

## 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 COMSOL Multiphysics 6.0, GOM Correlate Pro, ZEISS ZEN Core, CLARIUS V1.9, TestXpert II.

Data analysis OriginPro 2018, Microsoft Office 365.

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](#)

The authors declare that all data supporting the findings of this study are available within the paper and its Supplementary Information files or available from the corresponding authors upon request. Source data are provided as a Source Data file.

## 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

Use the terms *sex* (biological attribute) and *gender* (shaped by social and cultural circumstances) carefully in order to avoid confusing both terms. Indicate if findings apply to only one sex or gender; describe whether sex and gender were considered in study design; whether sex and/or gender was determined based on self-reporting or assigned and methods used. Provide in the source data disaggregated sex and gender data, where this information has been collected, and if consent has been obtained for sharing of individual-level data; provide overall numbers in this Reporting Summary. Please state if this information has not been collected. Report sex- and gender-based analyses where performed, justify reasons for lack of sex- and gender-based analysis.

### Reporting on race, ethnicity, or other socially relevant groupings

Please specify the socially constructed or socially relevant categorization variable(s) used in your manuscript and explain why they were used. Please note that such variables should not be used as proxies for other socially constructed/relevant variables (for example, race or ethnicity should not be used as a proxy for socioeconomic status). Provide clear definitions of the relevant terms used, how they were provided (by the participants/respondents, the researchers, or third parties), and the method(s) used to classify people into the different categories (e.g. self-report, census or administrative data, social media data, etc.) Please provide details about how you controlled for confounding variables in your analyses.

### Population characteristics

Describe the covariate-relevant population characteristics of the human research participants (e.g. age, genotypic information, past and current diagnosis and treatment categories). If you filled out the behavioural & social sciences study design questions and have nothing to add here, write "See above."

### Recruitment

Describe how participants were recruited. Outline any potential self-selection bias or other biases that may be present and how these are likely to impact results.

### Ethics oversight

Identify the organization(s) that approved the study protocol.

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](https://www.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 predetermined from pilot experiments and/or experiments that have been done in the past, to obtain statistically significant data.

### Data exclusions

No data were excluded from the analyses.

### Replication

Experimental results were successfully reproduced. All of the studies are repeated at two times.

### Randomization

Samples were randomly allocated into experimental groups.

### Blinding

Since the animal experiment was performed on only one substance, the preparation of the sample (Y. Li) and the animal experimenter (S. Kang) were divided, and information on the substance was not provided to the animal experimenter (S. Kang), it was determined that additional blind test was not unnecessary.

## 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 &amp; experimental systems

n/a	Involved in the study
<input type="checkbox"/>	<input checked="" type="checkbox"/> Antibodies
<input checked="" type="checkbox"/>	<input type="checkbox"/> Eukaryotic cell lines
<input checked="" type="checkbox"/>	<input type="checkbox"/> Palaeontology and archaeology
<input type="checkbox"/>	<input checked="" type="checkbox"/> Animals and other organisms
<input checked="" type="checkbox"/>	<input type="checkbox"/> Clinical data
<input checked="" type="checkbox"/>	<input type="checkbox"/> Dual use research of concern
<input checked="" type="checkbox"/>	<input type="checkbox"/> Plants

## Methods

n/a	Involved in the study
<input checked="" type="checkbox"/>	<input type="checkbox"/> ChIP-seq
<input checked="" type="checkbox"/>	<input type="checkbox"/> Flow cytometry
<input checked="" type="checkbox"/>	<input type="checkbox"/> MRI-based neuroimaging

## Antibodies

## Antibodies used

Antibodies used in this work include Donkey anti-Rat IgG (H+L) Alexa Fluor™ 594 Secondary Antibody, Goat anti-Rabbit IgG Alexa Fluor™ 647 Secondary Antibody (Invitrogen).  
For the fluorescence staining, smooth muscle actin Polyclonal antibody (Proteintech, Cat# 14395-1-AP, Lot# 00081698, clone: polyclonal, dilution: 1:800), CD68 Monoclonal Antibody (Invitrogen, Cat# 14-0681-82, Lot# 2472523, clone: FA-11, dilution: 1:100), Donkey anti-Rabbit IgG (H+L) Highly cross-adsorbed Secondary Antibody, Alexa Fluor™ 594 (Invitrogen, Cat# A-21207, Lot# 2145022, clone: polyclonal, dilution: 1:500), Goat anti-Rat IgM (Heavy chain) Secondary Antibody Alexa Fluor™ 647 (Invitrogen, Cat# A21248, Lot# 1964390, clone: polyclonal, dilution: 1:500)

## Validation

The immunofluorescence performance of smooth muscle actin Polyclonal antibody (Proteintech, Cat# 14395-1-AP, Lot# 00081698, clone: polyclonal, dilution: 1:800) is validated using mouse heart or C2C12 cell line, mouse myoblast cell line. The immunofluorescence performance of CD68 Monoclonal Antibody (Invitrogen, Cat# 14-0681-82, Lot# 2472523, clone: FA-11, dilution: 1:100) is validated using mouse spleen.

## 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

Male C57BL/6 (age 8 weeks) were purchased from Charles River Laboratory. 4~5 mice were housed in a cage, and a sizzle-nest was added in a cage for animal welfare. After the mice were delivered to the animal research center of the university of Chicago, a stabilization period of 7 days was set at 12/12 dark/light cycle (6 am to 6 pm light and 6 pm to 6 am dark), 18~23 degrees Celsius, and 40~60% humidity. The mice's condition was checked by the experimenter twice a day (9 am and 5 pm).

## Wild animals

This study did not involve wild animals.

## Reporting on sex

Male mice were used in this study.

## Field-collected samples

This study did not involve samples collected from the field.

## Ethics oversight

All protocols used in this study were approved by the Institutional Animal Care and Use Committee of the University of Chicago. (Protocol number, 72450 and 72378)

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