

Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our [Editorial Policies](#) and the [Editorial Policy Checklist](#).

Statistics

For all statistical analyses, confirm that the following items are present in the 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 |
| ☐ | ☒ | A statement on 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
<i>Only common tests should be described solely by name; describe more complex techniques in the Methods section.</i> |
| ☐ | ☒ | 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 statistical parameters 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
<i>Give P values as exact values whenever suitable.</i> |
| ☒ | ☐ | 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 |

Our web collection on [statistics for biologists](#) contains articles on many of the points above.

Software and code

Policy information about [availability of computer code](#)

Data collection pClamp11

Data analysis GraphPad Prism 9.5, Coot 0.8.9.3, Phenix 1.19.1-4122, Phenix 1.20.1-4487, Relion 3.1.2_cu9.2, Relion 3.1.3_cu10.2, MotionCor2, GCTF, crYOLO, Chimera 1.15, Chimera X, ResMap, Pymol 2.4.1, Hole2, CHAP

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 and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio [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 description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our [policy](#)

Deep sequencing data are available via the Sequence Read Archive (SRA) repository under the accession code PRJNA906054. Atomic model coordinates and cryo-EM density maps for the CRB1 structure have been deposited in the Protein Data Bank with accession code 8EIZ and in the Electron Microscopy Data Bank with accession code EMD-28167, respectively.

Human research participants

Policy information about [studies involving human research participants and Sex and Gender in Research](#).

Reporting on sex and gender	n/a
Population characteristics	n/a
Recruitment	n/a
Ethics oversight	n/a

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

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

☒ Life sciences ☐ Behavioural & social sciences ☐ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Life sciences study design

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

Sample size	Sample sizes were determined based on preliminary experiments and prior experiences of the investigators.
Data exclusions	RELION-based 2D and 3D classification of single particle datasets were used to remove junk particles.
Replication	All attempts at replication were successful as described in figure legends and methods.
Randomization	All experimental treatments were randomized. EM particle sets were randomly split to estimate overall resolution.
Blinding	Animal behavior experiments were blinded. Due to technical reasons, electrophysiological and structural analyses were not blinded, however results were near binary so we are confident they remain unbiased.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

Methods

n/a	Involved in the study	n/a	Involved in the study
☐	☒ Antibodies	☒	☐ ChIP-seq
☐	☒ Eukaryotic cell lines	☒	☐ Flow cytometry
☒	☐ Palaeontology and archaeology	☒	☐ MRI-based neuroimaging
☐	☒ Animals and other organisms		
☒	☐ Clinical data		
☒	☐ Dual use research of concern		

Antibodies

Antibodies used	1:500 anti-HRP-Cy3 (Jackson Immuno # 123-545-021)
Validation	This is a well established antibody for invertebrate neurons that was obtained from an established commercial source. We did not validate it further than visualized that it stains nerves and not other tissues.

Eukaryotic cell lines

Policy information about [cell lines and Sex and Gender in Research](#)

Cell line source(s)	HEK293: ATCC CRL-3022; Sf9: ATCC CRL-1711
Authentication	Purchased from commercial supplier. Not further tested.
Mycoplasma contamination	Not tested.
Commonly misidentified lines (See ICLAC register)	No commonly misidentified cells lines were used.

Animals and other research organisms

Policy information about [studies involving animals](#); [ARRIVE guidelines](#) recommended for reporting animal research, and [Sex and Gender in Research](#)

Laboratory animals	Octopus bimaculoides (adult, 1-2 years), Sepioloidea lineolata (adult, 1-2 years), Euprymna berryi (adult, 1-2 years),
Wild animals	Doryteuthis pealeii (adult, 1-2 years) were caught by jigging at the MBL (Woods Hole, MA), transported in aerated coolers to Harvard University, and euthanized euthanized based on established methods with immersion of 3.5% MgCl ₂ and 15% ethanol followed by pithing.
Reporting on sex	Sex was not considered as a variable due to limited animal availability.
Field-collected samples	No
Ethics oversight	Animal protocols were approved by the Harvard University Animal Care and Use Committee (protocol ID 18-05-325).

Note that full information on the approval of the study protocol must also be provided in the manuscript.