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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 *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 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 *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

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	Microsoft Excel was uesd to collect data
Data analysis	Data analysis was done using GraphPad Prism 8.0

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

Provide your data availability statement here.

Research involving human participants, their data, or biological material

Policy information about studies with human participants or human data. See also policy information about sex, gender (identity/presentation), and sexual orientation and race, ethnicity and racism.

Reporting on sex and gender	Both male and female samples were included. The ethical approval for this study was approved by Institutional Ethics Sub-committee at Chongqing Hospital ,Jiangsu Province Hospital (approval number: 2025043).
Reporting on race, ethnicity, or other socially relevant groupings	Race and ethnicity information was not reported.
Population characteristics	Subjects were categorized into two age cohorts: young adults (≤30 years) and older adults (≥50 years).
Recruitment	Standardized tests were administered to evaluate cognitive and motor functions across all participants.
Ethics oversight	Institutional Ethics Sub-committee at Chongqing Hospital ,Jiangsu Province Hospital (approval number: 2025043).

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	No statistical methods were used to predetermine sample size. The number of mice used was set to n=6.
Data exclusions	No data were excluded from the analysis.
Replication	All experiments were performed with at least three biological replicates, yielding similar results.
Randomization	All animals were randomly allocated into experiments groups using a simple randomization method.
Blinding	Blinding was not possible during data collection due to the nature of the experimental procedures, but investigators were blinded during data analysis.

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

n/a	Involved in the study
☐	☒ Antibodies
☐	☒ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☐	☒ Animals and other organisms
☐	☒ Clinical data
☒	☐ Dual use research of concern
☒	☐ Plants

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Antibodies

Antibodies used	anti-ARG1 (Beyotime, AF1381; 1:1200), anti-ODC1 (Proteintech, #67336-1-Ig; 1:1200), anti-OTC (Proteintech, #26470-1-AP; 1:1200), anti-UT-B (Proteintech, #25962-1-AP; 1:1200), anti-P53 (Proteintech, #10442-1-AP; 1:1200), anti-ASL (Proteintech, #16645-1-AP;

	1:1200), anti-ASS1 (Abcam, ab191165; 1:1200), anti-CPS1 (Abcam, ab129076; 1:1200), and anti-β-actin (Abmart, P60709; 1:1200)
Validation	All antibodies were validated by commercial source.

Eukaryotic cell lines

Policy information about cell lines and Sex and Gender in Research

Cell line source(s)	BV2, C8-D1A, Neuro-2a, SH-SY5Y and PC12 were obtained from a commercial source.
Authentication	All cell lines were not subjected to additional authentication procedures in this study.
Mycoplasma contamination	All cell lines used in this study tested negative for mycoplasma contamination prior to experiments.
Commonly misidentified lines (See ICLAC register)	All cell lines are commonly misidentified cell lines.

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	C57BL/6J mice (7-8 weeks of age; weighing 22-25 g).
Wild animals	This study did not involve samples collected from the field
Reporting on sex	Male
Field-collected samples	This study did not involve samples collected from the field.
Ethics oversight	Prior to the commencement of the study, formal approval was secured from the relevant University Animal Ethics Committee. All subsequent procedures strictly followed national and institutional animal welfare policies (approval number: IACUC-CQMU-2022-0026)

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

Clinical data

Policy information about clinical studies

All manuscripts should comply with the ICMJE guidelines for publication of clinical research and a completed CONSORT checklist must be included with all submissions.

Clinical trial registration	Institutional Ethics Sub-committee at Chongqing Hospital ,Jiangsu Province Hospital (approval number: 2025043).
Study protocol	Standardized tests were administered to evaluate cognitive and motor functions across all participants.
Data collection	All data were collected from Chongqing Hospital ,Jiangsu Province Hospital
Outcomes	N/A

Plants

Seed stocks	N/A
Novel plant genotypes	N/A
Authentication	N/A