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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	EEG data were recorded using a 21-channel amplifier (Stellate System Inc., CA, USA) according to the standard 10-20 system.
Data analysis	Data analysis was performed using custom scripts in MATLAB 2022b (MathWorks, MA, USA) and EEGLAB toolbox (https://eeglab.org). The available data and code can be found at the Open Science Framework (https://osf.io/mqzga).

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

All data and code used in this study are available at the Open Science Framework (https://osf.io/mqzga).

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	In this study, a total of 238 children were recruited, comprising 126 children with ADHD and 112 TD children. The final sample included 114 children with ADHD (31 females) and 109 TD children (40 females).The two groups did not differ significantly in sex distribution. No analyses were conducted based on sex. Participant sex was self-reported.
Reporting on race, ethnicity, or other socially relevant groupings	Race, ethnicity, and other socially relevant grouping variables were not collected or analyzed in this study, as they were not part of the predefined research objectives.
Population characteristics	A total of 238 children aged 6–12 years were recruited, including 126 children with ADHD and 112 TD children. After excluding 15 participants due to poor memory performance, the final sample comprised 223 children (114 ADHD and 109 TD children). The mean ages were 8.39 ± 1.32 years for the ADHD group and 8.62 ± 1.37 years for the TD group. ADHD was diagnosed by qualified psychiatrists through semistructured interviews using the K-SADS and DSM-5 diagnostic criteria, and symptom severity was assessed using the SNAP-IV parental rating scale. All participants were right-handed, had normal or corrected-to-normal vision, and had full-scale IQ scores above 80. Participants had no specified neurological or psychiatric comorbidities, history of head trauma, or serious medical conditions. None had received psychostimulant medication before the experiment.
Recruitment	Children with ADHD were recruited from the clinics of local children's hospitals, and healthy controls (TD children) were recruited from local schools. All participants were recruited based on predefined eligibility criteria.
Ethics oversight	This work was approved by the Ethics Committee of the Changzhou Children's Hospital of Nantong University (No.2019-005, approved on January 15, 2019) in accordance with the Declaration of Helsinki (1991). Written informed consent was obtained from the legal guardians before the experiment, and children provided consent or assent appropriate to their age and understanding.

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	In this study, a total of 238 children (6–12 years old) were recruited, comprising 126 children with ADHD and 112 TD children. The final sample included 114 children with ADHD (31 females; 8.39 ± 1.32 years old) and 109 TD children (40 females; 8.62 ± 1.37 years old). No formal a priori sample-size calculation was performed. The sample size was determined based on participant availability, recruitment feasibility, and the application of the study's eligibility and exclusion criteria.
Data exclusions	Fifteen participants were excluded from all analyses because of poor memory performance(Pr ≤ 0). These exclusion criteria were pre-established and applied uniformly across all participants and sessions.
Replication	The experimental procedures and data-processing pipelines were applied consistently across all participants. All participants completed the same experimental paradigm under standardized testing conditions. The analyses were conducted using consistent preprocessing and statistical procedures across the ADHD and TD groups. No independent replication cohort was included in the present study.
Randomization	Participants were not randomly assigned to the ADHD and TD groups because group membership was determined by clinical diagnosis. Children with ADHD were recruited from local children's hospitals, whereas TD children were recruited from local schools.
Blinding	Blinding of participants to group allocation was not implemented because group membership was determined by clinical diagnosis and was relevant to participant recruitment and assessment. EEG data were processed using standardized preprocessing and analysis procedures across both groups to minimize potential analytical bias.

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

Plants

Seed stocks

Report on the source of all seed stocks or other plant material used. If applicable, state the seed stock centre and catalogue number. If plant specimens were collected from the field, describe the collection location, date and sampling procedures.

Novel plant genotypes

Describe the methods by which all novel plant genotypes were produced. This includes those generated by transgenic approaches, gene editing, chemical/radiation-based mutagenesis and hybridization. For transgenic lines, describe the transformation method, the number of independent lines analyzed and the generation upon which experiments were performed. For gene-edited lines, describe the editor used, the endogenous sequence targeted for editing, the targeting guide RNA sequence (if applicable) and how the editor was applied.

Authentication

Describe any authentication procedures for each seed stock used or novel genotype generated. Describe any experiments used to assess the effect of a mutation and, where applicable, how potential secondary effects (e.g. second site T-DNA insertions, mosiacism, off-target gene editing) were examined.