whether they are one- or two-sided *Only common tests should be described solely by name; describe more complex techniques in the Methods section.*
☒	☐	A description of all covariates tested
☒	☐	A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
☐	☒	A full description of the statistics including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
☐	☒	For null hypothesis testing, the test statistic (e.g. F, t, r) with confidence intervals, effect sizes, degrees of freedom and P value noted *Give P values as exact values whenever suitable.*
☒	☐	For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
☒	☐	For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
☐	☒	Estimates of effect sizes (e.g. Cohen's d, Pearson's r), indicating how they were calculated
☐	☒	Clearly defined error bars *State explicitly what error bars represent (e.g. SD, SE, CI)*

Our web collection on statistics for biologists may be useful.

Software and code

Policy information about availability of computer code

Data collection	Photoresponse-measurement data were collected with Clampex 10.4. In vitro electrophysiology data from brain slices were collected with Ephus software. In vivo electrophysiology data were collected from a free and open-source data-acquisition software: RHD2000 interface GUI software V. 1.4 with Rhythm API written in C++/Qt available at http://intantech.com/downloads.html#software. Videos of forelimb movement stimulations were recorded by custom software developed with NI-IMAQdx library in LabVIEW 2016.
Data analysis	Electron microscopy data were analyzed using ImageJ 1.48r. XPS data were analyzed using Microsoft Excel 2016 MSO (16.0.8625.2121) 64-bit. Photo-response data were analyzed using Clampfit 10.4.0.36, Microsoft Excel 2016 MSO (16.0.8625.2121) 64-bit and OriginPro 2016 b9.3.226 (64-bit). Confocal microscope images and calcium imaging data were processed and analyzed using Leica LAS AF Lite 2.6.3.8173, ImageJ 1.48r, and custom code written in Python 3.5. In vitro electrophysiology data were analyzed using OriginPro 2016 b9.3.226 (64-bit). Animal experiment data were analyzed using custom code in Matlab R2013a. Micro-CT data were analyzed using Amira 5.6.

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors/reviewers upon request. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Research guidelines for submitting code & software for further information.

Data

Policy information about availability of data

All manuscripts must include a data availability statement. This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A list of figures that have associated raw data
- A description of any restrictions on data availability

The authors declare that all data supporting the findings of this study are available within the paper and its supplementary information. Other supporting data are available upon reasonable request to the corresponding author.

Field-specific reporting

Please select the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☒ Life sciences ☐ Behavioural & social sciences

For a reference copy of the document with all sections, see nature.com/authors/policies/ReportingSummary-flat.pdf

Life sciences

Study design

All studies must disclose on these points even when the disclosure is negative.

Sample size	Sample size was not calculated beforehand. Sample size was determined by the number of biological and technical replicates necessary to convince us that the effect was real. The number of biological replicates we aimed for was at least 3, with several technical replicates in each sample.
Data exclusions	No data were excluded from the analyses.
Replication	All experimental findings, including TEM and SEM images, EDS spectra, XPS spectra, photoresponse measurements, electrophysiology experiments, and animal experiments, were reliably reproduced.
Randomization	Experimental groups were formed based on what was being tested with random selections. The same type of materials, cells and animals were used for all experiments.
Blinding	Sample sizes were determined by the number of biological and technical replicates necessary to convince us that all the observations were reproducible. The investigators were not blinded.

Materials & experimental systems

Policy information about availability of materials

n/a	Involved in the study
☐	☒ Unique materials
☐	☒ Antibodies
☐	☒ Eukaryotic cell lines
☐	☒ Research animals
☒	☐ Human research participants

Unique materials

Obtaining unique materials	Unique materials used in this study include the various types of silicon nanostructures. These are available upon reasonable request.

Antibodies

Antibodies used	Primary antibodies used in this work include GFAP (GA5) Mouse mAb (catalog #3670T) for glia and NeuN (D4G40) XP Rabbit mAb (catalog #24307T) for neuron from Cell Signaling Technology. Secondary antibodies used in this work include Goat anti-Mouse IgG (H+L) Superclonal Secondary Antibody, Alexa Fluor 647 (catalog #A28181) and Goat anti-Rabbit IgG (H+L) Secondary Antibody, Alexa Fluor 488 (catalog #R37116) from Life Technologies. Another set of primary antibodies used in this work include S100 Polyclonal Antibody (catalog #PA5-16257) for glia from Life Technologies and Neurofilament-H (RMdO 20) Mouse mAb (catalog #2836) from Cell Signaling Technology. Another set of secondary antibodies used include Goat anti-Rabbit IgG (H+L) Cross-Adsorbed Secondary Antibody, Alexa Fluor 488 (catalog #A11008) and Goat anti-Mouse IgG (H+L) Cross-Adsorbed Secondary Antibody, Alexa Fluor 647 (catalog #A21235) from Life

Technologies.

Validation

Primary antibodies used in this work include GFAP (GA5) Mouse mAb (catalog #3670T) for glia and NeuN (D4G40) XP Rabbit mAb (catalog #24307T) for neuron from Cell Signaling Technology. Validation for these antibodies can be found on the Cell Signaling website. https://www.cellsignal.com/products/primary-antibodies/gfap-ga5-mouse-mab/3670 and https://www.cellsignal.com/products/primary-antibodies/neun-d4g4o-xp-rabbit-mab/24307. The antibody for glia has been used in previous publications including Olig2-targeted G-protein-coupled receptor Gpr17 regulates oligodendrocyte survival in response to lysolecithin-induced demyelination. in The Journal of Neuroscience on 12 October 2016 by Ou, Z., Sun, Y., et al. PubMed ID 27733608, Translational control of nociception via 4E-binding protein 1. in eLife on 18 December 2015 by Khoutorsky, A., Bonin, R. P., et al. PubMed ID 26678009, and Cell-fate determination by ubiquitin-dependent regulation of translation. In Nature on 24 September 2015 by Werner, A., Iwasaki, S., et al. PubMed ID 26399832. The antibody for neuron has been used in previous publications including Fucoxanthin provides neuroprotection in models of traumatic brain injury via the Nrf2-ARE and Nrf2-autophagy pathways. in Scientific Reports on 21 April 2017 by Zhang, L., Wang, H., et al.. PubMed ID 28429775, and Ephrin-B3 coordinates timed axon targeting and amygdala spinogenesis for innate fear behaviour. in Nature Communications on 25 March 2016 by Zhu, X. N., Liu, X. D., et al. PubMed ID 27008987.

Another set of primary antibodies used in this work include S100 Polyclonal Antibody (catalog #PA5-16257) for glia from Life Technologies and Neurofilament-H (RMdO 20) Mouse mAb (catalog #2836) from Cell Signaling Technology. Validation for these antibodies can be found on both vendor's website.
https://www.thermofisher.com/antibody/product/S100-Antibody-Polyclonal/PA5-16257 and https://www.cellsignal.com/products/primary-antibodies/neurofilament-h-rmdo-20-mouse-mab/2836.
The antibody for glia has been used for immunofluorescence in a previous publication on Frontiers in Molecular Neuroscience entitled Intravenous AAV9 efficiently transduces myenteric neurons in neonate and juvenile mice on 2014. The antibody for neuron has been used in previous publications including AlphaB-crystallin regulates remyelination after peripheral nerve injury in Proceedings of the National Academy of Sciences of the United States of America on 2017 by Lim, E. F., Nakanishi, S. T., et al. PubMed Id 28137843, Generation of human-induced pluripotent stem cells to model spinocerebellar ataxia type 2 in vitro. in Journal of Molecular Neuroscience on 2013 by Xia, G., Santostefano, K., et al. PubMed Id 23224816, and Protection of FK506 against neuronal apoptosis and axonal injury following experimental diffuse axonal injury. in Molecular Medicine Reports on 2017 by Huang, T. Q., Song, J. N., et al. PubMed Id 28339015.

The secondary antibodies used in this work include Goat anti-Mouse IgG (H+L) Superclonal Secondary Antibody, Alexa Fluor 647 (catalog #A28181) and Goat anti-Rabbit IgG (H+L) Secondary Antibody, Alexa Fluor 488 (catalog #R37116) from Life Technologies. Details of the validation can be found in the following links from the Life Technologies website. https://www.thermofisher.com/order/genome-database/generatePdf?productName=Mouse%20IgG%20(H+L)&assayType=PRANT&detailed=true&productId=A28181 and https://www.thermofisher.com/order/genome-database/generatePdf?productName=Rabbit%20IgG%20(H+L)&assayType=PRANT&detailed=true&productId=R37116.

Another set of secondary antibodies used include Goat anti-Rabbit IgG (H+L) Cross-Adsorbed Secondary Antibody, Alexa Fluor 488 (catalog #A11008) and Goat anti-Mouse IgG (H+L) Cross-Adsorbed Secondary Antibody, Alexa Fluor 647 (catalog #A21235). Details of the validation can be found in the following links from the Life Technologies website. https://www.thermofisher.com/order/genome-database/generatePdf?productName=Rabbit%20IgG%20(H+L)%20Cross-Adsorbed&assayType=PRANT&detailed=true&productId=A-11008 and https://www.thermofisher.com/order/genome-database/generatePdf?productName=Mouse%20IgG%20(H+L)%20Cross-Adsorbed&assayType=PRANT&detailed=true&productId=A-21235.

Details of the staining conditions are descibed in the Methods section. Briefly, cells after fixation and permeabilization were incubated with primary antibodies (GFAP (GA5) Mouse mAb, 1:300 in 1.5% BSA-PBS for glia; NeuN (D4G40) XP Rabbit mAb, 1:50 in 1.5% BSA-PBS for neuron, Cell Signaling, USA) at room temperature for 1 hour. After washing, secondary antibodies (Goat anti-Mouse IgG (H+L) Superclonal Secondary Antibody, Alexa Fluor 647, 1:150 in 1.5% BSA-PBS for glia; Goat anti-Rabbit IgG (H+L) Secondary Antibody, Alexa Fluor 488, 1:150 in 1.5% BSA-PBS for neuron, Life Technologies, USA) were finally applied. For another set of antibodies, cells after fixation and permeabilization were incubated with primary antibodies (S100 Polyclonal Antibody, 1:100 in 1.5% BSA-PBS for glia, Life Technologies, USA; Neurofilament-H (RMdO 20) Mouse mAb, 1:200 in 1.5% BSA-PBS for neuron, Cell Signaling, USA) at room temperature for 1 hour. After washing, secondary antibodies (Goat anti-Mouse IgG (H+L) Cross-Adsorbed Secondary Antibody, Alexa Fluor 647, 1:200 in 1.5% BSA-PBS for neuron; Goat anti-Rabbit IgG (H+L) Cross-Adsorbed Secondary Antibody, Alexa Fluor 488, 1:200 in 1.5% BSA-PBS for glia, Life Technologies, USA) were finally applied.

Eukaryotic cell lines

Policy information about cell lines

Cell line source(s)

Human Umbilical Vein Endothelial Cells (HUVEC) were obtained from Life Technologies (catalog #C0035C) and U-2 OS cells were obtained from ATCC (catalog #ATCC® HTB-96™).

Authentication

According to the Life Technologies website, the HUVEC cell line has been validated for the following assays
• Hepatitis B: Not Detected
• Hepatitis C: Not Detected
• HIV-1: Not Detected
• Bacteria, yeast, and other fungi: Not Detected
• Positive for von Willebrand factor (vWf)
• Positive for CD31
• Negative for a-actin
• Positive for dil-Ac-LDL uptake

According to the ATCC website, the cell line U-2 OS is chromosomally highly altered, with chromosome counts in the hypertriploid range. We did not find the hypodiploid cell population described by J. Ponten et al. Instead, most of the

	population has slightly higher counts than first described. Very few normal chromosomes are present, but a high number of stable marker chromosomes are identified., Different chromosomal rearrangements involving the same chromosomes (N1, N7, N9, and N11 particularly), are seen. Viruses were not detected during co-cultivation with WI-38 cells or in CF tests against SV40, RSV or adenoviruses.
Mycoplasma contamination	Mycoplasma is not detected in HUVEC according to the Life Technologies website. https://www.thermofisher.com/order/catalog/product/C0035C. Mycoplasma contamination was detected and eliminated in 1972 according to the ATCC website https://www.atcc.org/Products/All/HTB-96.
Commonly misidentified lines (See ICLAC register)	No commonly misidentified cell lines were used.

Research animals

Policy information about studies involving animals; ARRIVE guidelines recommended for reporting animal research

Animals/animal-derived materials	Dorsal root ganglia was extracted from P1-P3 Sprague-Dawley rats (female and male) from Charles River Laboratories. For in vivo physiology experiments, wild-type mice (C57BL/6, female and male; Jackson Laboratory, USA) were bred in-house. Mice were 6-9 weeks old at the time of the slice and in vivo experiments.

Method-specific reporting

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ Magnetic resonance imaging